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JP1 Version 13

JP1/Network Node Manager i Setup Guide

3021-3-L32(E)

Notices

■ Relevant program products

For Windows Server 2016, Windows Server 2019, and Windows Server 2022

P-2942-82DL JP1/Network Node Manager i 13-00

P-2942-89DL JP1/Network Node Manager i Developer's Toolkit 13-00

For Linux 7.1 and later, Linux 8.1 and later, Linux 9.1 and later, Oracle Linux 7.1 and later, Oracle Linux 8.1 and later, Oracle Linux 9.1 and later, and SUSE Linux 12

P-8442-82DL JP1/Network Node Manager i 13-00

P-8442-89DL JP1/Network Node Manager i Developer's Toolkit 13-00

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■ Microsoft product name abbreviations

This manual uses the following abbreviations for Microsoft product names.

Abbreviation	Full name or meaning
Active Directory	Microsoft(R) Active Directory
Excel	Microsoft(R) Office Excel

Abbreviation		Full name or meaning
Microsoft Cluster Service		Microsoft(R) Cluster Service
Windows	Windows Server 2016	Microsoft(R) Windows Server(R) 2016 Datacenter
		Microsoft(R) Windows Server(R) 2016 Standard
	Windows Server 2019	Microsoft(R) Windows Server(R) 2019 Datacenter
		Microsoft(R) Windows Server(R) 2019 Standard
	Windows Server 2022	Microsoft(R) Windows Server(R) 2022 Datacenter
		Microsoft(R) Windows Server(R) 2022 Standard
WSFC		Microsoft(R) Windows Server(R) Failover Cluster

■ Acknowledgements

This product includes software developed by the Apache Software Foundation.
(http://www.apache.org)
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(http://www.extreme.indiana.edu)
This product includes software developed by The Legion Of The Bouncy Castle.
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■ Copyright

Summary of amendments

The following table lists changes in this manual (3021-3-L32(E)) and product changes related to this manual.

Changes	Location
The library files, commands, and packages required to install NNMi on a Linux server were changed.	1.2, 1.5.4
The following supported operating systems were added. • Linux 9.1 • Oracle Linux 9.1 The following supported operating systems were removed. • Windows Server 2012 • CentOS • Linux 6.1 • Oracle Linux 6.1	1.2, 1.5.4, 2.1.1, 11.2.1, 19.2, 19.4.4(1)(c), 19.4.4(2)(b), 19.7.2, 19.7.3, 19.8.3(1)
Following the end of support for the Internet Explorer web browser, the relevant descriptions were changed or deleted.	1.5.3, 11.2, 11.3.1, 11.3.2, 11.3.3
The default values of the HTTP port and HTTPS port used by NNMi were changed.	2.1.1, 2.1.2, 15.4.2(1), Appendix E
Descriptions related to distribution without using systemd were deleted.	2.1.3(3), 19.4.4(1)(b), 19.4.4(2)(b), 19.6.2(2)(b), 19.7.2, 19.7.3, 19.8.4(7), 21.8.2, 21.16.2
The folder to which configuration files are to be copied during the installation of NNMi was changed.	4.9
Authentication protocols that are supported by NNMi for SNMPv3 communication were added.	5.1.3, 5.2.6(2)
The procedure for adding a background image to a node group map was changed.	9.1.2(5)
Descriptions related to the Subject Alternative Name (SAN) were added.	10.3, 10.3.1, 10.3.2
Descriptions related to Windows operating systems on which a telnet client runs were changed.	11.2, 11.2.1
Notes about using related products for HA configurations were added.	19.3.1
Notes about the messages that are output when the FQDN settings of NNMi nodes are changed were changed.	19.7.2, 19.7.3
Descriptions of how to configure settings to suppress health incidents when NNMi performs self-monitoring were added.	21.23.2
Notes about changing the host name or domain name of the NNMi management server were added.	22.5
The description *Upgrading from NNMi Version 9, 10, 11, or 12* was changed to a description of upgrading to version 13-00.	24.
Following support for JP1/IM3, the relevant descriptions were added or changed.	26.
The path names of environment variables (`%jdkdir%` and `$jdkdir`) were changed.	Appendix C.1
Descriptions related to using certificates with the JKS repository were deleted.	--
Descriptions related to migrating NNMi from an HP-UX or Solaris operating system were deleted.	--
Descriptions related to JP1/Cm2/Network Node Manager (NNM) version 8 or earlier were deleted.	--

In addition to the above changes, minor editorial corrections were made.

Preface

This manual describes the settings needed to deploy *JP1/Network Node Manager i* and *JP1/Network Node Manager i Advanced* (referred to hereafter as *NNMi* if there is no difference in the products).

Note also that this manual is intended for all supported operating systems. When there are differences between the NNMi editions on different operating systems, this manual provides separate descriptions for the relevant operating systems.

■ Intended readers

This manual is intended for users who evaluate and implement a network distributed management system configuration that uses NNMi. This manual assumes that the readers are experienced system administrators, network engineers, and others who are familiar with deploying and managing networks for large-scale systems.

■ Organization of this manual

This manual is organized into the following parts:

PART 1: Preparation

Part 1 explains the preparations required before NNMi is installed, as well as the procedures for installation and uninstallation of NNMi.

PART 2: Introduction

Part 2 explains the minimum settings required for starting network management when NNMi is used.

PART 3: Configuration

Part 3 explains the settings needed for managing a network.

PART 4: Advanced Configuration

Part 4 explains the settings needed to use NNMi functions, such as certification, integration of directory services through NNMi and LDAP, and so on.

PART 5: High Availability Environment Configuration

Part 5 describes support for high availability (HA) clusters and application failover.

PART 6: NNMi Maintenance

Part 6 explains how to back up, restore, and maintain NNMi.

PART 7: Migration

Part 7 explains the operations needed to upgrade NNMi to version 13.

PART 8: Integration with NNMi

Part 8 explains integration of related products with NNMi.

PART 9: Integration

Part 9 explains linkage of NNMi with related products.

■ Correspondence between previous and current edition manuals

The manual listed below have been incorporated into this manual, *JP1/Network Node Manager i Setup Guide* (3021-3-L32(E)), which has been updated with the enhancements of version 13:

- *Job Management Partner 1/Consolidated Management 2/Network Node Manager i Installation Guide* (3021-3-342-20 (E))

The table below shows the correspondence between the previous and current edition setup guides.

Correspondence between the previous and current edition setup guides

Previous Edition Setup Guide (3021-3-343-20(E))	Current Edition Setup Guide (3021-3-E02(E))
PART 1: Preparation	*PART 1: Preparation*
1 Hardware and Software Requirements	--
1.1 Supported hardware and software	(Corresponds to *1.1 Checking the hardware and software*)
1.2 System configuration (UNIX)	(This section was moved to *Appendix A. When NNMi Manpages Cannot Be Displayed (Linux)*.)
(*2. Preinstallation Checklists* was inserted from the *Installation Guide* into the current edition Setup Guide)	*1. Preinstallation Checklists*
	1.1 Checking the hardware and software
	1.2 Preparing the preinstallation NNMi management server environment
	1.3 Checking for a well-configured DNS
	1.4 Preparing to use the NNMi Quick Start Configuration Wizard
(*A. Additional Information About Installation* was inserted from the *Installation Guide* into the current edition Setup Guide)	*1.5 Additional information about installation*
(*3. Installing and Uninstalling NNMi* was inserted from the *Installation Guide* into the current edition Setup Guide)	*2 Installing and Uninstalling NNMi*
	2.1 Installing NNMi
	2.2 Using the Quick Start Configuration Wizard
	2.3 Licensing NNMi
	2.4 Removing NNMi
(*B. Troubleshooting Installation and Initial Startup* was inserted from the *Installation Guide* into the current edition Setup Guide)	*2.5 Troubleshooting installation and initial startup*
(*4. Getting Started with NNMi* was inserted from the *Installation Guide* into the current edition Setup Guide)	*Part 2: Introduction*
	3. Getting Started with NNMi
	3.1 Accessing NNMi
	3.2 Accessing NNMi Help
	3.3 Configuring network discovery
PART 2: Configuration	*PART 3: Configuration*
2. General Concepts for Configuration	*4. General Concepts for Configuration*
3. NNMi Communication	*5. NNMi Communications*
4. NNMi Discovery	*6. NNMi Discovery*
5. NNMi State Polling	*7. NNMi State Polling*
6. NNMi Incidents	*8. NNMi Incidents*

Previous Edition Setup Guide (3021-3-343-20(E))	Current Edition Setup Guide (3021-3-E02(E))
7. NNMi Console	*9. NNMi Console*
PART 3: Advanced Configuration	*PART 4: Advanced Configuration*
8. Working with Certificates for NNMi	*10. Working with Certificates for NNMi*
9. Configuring the Telnet and SSH Protocols for Use by NNMi	*11. Configuring the Telnet and SSH Protocols for Use by NNMi*
10. Integrating NNMi with a Directory Service Through LDAP	*12. Integrating NNMi with a Directory Service Through LDAP*
11. Managing Overlapping IP Addresses in a NAT Environment	*13. Managing Overlapping IP Addresses in a NAT Environment*
12. NNMi Security and Multi-Tenancy	*14. NNMi Security and Multi-Tenancy*
13. Global Network Management	*15. Global Network Management*
14. NNMi IPv6 Management Feature	*16. NNMi IPv6 Management Feature*
PART 4: High Availability Environment Configuration	*PART 5: High Availability Environment Configuration*
15. NNMi Data Resilience	*17. NNMi Data Resilience*
16. Configuring NNMi for Application Failover	*18. Configuring NNMi for Application Failover*
17. Configuring NNMi in a High Availability Cluster	*19. Configuring NNMi in a High Availability Cluster*
PART 5: NNMi Maintenance	*PART 6: NNMi Maintenance*
18. NNMi Backup and Restore Tools	*20. NNMi Backup and Restore Tools*
19. Maintaining NNMi	*21. Maintaining NNMi*
20. Changing the NNMi Management Server	*22. Changing the NNMi Management Server*
21. NNMi Security	*23. NNMi Security*
PART 6: Migration	*PART 7: Migration*
22. Upgrading from NNMi Version 9, 10-00, or 10-10	*24. Upgrading from NNMi Version 9, 10, 11, or 12*
23. Comparison with NNM Version 8 or Earlier	--
24. Upgrading from NNM Version 8 or Earlier	--
PART 7: Integration with NNMi	*PART 8: Integration with NNMi*
25. NNMi Northbound Interface	*25. NNMi Northbound Interface*
--	*PART 9: Integration*
--	*26. Integration with JP1/IM2 Intelligent Integrated Management Base*
--	*27. RESTful API*
Appendixes	Appendixes
(This appendix was moved from *1.2 System configuration (UNIX)*.)	*A. When NNMi Manpages Cannot Be Displayed (Linux)*
(*C. List of MIBs Read During a New Installation* was inserted from the *Installation Guide* into the current edition Setup Guide)	*B. List of MIBs Read During a New Installation*
A. NNMi Environment Variables	*C. NNMi Environment Variables*
B. The Causal Engine and NNMi Incidents	*D. The Causal Engine and NNMi Incidents*

Previous Edition Setup Guide (3021-3-343-20(E))	Current Edition Setup Guide (3021-3-E02(E))
C. List of Ports Used by NNMi	*E. List of Ports Used by NNMi*
D. Version Changes	*F. Version Changes*
E. Reference Material for This Manual	*G. Reference Material for This Manual*
F. Glossary	*H. Glossary*

■ Conventions: Fonts and symbols

The following table explains the text formatting conventions used in this manual:

Text formatting	Convention
Bold	Bold characters indicate text in a window, other than the window title. Such text includes menus, menu options, buttons, radio box options, or explanatory labels. For example: • From the **File** menu, choose **Open**. • Click the **Cancel** button. • In the **Enter name** entry box, type your name.
Italic	Italic characters indicate a placeholder for some actual text to be provided by the user or system. For example: • Write the command as follows: `copy` *source-file target-file* • The following message appears: `A file was not found. (file =` *file-name*`)` Italic characters are also used for emphasis. For example: • Do *not* delete the configuration file.
`Monospace`	Monospace characters indicate text that the user enters without change, or text (such as messages) output by the system. For example: • At the prompt, enter `dir`. • Use the `send` command to send mail. • The following message is displayed: `The password is incorrect.`

The following table explains the symbols used in this manual:

Symbol	Convention
`|`	In syntax explanations, a vertical bar separates multiple items, and has the meaning of OR. For example: `A|B|C` means `A`, or `B`, or `C`.
`{ }`	In syntax explanations, curly brackets indicate that only one of the enclosed items is to be selected. For example: `{A|B|C}` means only one of `A`, or `B`, or `C`.
`[ ]`	In syntax explanations, square brackets indicate that the enclosed item or items are optional. For example: `[A]` means that you can specify `A` or nothing. `[B|C]` means that you can specify `B`, or `C`, or nothing.
`. . .`	In coding, an ellipsis (`. . .`) indicates that one or more lines of coding have been omitted.

Symbol	Convention
. . .	In syntax explanations, an ellipsis indicates that the immediately preceding item can be repeated as many times as necessary. For example: `A, B, B, . . .` means that, after you specify `A, B,` you can specify `B` as many times as necessary.

Contents

Part 2: Introduction

Part 3: Configuration

Part 7: Migration

Part 8: Integration with NNMi

Part 9: Integration

1 Preinstallation Checklists

This chapter describes how to perform the preparations and checks required before you install NNMi.

1.1 Checking the hardware and software

Before installing NNMi, read the information about supported NNMi hardware and software in the NNMi *Release Notes*.

1.2 Preparing the preinstallation NNMi management server environment

An NNMi management server is a server on which the NNMi software is installed. Each NNMi management server must be a dedicated 64-bit machine. To learn more about hardware prerequisites, see 1.1 Checking the hardware and software.

Before you install NNMi on the NNMi management server, complete the checklist in Table 1-1.

Important

Configure the remote desktop as described below before installing and configuring NNMi. This configuration increases the resources that Windows uses, so we recommend that you return to the original configuration after you complete these tasks, if necessary.

- Configuration path

  Local Group Policy Editor# > **Computer Configuration** > **Administrative Templates** > **Windows Components** > **Remote Desktop Services** > **Remote Desktop Session Host** > **Temporary folders**

  #: To open **Local Group Policy Editor**, enter `gpedit.msc` in the **Start** window.

- Configuration settings

  Enable **Do not use temporary folders per session** and **Do not delete temp folder upon exit**. To apply these settings to the system, log off and then log on again.

Table 1-1: NNMi management server preinstallation checklist

Completed? (y/n)	NNMi management server preparation
	If you fail installing NNMi and install it again to the same environment, please refer to the manual deletion procedure in the appendix of the release note before installation.
	Make sure that the host name of the server where you plan to install NNMi is RFC-compliant. Host names are allowed to use alphanumerics (`A` to `Z`, `a` to `z`, `0` to `9`), hyphens (`-`), and periods (`.`) (to demarcate domain names). Setup of host names that are not RFC-compliant (host names that use underscores (_), for example) might result in failure of the NNMi console connection or command execution.
	Make sure that the name of the local host can be resolved on the server on which NNMi is installed and that `localhost` is set up with the name resolved to `127.0.0.1`.
	Windows Make sure that the `C` drive is used as the OS's system drive. NNMi cannot be installed in an environment where the system drive is not drive `C`.
	Windows If you have restrictive security settings in place, you might need to adjust the permission on the drive or drives on which you want to place the NNMi install and data directories. For details, see 1.5.1 Specifying disk drive security settings (Windows).
	Windows Check for the SNMP service; if installed, the SNMP trap service needs to be disabled on this server.
	Install and enable a supported Web browser. For details, see 1.1 Checking the hardware and software and 1.5.3 Enabling the Web browser for the NNMi console.
	Dynamic Host Configuration Protocol (DHCP) users: Makes sure that the NNMi management server is consistently assigned the same IP address.

Completed? (y/n)	NNMi management server preparation
	Disable anti-virus software until NNMi installation is complete. When NNMi installation is complete, restart the anti-virus software.
	Linux Before you can install NNMi on a Linux server, the packages listed below that are required by NNMi must be installed. Also, install the library files that have dependence relationships with these packages: • `libaio` (x86_64) • `libXtst` (x86_64) • `libXi` (x86_64) • `net-tools` (x86_64) • `unzip` (x86_64) • `fontconfig` (x86_64) • `liberation-sans-fonts` (noarch)# #: This package isn't necessary if the `fc-list` command shows one or more fonts. For RHEL 8.1 or later, or Oracle Linux 8.1 or later, additionally install the following. • `libnsl` (x86_64) For details, see 1.5.4 Installing required libraries in Linux.
	The database used by NNMi is PostgreSQL. If you install NNMi on a server on which PostgreSQL is already installed, make sure that there are no conflicts in the port settings. The port for PostgreSQL that NNMi uses is `5432/TCP`. Therefore, change the port used by any existing PostgreSQL to a value other than `5432/TCP` before you install NNMi. After installation, you can change the PostgreSQL port to be used by NNMi, if necessary.
	Do not install NNMi until you have verified that all ports used by NNMi are available. For a list of the ports used by NNMi and the direction in which data passes through a firewall, see E. List of Ports Used by NNMi.
	Do not block communication with the IP address of the local host, such as by using a firewall.
	Windows NNMi is installed in the language specified in the language settings in **Format** in **Control Panel**. NNMi cannot be used in any language other than the one specified in **Format**. If you want to change the language which is selected during OS installation, only changing from **English** to other languages is supported. Before you install NNMi, specify the following settings: 1. In the **Formats** tab of the **Region and Language** control panel, specify **Japanese**, **English**, or **Chinese** in **Format**, and make sure that the language set under **Display language** (in the **Keyboards and Languages** tab) matches the one set here. In an overwrite installation, the language setting specified here must match the setting for NNMi prior to the overwrite installation. 2. In the **Administrative** tab, click **Copy settings**, and then click **OK** to copy the settings to the system account. 3. In the **Administrative** tab, specify the language under **Language for non-Unicode programs**. Specify the language that was specified in **Format** in step 1. **Linux** For the NNMi management server's locale, specify one of the following: `ja_JP.utf8`, `ja_JP.UTF-8`, `C`, `en_US.utf8`, `en_US.UTF-8`, or `zh_CN.utf8`
	Configuration information from earlier versions of NNM remains, even if NNM is removed. See the *Release Notes* for the earlier version of NNM to identify the older information, and then delete that information prior to installing NNMi.
	Windows Before installing NNMi, make sure that the Windows Services window (the window started from **Control Panel** > **Administrative Tools** > **Services**) is not running. If it is, close it.
	Windows If the sum of the character string set in the system environment variable `Path` and the lengths of the directory paths below is 950 bytes or more, the directory paths below might fail to be added to the system environment variable `Path` even if NNMi is successfully installed.

Completed? (y/n)	NNMi management server preparation

	`%NnmInstallDir%bin\;`
	`%NnmDataDir%shared\nnm\actions\;`
	If the directory paths above are not added to the system environment variable `Path` after installation is complete, add the directory paths manually to the system environment variable `Path`.
	For details about the environment variables, see C.1 Environment variables used in this manual.

	Windows If you are installing NNMi using a path other than the default, you can use alphanumerics (`A` to `Z`, `a` to `z`, `0` to `9`), hyphens (`-`), periods (`.`), underscores (_), and single-byte spaces for the names of the install and data directories. Note that multiple consecutive single-byte spaces cannot be used. The maximum length of the absolute paths for these directories is 60 characters.
	Windows Do not specify paths that include junction points, such as *drive*`:\Documents and Settings`. Doing so might cause problems, such as temporary files not being deleted.
	Windows If you install NNMi in an environment in which environment variables `%TEMP%` and `%TMP%` have different values, installation might fail. Make sure that the values of `%TEMP%` and `%TMP%` are the same before installation. If they differ, set `%TEMP%` and `%TMP%` to the same values.
	Windows Do not set the following variables as environment variables: • `LANG` • Anything that begins with `LC` If another product sets these environment variables, it might not be compatible with NNMi. Installation might fail if NNMi is installed with these variables set.
	Windows If a Remote Desktop session host has been installed in Remote Desktop Services, the following setting is required before you install NNMi: • Execute`changeuser/install` to change to install mode. For details about this setting, see Help for the Remote Desktop session host.
	Windows If changes you have made to the system on which you plan to install NNMi require restarting the OS, do so prior to installing NNMi. For example, the OS must be restarted if the registry value below exists. If this value exists, NNMi might suspend the installation: `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\PendingFileRenameOperations` This registry value normally disappears when the OS is restarted.
	Windows NNMi uses a `%TEMP%` directory of up to 500 MB when it is installed or removed. The install or removal might fail without sufficient disk space. **Linux** NNMi uses a `/tmp` directory of up to 1 GB when it is installed or removed. The install or removal might fail without sufficient disk space.
	Windows During installation, under **Local Group Policy Editor** > **Computer Configuration** > **Administrative Templates** > **Windows Components** > **Remote Desktop Services** > **Remote Desktop Session Host** > **Temporary folders**, enable **Do not use temporary folders per session** and **Do not delete temp folder upon exit**. To apply these settings to the system, log off and then log on again.

Completed? (y/n)	NNMi management server preparation
	Windows Set Application Experience service to "Manual" if it is "Disabled".If Application Experience service is set as "Disabled", NNMi installation will fail.
	Linux If you are re-installing NNMi, also re-install all applications that require NNMi and configure them accordingly.
	Linux Install applications that require NNMi after the configuration of the environment that follows NNMi installation has been completed. Remember to execute the `ovstop` command before you install applications.
	Linux During NNMi installation, do not change the size of the terminal window in which Hitachi PP Installer is running. Doing so might prevent NNMi from installing properly.

	Linux
	NNMi requires a UDP reception buffer of 8 MB and a UDP transmission buffer of 2 MB.
	To change the settings for memory spaces allocated to buffers, edit the `/etc/sysctl.conf` file to add the following entries:
	`# NNM settings for UDP receive and send buffer sizes`
	`net.core.rmem_max = 8388608`
	`net.core.wmem_max = 2097152`
	After editing the `/etc/sysctl.conf` file, apply the changes by restarting the OS or executing the `/sbin/sysctl -p` command.

	Linux
	The value of `kernel.shmmax` or `kernel.shmall` might be too small. If they are, edit the `/etc/sysctl.conf` file to add the following entries. We recommend a value of 64 GB.
	`# NNM settings for embedded database`
	`kernel.shmmax = 68719476736`
	`kernel.shmall = 68719476736`
	If you set the value of `kernel.shmmax` or `kernel.shmall` after editing the `/etc/sysctl.conf` file, apply the changes by restarting the OS or executing the `/sbin/sysctl -p` command.

	Linux The NNMi installation script automatically creates two groups (`nmsgrp` and `nmsdb`), two users (`nmsproc` and `nmsdbmgr`), and the corresponding `$HOME` directories. This operation might fail for either of the following reasons: • Users and groups cannot be created because `useradd` or `groupadd` was disabled by the IT department. • The root user cannot create a `$HOME` directory because the `$HOME` directory exists on NFS. Installation stops whenever the NNMi installer is unable to create these groups, users, or directories. In such a case, you can create the users manually and start the installation. 1. Create the `nmsproc` user in the `nmsgrp` group. Set the `$HOME` directory to any directory that exists. 2. Create the `nmsdbmgr` user in the `nmsdb` group. Set the `$HOME` directory to any directory that exists. If you know that these operations will fail but you need to control user IDs, group IDs, or the locations of `$HOME`, you can first create the groups, users, and `$HOME` directories, and then start the installer. When the `useradd` command is used to create a user, the default home directory will be `/home/`*user-name*.

1.3 Checking for a well-configured DNS

NNMi uses Domain Name System (DNS) to determine relationships between host names and IP addresses. This can result in a large number of name service queries when auto-discovery is enabled.

Make sure that your DNS servers are well configured to prevent long delays when resolving name service queries. This means that the DNS server responding to NNMi name service queries has these characteristics:

- The DNS server is an authoritative server and does not forward DNS requests.
- The DNS server has consistent host name-to-IP address mappings and IP address-to-host name mappings.

If the network uses multiple DNS servers, all of them must respond consistently to all name service queries.

Important

Round-robin DNS (used to do load balancing of Web application servers) is not appropriate because any given host name can map to different IP addresses over time.

Note

To improve the response time for `nslookup`, deploy a secondary DNS service on the NNMi management server or another system on the same subnet as the NNMi management server. Configure this secondary DNS service to mirror the information from the primary DNS service. Another option is to use the following files instead of DNS in small environments:

- Windows
  `%SystemRoot%\system32\drivers\etc\hosts`
- Linux
  `/etc/hosts`

On the NNMi management server, make sure that the following are configured appropriately for your environment:

- The `hosts` file might take precedence with some OS configurations. Make sure that the `hosts` file contains a minimum of two entries:
  `127.0.0.1 localhost`
  NNMi-management-server-IP-address NNMi-management-server-name
  NNMi-management-server-IP-address is the IP address of the fully qualified domain name (FQDN) of the NNMi management server. *NNMi-management-server-name* is the FQDN name for the NNMi management server set during installation.
- Windows
  Make sure that all DNS servers used by the NNMi management server provide consistent host name-to-IP address mappings and IP address-to-host name mappings.
- Linux
  Make sure that `nslookup` discovery conforms to the `nslookup` command discovery sequence set in the `nsswitch.conf` file.
  Make sure that all DNS servers that you are aware of provide consistent host name-to-IP address mappings and IP address-to-host name mappings.

If you know that there are problems with the DNS configuration in your network domain (host names or addresses that do not resolve properly), instruct NNMi to avoid `nslookup` requests for unimportant devices. The benefits of doing this are as follows:

- Speed up spiral discovery
- Keep network traffic generated by NNMi to a minimum.

To identify problem devices to NNMi, create the two files listed below before configuring NNMi discovery. NNMi never issues a DNS request for host names or IP addresses identified in these files.

- `hostnolookup.conf` (enter fully qualified domain names or wildcards that identify groups of host names)
- `ipnolookup.conf` (enter IP addresses or wildcards that identify groups of IP addresses)

Use a text editor to populate the files. Place the files in the following locations on the NNMi management server:

Windows

```
%NnmDataDir%shared\nnm\conf\
```

`%NnmDataDir%` is the data directory specified during installation.

Linux

```
/var/opt/OV/shared/nnm/conf/
```

1.4 Preparing to use the NNMi Quick Start Configuration Wizard

You can run the Quick Start Configuration Wizard immediately after installation to configure NNMi in a limited (or test) environment. If you plan to use this wizard, complete the checklist in Table 1-2.

Table 1-2: NNMi Quick Start Configuration Wizard preinstallation checklist

Completed? (y/n)	Preparation for initial environment configuration
	Determine a limited IP address range for auto-discovery#. For details about the number of licenses (number of management nodes), see 2.3 Licensing NNMi.
	Determine IP addresses for discovery seeds. For details about seeds, see *About discovery seeds and auto-discovery rules* in 2.2 Using the Quick Start Configuration Wizard.
	Obtain the read-only SNMP community strings for the nodes within the discovery range from your network administrator.
	Determine a user name and password for an NNMi administrator account.

#

If use of network address translation (NAT) means that you will be managing areas in the network that contain duplicated IP addresses, select one address domain (an unduplicated address) that is to be detected by the Quick Start Wizard. Then, see *Overlapping Addresses in NAT Environments* in NNMi Help or 13. Managing Overlapping IP Addresses in a NAT Environment.

1.5 Additional information about installation

This section provides additional information about installing NNMi.

1.5.1 Specifying disk drive security settings (Windows)

To set disk drive security before installing NNMi, complete the following steps:

1. Open **Computer** to view your disk drives.
2. For the drive you plan to use for the NNMi installation, choose **Properties** in the right-click menu, and then click the **Security** tab.
3. Log on as a user with administrator privileges, making sure that **Full control** is allowed (either directly or derived through group membership).
4. On the **Security** tab, click **Advanced** to open **Advanced Security Settings**, and make sure the **Applies To** field for Administrators is set to **This folder, subfolders, and files**. If this is not the case, change the setting.
5. Make sure that **Full control** is allowed for the built-in **Local Service** user (either directly or derived through the local users group). If this is not the case, change the setting.
6. On the **Security** tab, click **Advanced** to open **Advanced Security Settings**, and make sure the **Applies To** field for the built-in **Local Service** user is set to **This folder, subfolders, and files**. If this is not the case, change the setting.
7. Apply your changes.
8. Proceed with the NNMi installation.

1.5.2 Obtaining or setting the official fully qualified domain name

NNMi users access NNMi by using the official fully qualified domain name (FQDN).

1. To determine the official FQDN of the NNMi management server, use one of the following methods:
   - Use the `nnmofficialfqdn.ovpl` command to display the value of the FQDN setting. For details, see the *nnmofficialfqdn.ovpl Reference Page*.
   - In the NNMi console, click **Help** > **System Information**. From the **Server** tab, find the value for the fully qualified domain name.
2. If you need to change the FQDN that was set during installation, use the `nnmsetofficialfqdn.ovpl` command.
   For details, see the *nnmofficialfqdn.ovpl Reference Page*.

1.5.3 Enabling the Web browser for the NNMi console

Before you sign on to NNMi, make sure that the Web browser is configured to interact with the NNMi console. The following items must be enabled in the Web browser on each client machine that will access the NNMi management server:

- JavaScript
- Pop-up windows from the NNMi management server

- Cookies from the NNMi management server
- ActiveX
- Automatic page loading

Below are Web browser configuration examples.

Important

To complete the procedures below, you need to know the fully qualified domain name of the NNMi management server.

If your NNMi management server has more than one domain name, NNMi chooses one during the installation process. To determine which fully qualified domain name NNMi is using, run the `nnmofficialfqdn.ovpl` script. See the *nnmofficialfqdn.ovpl Reference Page* for more information.

(1) Mozilla Firefox

JavaScript is enabled by default in Mozilla Firefox. Privacy extensions are required to disable JavaScript. If an error is displayed in NNMi indicating that JavaScript is disabled, check the **Extensions** options in **Add-ons Manager** in Firefox to determine whether the privacy extensions are being used.

1. Enable pop-up windows by the following procedure:
   a. In Mozilla Firefox, click **Tools**, and then choose **Options**.
   b. Click **Content**.
   c. Select the **Block pop-up windows** check box.
   d. Click **Exceptions** located next to the **Block pop-up windows** check box.
   e. Add the fully qualified domain name of the NNMi management server to the list of allowed sites, and then click **Allow**.
   f. Click **Close**.
2. Enable cookies by the following procedure:
   a. In Mozilla Firefox, click **Tools**, and then choose **Options**.
   b. Click **Privacy**.
   c. Move to **History**, and then select **Remember history**.
3. Restart the Web browser.

1.5.4 Installing required libraries in Linux

Before you can install NNMi on a Linux server, the packages listed below that are required by NNMi must be installed. Also, install the library files that have dependence relationships with these packages:

- `libaio` (x86_64)
- `libXtst` (x86_64)
- `libXi` (x86_64)
- `net-tools` (x86_64)
- `unzip` (x86_64)

- `fontconfig` (x86_64)
- `liberation-sans-fonts` (noarch)#

  #: This package isn't necessary if the `fc-list` command shows one or more fonts.

For RHEL 8.1 or later, or Oracle Linux 8.1 or later, additionally install the following.

- `libnsl` (x86_64)

For details, see the NNMi *Release Notes* and the operating system documentation.

1.5.5 Setting the system account password

The system account password is set during the installation. If you skipped the configuration during installation, or if you want to change the password, you can change it using the `nnmchangesyspw.ovpl` script. Follow these steps:

1. Use the `ovstop -c` command to stop the NNMi processes.
2. As an administrator, run the `nnmchangesyspw.ovpl` script to set the system password.
3. Use the `ovstart -c` command to start the NNMi processes.

For details, see the *nnmchangesyspw.ovpl Reference Page*.

2 Installing and Uninstalling NNMi

This chapter guides you through the process of installing and uninstalling NNMi. It also explains how to specify settings and how to obtain licenses after installation. Because the Release Notes also contain information about installation, please refer to the Release Notes as you read this chapter.

2.1 Installing NNMi

Windows

Before installing NNMi, complete the requirements listed in the preinstallation checklist, including disabling anti-virus software. (See 1. Preinstallation Checklists.)

Linux

Before installing NNMi, complete the requirements listed in the preinstallation checklists. (See 1. Preinstallation Checklists.)

See the *Release Notes* for procedures for upgrading NNMi (including how to apply patches).

2.1.1 Installing NNMi (Windows)

To perform a new installation of NNMi in a Windows system, follow these steps:

Important

Configure the remote desktop as follows before you install and configure NNMi. This configuration increases the resources that Windows uses, so you can return to the original configuration after completing these tasks, if necessary.

- Configuration path

  Local Group Policy Editor# > **Computer Configuration** > **Administrative Templates** > **Windows Components** > **Remote Desktop Services** > **Remote Desktop Session Host** > **Temporary folders**

  #: To open **Local Group Policy Editor**, enter `gpedit.msc` in the Start window.

- Configuration settings

  Enable **Do not use temporary folders per session** and **Do not delete temp folder upon exit**. To apply these settings to the system, log off and then log on again.

1. Log on as a user with administrator privileges to the system where you plan to install NNMi.

   If UAC is enabled, a user who is not the built-in `Administrator` must be promoted to administrator.

2. Insert the NNMi installation media into the drive.

   The Hitachi Program Product Installer window opens.

3. Start installation as indicated by the installer.

4. Enter information as indicated by the installer.

   To use a default value, press the **Enter** key without entering any value. The default is the value shown in brackets.

   - Specify the HTTP port number for the NNMi Web server.

     Enter the HTTP port number for the NNMi Web server used to access NNMi. Enter a port number that is not being used by another program. The default value is `20480`.

     An input example follows:

     ```
     ** Network Node Manager i Installer **
     * Starting NNMi installation.
     * Enter default port for HTTP server =>
     * [20480]
     8004 ↵
     ```

- Specify the HTTPS port number for the NNMi Web server.

  Enter the HTTPS port number for the NNMi Web server used to access NNMi. Enter a port number that is not being used by another program. The default value is `20481`.

  An input example follows:

  ```
  * Enter default port for HTTPS server =>
  * [20481]
  8443 ↵
  ```

- Specify the installation directory.

  Enter the directory where you want to install the NNMi program. The default value is as follows:

  drive`:\Program Files (x86)\Hitachi\Cm2NNMi\`

  An input example follows:

  ```
  * Enter program install directory =>
  * [C:\Program Files (x86)\Hitachi\Cm2NNMi\]
  C:\Hitachi\Cm2NNMi\ ↵
  ```

  > **Important**
  >
  > NNMi cannot be installed in the *drive*`:\Program Files\` folder.

- Specify the data directory.

  Enter the directory where you want to store NNMi configuration files and data such as databases and log files. The default value is as follows:

  drive`:\ProgramData\Hitachi\Cm2NNMi\`

  An input example follows:

  ```
  * Enter program data directory =>
  * [C:\ProgramData\Hitachi\Cm2NNMi\]
  D:\NNMiData\ ↵
  ```

- Check the display of entered data and make sure that installation has started.

  The three data entries shown above are displayed. If there are no problems with the data displayed, enter `yes` to start installation. To change the entered data, enter `no`.

  An input example follows:

  ```
  * http port : 20480
  * https port : 20481
  * install directory : C:\Hitachi\Cm2NNMi\
  * data directory : D:\NNMiData\
  * Do you start installation with above settings you entered ? (yes/no)
  * If you need to change the settings, please enter no.
  yes ↵
  ```

- Confirmation of the completion of installation

  If installation finishes normally, "Installation complete successfully." is displayed and the command prompt stops, so press the **Enter** key.

- Confirm whether to perform the preinstallation checks and continue the installation.

  The preinstallation checks will be performed first when installation starts.

> **Note**
>
> In order to verify the items listed in Table 1-1: NNMi management server preinstallation checklist, the preinstallation check will verify that the ports used by NNMi are available.
>
> Do not install NNMi until you have verified that all the ports used by NNMi are available. For a list of the ports used by NNMi and the direction in which data passes through a firewall, see E. List of Ports Used by NNMi.

If no problems are found in this preinstallation check, continue with the installation.

If there is a problem with the preinstallation check, the installer will output the problem and ask whether you want to continue the installation. Enter `yes` to continue the installation or `no` to terminate the installation.

Example of input when there is a problem in the preinstallation check:

```
* Starting NNMi Precheck ...
* TCP Port: [20481] is used.
* UDP Port: [162] is used.
* NNMi Precheck result: NG
* There are some problem(s) with the settings.
* Do you want to continue NNMi installation ? (yes/no)
* If you enter no, the installation will stop.
no ↵
```

> **Important**
>
> Do not use **Ctrl+Z** when entering this data. Entering **Ctrl+Z** suspends the installation. If the installation is suspended, resume the installation procedure from step 3.
>
> Note that the installation takes ten to twenty minutes or more. Do not suspend the installation once it is underway. Interrupting the installation creates undesirable conditions that might render re-installation by normal means impossible.
>
> Even if the precheck result is `OK`, this is not a guarantee that the installation will be successful. You must also make sure all the checklists in 1. Preinstallation Checklists are completed.

- Setting the system account password.

  After a while, you will be prompted to enter the password for the system account. Between 1 and 40 characters can be entered for the password. Alphanumeric characters (A to Z, a to z, 0 to 9), and underscores (_) can be used. To set it after installation, enter `\quit`.

  ```
  * Setup system password for the initial sign-in to the NNMi console.
  * If you want to setup the password later, enter "\quit".
  * Please enter system password:
  * Please enter system password again:
  ```

  > **Note**
  >
  > The system account is a special administrator account created by the installation process. It is used when you sign in to the NNMi console for the first time. It is not normally used after the creation of a user with the administrator role on the NNMi console. The system account remains enabled after the installation finishes, but it is used only to execute on the command line or for restoration

purposes. For details about how to set or change the system password, see 1.5.5 Setting the system account password.

- Check the installation completion.

  After installation complete rightly, a message that "Installation complete successfully." is output. Then press the **Enter** key.

- Check the installation results.

  If the status shown in the last row of the log file `%TEMP%\JP1NNMiInstaller.log` is as follows, where a message stating that the process finished with `[0]` is output, installation was successful. If the status shows a value other than `[0]`, installation might have failed.

  ```
  [Trace] Process finished with [0]
  ```

Execute NNMi commands in a command prompt window that is opened after the installation has finished. Commands will not run correctly if they are executed from a window opened before the installation has finished, because settings required by NNMi commands, such as the NNMi environment variables, will not have been configured yet.

2.1.2 Installing NNMi (Linux)

To perform a new installation of NNMi in a Linux system:

1. Log in as a user with root privileges to the system where you plan to install NNMi.
2. Set a supported locale in the environment variable `LC_ALL`, `LANG`:

   ```
   # LC_ALL=ja_JP.UTF-8
   # export LC_ALL
   # LANG=ja_JP.UTF-8
   # export LANG
   ```

   For details about supported locales, see the *Release Notes*.
3. Place the NNMi media in the drive, and then mount the drive.

   For details about how to mount drives, see the NNMi *Release Notes* and OS documentation.
4. Start Hitachi PP Installer.

   Execute the following commands. *mount-dir* indicates the directory the drive is mounted as.

   `#` */mount-dir*`/X64LIN/setup` */mount-dir*

   For details about how to start Hitachi PP Installer, see the NNMi *Release Notes*.
5. In the Hitachi PP Installer startup window, enter `I` to display a list of software that can be installed.
6. Move the cursor to `JP1/Network Node Manager i`, select it using the space bar, and then enter `I`.

   A message will appear asking you whether you want to continue the installation.
7. Enter `y` or `Y`.
8. Enter information as indicated by the installer.

   To use default values, press the **Enter** key without entering any values. Defaults are the values shown in brackets.

   - Specify the HTTP port number for the NNMi Web server.

     Enter the HTTP port number for the NNMi Web server used to access NNMi. Enter a port number that is not being used by another program. The default value is `20480`.

     An input example follows:

```
** Network Node Manager i Installer **
* Starting NNMi installation.
* Enter default port for HTTP server =>
* [20480]
8004 ↵
```

- Specify the HTTPS port number for the NNMi Web server.

  Enter the HTTPS port number for the NNMi Web server used to access NNMi. Enter a port number that is not being used by another program. The default value is `20481`.

  An input example follows:

  ```
  * Enter default port for HTTPS server =>
  * [20481]
  8443 ↵
  ```

- Check the display of entered data and make sure that installation has started.

  The data entered as shown above is displayed. If there are no problems with the data displayed, enter `yes` to start installation. To change the entered data, enter `no`.

  An input example follows:

  ```
  * http port : 20480
  * https port : 20481
  * Do you start installation with above settings you entered ? (yes/no)
  * If you need to change the settings, please enter no.
  yes ↵
  ```

- Confirm whether to perform the preinstallation checks and continue the installation.

  The preinstallation checks will be performed first when installation starts.

  > **Note**
  >
  > In order to verify the items listed in Table 1-1: NNMi management server preinstallation checklist, the preinstallation check will verify that the ports used by NNMi are available.
  >
  > Do not install NNMi until you have verified that all the ports used by NNMi are available. For a list of the ports used by NNMi and the direction in which data passes through a firewall, see E. List of Ports Used by NNMi.

  If no problems are found in this preinstallation check, continue with the installation.

  If there is a problem with the preinstallation check, the installer will output the problem and ask whether you want to continue the installation. Enter `yes` to continue the installation or `no` to terminate the installation.

  Example of input when there is a problem in the preinstallation check:

  ```
  * Starting NNMi Precheck ...
  * TCP Port: [20481] is used.
  * UDP Port: [162] is used.
  * NNMi Precheck result: NG
  * There are some problem(s) with the settings.
  * Do you want to continue NNMi installation ? (yes/no)
  * If you enter no, the installation will stop.
  no ↵
  ```

Important

Note that the installation takes ten to twenty minutes or more. Do not interrupt the installation once it is underway. Interrupting the installation creates undesirable conditions that could render re-installation by normal means impossible.

Even if the precheck result is `OK`, this is not a guarantee that the installation will be successful. You must also make sure all the checklists in 1. Preinstallation Checklists are completed.

- Setting the system account password.

  After a while, you will be prompted to enter the password for the system account. Between 1 and 40 characters can be entered for the password. Alphanumeric characters (A to Z, a to z, 0 to 9), and underscores (_) can be used. To set it after installation, enter `\quit`.

```
* Setup system password for the initial sign-in to the NNMi console.
* If you want to setup the password later, enter "\quit".
* Please enter system password:
* Please enter system password again:
```

Note

The system account is a special administrator account created by the installation process. It is used when you sign in to the NNMi console for the first time. It is not normally used after the creation of a user with the administrator role on the NNMi console. The system account remains enabled after the installation finishes, but it is used only to execute on the command line or for restoration purposes. For details about how to set or change the system password, see 1.5.5 Setting the system account password.

2.1.3 Operations after the installer finishes

This section describes tasks that must be performed after NNMi is installed. Perform these tasks no matter which OS you are using.

(1) Exclude NNMi files and directories from the scan target

Anti-virus software might trigger the exclusive control of files and directories used by NNMi. This might cause a startup failure or abnormal termination of the NNMi service, or delay command execution. To perform a virus scan while NNMi is running, exclude files and directories within the following directories from the scan target:

Windows:

- NNMi installation directory
- NNMi data directory
- *drive*`:\Program Files\Hitachi\Cm2NNMi` (this directory might not exist.)
- *HA-mount-point*`\NNM` (In the case of cluster configuration)

Linux:

- `/opt/OV`
- `/var/opt/OV`

- *HA-mount-point*/NNM (In the case of cluster configuration)

If you perform a virus scan while NNMi is stopped, you need to restart NNMi after confirming that the virus scan for the above directories has been completed.

(2) Set the NNMi system account password

In the NNMi installation, to skipped the system account settings, set the account password to sign in to the NNMi console first. Use the nnmchangesyspw.ovpl script to set the password. Run the nnmchangesyspw.ovpl script without arguments, and register a password as indicated by the displayed messages.

(3) Set the language environment (Linux only)

Depending on the OS settings, rebooting the machine might automatically invoke the ovstart command with the setting LANG=C. In such a case, background processes will output messages in English. In order to output the message in the intended language, configure the following settings to invoke the ovstart command in the supported locale at system startup.

- **How to configure**
  Make sure that of the following lines are entered before /opt/OV/bin/ovstart in the file /opt/OV/bin/netmgt, and before /opt/OV/bin/ovstart nnmtrapreceivermd in the file /opt/OV/bin/nettrap. If necessary, enter on of the following lines:

```
LANG=ja_JP.utf8
export LANG
```

  or

```
LANG=ja_JP.UTF-8
export LANG
```

  or

```
LANG=C
export LANG
```

  or

```
LANG=en_US.utf8
export LANG
```

  or

```
LANG=en_US.UTF-8
export LANG
```

  or

```
LANG=zh_CN.utf8
export LANG
```

(4) Check the maximum Java heap size

During installation, the maximum Java heap size (-Xmx) is set automatically according to the physical memory. Review the -Xmx value after consulting *Chapter 4. Memory and Disk Space Requirements* and *9.1 Systems* in the *Release Notes*. In addition, review the -Xmx value in the event of changes to the scale of the monitoring to be done with NNMi.

(5) Check the auto-trim configuration for incidents

Since NNMi 12-10, the auto-trim incidents is activated for new installations. Refer to 21.20 Configuring the auto-trim oldest SNMP trap incidents feature to review the presence of auto-trim configuration, the threshold for trimming, and the amount of deletions and settings to be deleted. If there is a change in the size of the object to be monitored, please review these configurations as well.

(6) Starting NNMi services

Execute the `ovstart` command to start NNMi services.

(7) Create an account to serve the administrator role

Sign in to the NNMi console and create an account to serve the administrator role.

1. A window for NNMi sign-in appears.
   Enter the following URL in the window for entering the Web browser address.

   ```
   http://fully-qualified-domain-name:port/nnm/
   ```

   where *fully-qualified-domain-name* is the fully qualified domain name of the NNMi administrator server, and *port* is the HTTP port number of the NNMi Web server that was set during installation.
2. Enter the user name and password for the system account, and click the sign-in button.
   - User name: `system`
   - Password: The system account password created in (2) Set the NNMi system account password
3. Create the user accounts.
   On the NNMi console, under **Configuration** workspace > **Security** > **User Accounts**, click the **New** icon. Enter a name and password and click the **Save and Close** icon to save the user account. For details, see *Configure User Accounts (User Account Form)* in NNMi Help.

   Important

   Between 1 and 40 characters can be entered for the name. Alphanumeric characters (`A` to `Z`, `a` to `z`, `0` to `9`), periods (`.`), underscores (_), at marks (`@`), and hyphens (`-`) can be used.

   You can use one or more characters for the password. Supported characters include alphanumeric characters (`A` to `Z`, `a` to `z`, `0` to `9`) and single-byte symbols.
4. Map the administrator role to the user account.
   On the NNMi console, under **Configuration** workspace > **Security** > **User Account Mappings**, click the **New** icon, and then specify the following parameters.
   - User account: The user account created in step 3
   - User group: NNMi administrator

   Click the **Save and Close** icon to save the mapping. For details, see *User Account Mapping Tasks* in NNMi Help.

   Important

   Do not create a new user group. Instead, select from among the default user groups.

2.2 Using the Quick Start Configuration Wizard

This section guides you through some basic configuration tasks for NNMi. These tasks must be completed after you install NNMi. Very few parameters can be set from the Quick Start Configuration Wizard, which means that it is not possible to configure all settings necessary to start monitoring with NNMi. Hitachi normally recommends that you perform configuration from the NNMi console. You can use the Quick Start Configuration Wizard for initial setup (such as in a test environment), including:

- Configuring SNMP community strings
- Completing discovery of a limited range of network nodes

  If use of network address translation (NAT) means that you will be managing areas in the network that contain duplicated IP addresses, select one address domain (an unduplicated address) that is to be detected by the Quick Start Wizard. Then see *Overlapping Addresses in NAT Environments* in the NNMi Help or 13. Managing Overlapping IP Addresses in a NAT Environment.
- Setting up an initial administrator account

> **Important**
>
> You cannot use the Quick Start Configuration Wizard to complete the SNMP Version 3 (SNMPv3) configuration. If you have devices that you prefer to monitor using SNMPv3, do the following:
>
> 1. Open the NNMi console.
> 2. In the **Configuration** workspace, select **Communication Configuration**.
> 3. Complete the SNMPv3 configuration.

After initial configuration, you can use the NNMi console for additional configuration tasks, such as adding nodes to the network topology and configuring monitoring. For details, see NNMi Help.

> **Note**
>
> About discovery seeds and auto-discovery rules
>
> A discovery seed is a node that can help NNMi discover the network topology. For example, a seed might be a core router in your monitoring environment. Each seed is identified by an IP address or host name; see *Configure Auto-Discovery Rules* in NNMi Help.
>
> - To configure discovery so that the devices that you specify as seeds become the starting point for additional discovery, create and configure auto-discovery rules; see *Specify Discovery Seeds* in NNMi Help.
> - To configure discovery so that only the devices that you specify as seeds are discovered, do not create auto-discovery rules.
>
> For overview information about the discovery process, see *How Spiral Discovery Works* in NNMi Help.

1. After the installation process finishes, launch the Quick Start Configuration Wizard as follows:

   Run the Quick Start Configuration Wizard immediately after installation. To manually launch the Quick Start Configuration Wizard, go to the following URL:

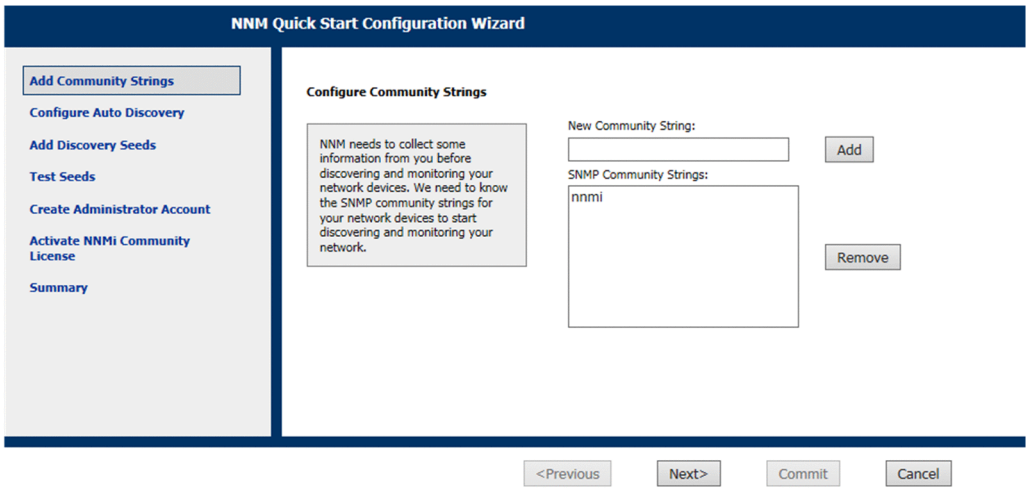
   ```
   http:// fully-qualified-domain-name:port/quickstart/
   ```

where *fully-qualified-domain-name* is the fully qualified domain name of the NNMi administrator server, and *port* is the port number that was set during installation.

If your NNMi management server has more than one domain name, NNMi chooses one during the installation process. To determine which fully qualified domain name NNMi is using, run the `nnmofficialfqdn.ovpl` script. For details, see the *nnmofficialfqdn.ovpl Reference Page*.

The NNMi Quick Start Configuration Wizard opens in a Web browser window.

2. Log on as follows:
   - User name: `system`
   - Password: Use the password for the system account that you created in (2) Set the NNMi system account password in 2.1.3 Operations after the installer finishes.
3. On the **Configure Community Strings** page, enter a community string for one of the nodes in the discovery range, and then click **Add**.

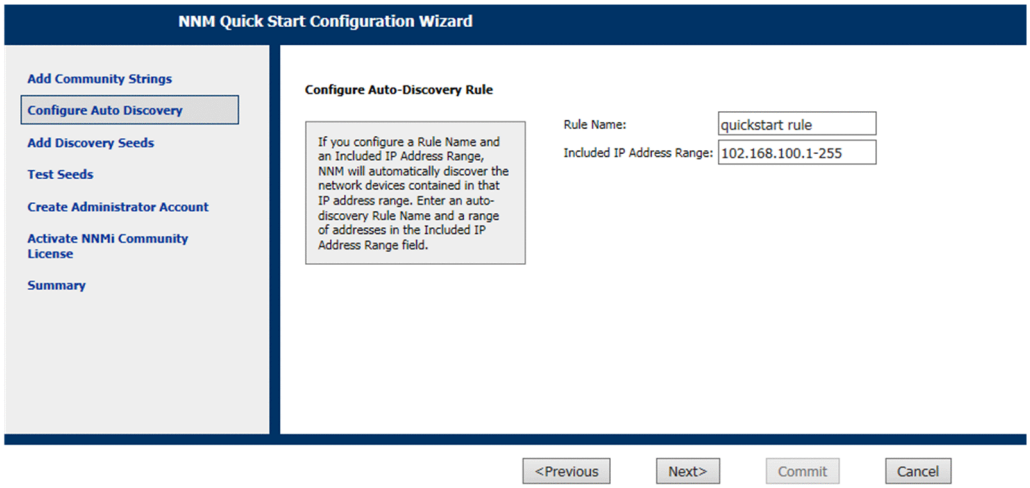


> **Note**
>
> NNMi automatically tries to match community strings to known devices. You do not need to manually associate each community string with a specific device.

4. Repeat step 3 until the **SNMP Community Strings** list includes the community strings for all nodes in the discovery range, and then click **Next**.

   The SNMP community strings that you add here are saved in the NNMi database. In the NNMi console, the SNMP community strings are visible on the **Default SNMPv1/v2 Community Strings** tab of the **Communication Configuration** form.
5. On the **Configure Auto-Discovery Rules** page, associate the existing rule name with the **Included IP Address Range**. Enter the range of IP addresses for the discovery rule, and then click **Next**.

   Examples of valid IP address ranges include:
   - `10.1.1.*`
   - `10.1.1.1-99`
   - `10.10.50-55.*`
   - `10.1-7.1-9.1-9`

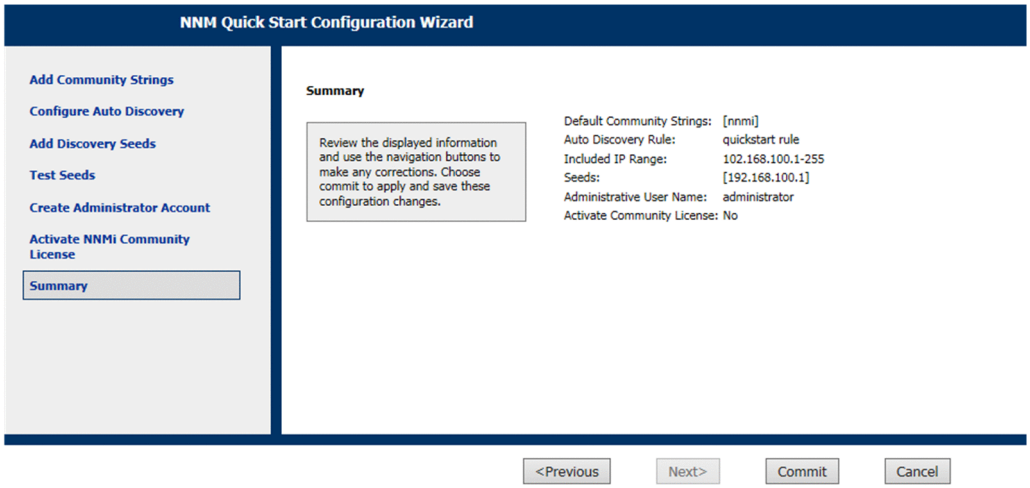


6. On the **Configure Seeds** page, enter discovery seed information for your network, and then click **Add**. After that, click **Next**.

   Enter discovery seeds in the form of IP addresses or fully qualified domain names. The network devices represented by these seeds help the NNMi spiral discovery process discover your network accurately.

   > **Note**
   >
   > You can use the `nnmloadseeds.ovpl` command to load seeds using a command line. For details, see the *nnmloadseeds.ovpl Reference Page*.

7. On the **Test Seeds** page, review the results of the communication tests. If any of the seed nodes cannot be reached with the community strings that you identified in step 3, click **Previous** to navigate to the **Configure Community Strings** page. Correct the community strings, and then click **Next**.
8. Repeat step 7 until all nodes can be reached, and then click **Next**.
9. On the **Configure Administrator Account** page, enter a **User Name**, and set the **Password** for a new account for administering the NNMi software. Then, click **Next**.
10. On the **Summary** page, review the information that you specified. Then, do one of the following actions:
    - To change any of the settings, click **Previous**.
    - To use the current settings, click **Commit**.



11. The **Wizard is complete** page indicates that you have successfully configured NNMi to discover a portion of your network. From here, do one of the following:
    - Click **Previous** to go back and make changes.
    - Click **Launch UI** to start the NNMi console user interface. To begin using NNMi, see 3. Getting Started with NNMi.

> **Note**
>
> For Windows, after installation, restart any anti-virus software.

2.3 Licensing NNMi

If you do not have a permanent license key installed, the NNMi product includes a temporary license key that is valid for 60 days after you install NNMi. Therefore, obtain and install a permanent license key as soon as possible.

Important

The format of the license key has been changed from NNMi 12-60.

The NNMi 12-50 and earlier license keys cannot be applied to NNMi 12-60 or later. If you want to upgrade to NNMi 12-60 or later, you need to obtain a new format license key from Hitachi Password Center in advance, and apply it to NNMi. (After upgrading, apply the new format license key to NNMi.)

2.3.1 Preparing to install a permanent license key

The temporary license has a 250 node limit. If you have been running NNMi with a temporary license key, you might be managing more nodes than your permanent license supports. When the permanent license takes effect, NNMi automatically unmanages nodes of its choosing to achieve the license limit.

When tracking license information, note the following:

- **Consumption:** NNMi discovers and manages nodes up to the NNMi licensed capacity limit (rounded up):
  - `VMware` environments: Each device with a Device Profile of `vmwareVM` is equivalent to 1/10th node.
  - All other devices are equivalent to one discovered node.

If you want to control which nodes are no longer managed with the permanent license, use the NNMi console to delete less important nodes before installing your new license key.

(1) Checking the license type and the number of managed nodes

To determine the type of license that NNMi is using, follow these steps:

1. In the NNMi console, click **Help** > **About Network Node Manager i**.
2. In the About Network Node Manager i window, click **Licensing Information**.
3. Look for the value shown in the **Consumption** field.
   This value is the number of nodes that NNMi is currently managing.
4. If your permanent license supports fewer nodes than NNMi is currently managing, use the NNMi console to delete less important nodes. For details, see *Delete Nodes* in NNMi Help.

2.3.2 Obtaining and installing a permanent license key

To request a permanent license key, gather the following information:

- The Software License Agreement
- The IP address of the NNMi management server
- The versions and revisions of the product to which the license key applies.

- Your company or organization information

For details about how to obtain and install a permanent license key, see the *Release Notes*.

2.3.3 Switching the temporary license

After NNMi is installed, a temporary license for NNMi is immediately applied.

To start the trial for functions of NNMi Advanced, it is necessary to switch the license key.

For details on how to switch between trial licenses for NNMi and for NNMi Advanced, see the *Release Notes*.

2.4 Removing NNMi

2.4.1 Removing NNMi (Windows)

1. Log on with administrator privileges to the system from which you plan to remove NNMi.
   If UAC is enabled, a user who is not the built-in Administrator must be promoted to administrator.
2. Stop all NNMi services.
3. Under **Control Panel** > **Programs and Features**, select **Network Node Manager** and then click **Uninstall or Change**.
4. A dialog box is displayed asking whether you want to start the uninstallation. Enter `yes` to start uninstalling NNMi.

   Example of input:

   ```
   ** Network Node Manager i Installer **
   * Starting uninstallation ? (yes/no) =>
   yes
   ```

5. After you have finished uninstalling NNMi, delete the NNMi installation directory and data directory.
   Performing an uninstallation might not always delete the NNMi installation and data directories. In this case, delete them manually.
   If default values were selected during installation, delete the following directories.
   - *drive*`:\Program Files (x86)\Hitachi\Cm2NNMi\`
   - *drive*`:\ProgramData\Hitachi\Cm2NNMi\`
6. Delete temporary directories and files.
   Delete the following temporary directories and files that are created by NNMi.
   The examples below show everything that might exist. There is no problem if some of the following do not exist. If you need the log output file for the uninstallation (`NNMUninstall.log`), make a copy of it before you delete the temporary file.

   ```
   %TEMP%\HPOvInstaller\
   %TEMP%\HPOvLic.log
   %TEMP%\HPOvPerlA-install.log
   %TEMP%\Install_Autopass.log
   %TEMP%\hsperfdata_Administrator
   %TEMP%\InstallerData
   %TEMP%\JP1NNMiMIBLoad.log
   %TEMP%\MicroFocusOvInstaller\
   %TEMP%\NNMUninstall.log
   %TEMP%\NNM_X.X.X_HPOvInstaller.txt (where X is one or more numeric characters)
   %TEMP%\NNM_X.X.X_MicroFocusOvInstaller.txt (where X is one or more numeric charact
   ers)
   %TEMP%\nmscreatedb.log
   %TEMP%\nnm_hotfixes.log
   %TEMP%\nnm_installconfig_vbs.log
   %TEMP%\nnm_premigration.log
   %TEMP%\nnm_preinstallcheck_phaseI.log
   %TEMP%\nnm_preinstallcheck_phaseII.log
   %TEMP%\ovRemoveDir.exe
   %TEMP%\ovDetach.exe
   %TEMP%\ovinstallparams.ini
   %TEMP%\ovCleanUp.bat
   %TEMP%\persistent_state
   %TEMP%\preinstallcheck
   ```

```
%TEMP%\JP1NNMiInstaller.log
%TEMP%\JP1NNMiPostinstaller.log
%TEMP%\InstallScript.iap_xml
%TEMP%\nnm_preupgrade.log
%TEMP%\nnm_pre_dialogcheck.log
%TEMP%\OvLauncher.log
%TEMP%\nnm_pre-uninstall.log
%TEMP%\nnmilog\
drive:\ProgramData\apregid.com.hpe
```

7. Delete the environment variables.

   Uninstalling NNMi does not delete the environment variables `OVCSL_LOG`, `OVCSL_LOG_APPLICATION`, and `OVCSL_LOG_FILE`, or *NnmInstallDir*`bin\`, which is added to the environment variable `PATH` when NNMi is installed. Delete them manually. Note that *NnmInstallDir* is the value set in environment variable `NnmInstallDir`.

2.4.2 Removing NNMi (Linux)

1. Log in as a user with root privileges to the system from which you plan to remove NNMi.
2. Stop all NNMi services.
3. Start the NNMi Uninstaller.

   Execute the following commands to start Hitachi PP Installer.

```
# /etc/hitachi_x64setup
```

4. Following the instructions, select the NNMi Uninstaller, and perform the uninstallation.
5. After you have finished uninstalling NNMi, delete the NNMi installation directory and data directory.

   Performing uninstallation might not always delete the NNMi installation and data directories. In this case, delete them manually.

   Delete the following directories.

   - Installation directory

```
/opt/OV
```

   - Data directories

```
/var/opt/OV
```

6. Delete temporary directories and files.

   Delete the following temporary directories and files that are created by NNMi.

   The examples below show everything that might exist. There is no problem if some of the following do not exist. If you need the log output file for the uninstallation (`NNMUninstall.log`), make a copy of it before you delete the temporary file.

```
/var/tmp/HPOvPerlA-install.log
/var/tmp/jp1nnmi
/var/tmp/JP1NNMiInstaller.log
/var/tmp/JP1NNMiPostinstaller.log
/var/tmp/rpm-tmp.xxx (where xxx is one or more alphanumeric characters)
/tmp/install.dir.xxx (where xxx is one or more numeric characters)
/tmp/ia_remove.shxxx.tmp (where xxx is one or more numeric characters)
/tmp/HPOvInstaller
/tmp/MicroFocusOvInstaller
/tmp/NNMUninstall.log
```

```
/tmp/NNM_X.X.X_HPOvInstaller.txt (where X is one or more numeric characters)
/tmp/NNM_X.X.X_MicroFocusOvInstaller.txt (where X is one or more numeric characters)
/tmp/debug
/tmp/JP1NNMiMIBLoad.log
/tmp/hsperfdata_bin
/tmp/hsperfdata_nmsdbmgr
/tmp/hsperfdata_nmsproc
/tmp/hsperfdata_root
/tmp/nnm-premigration.log
/tmp/nnm_preinstallcheck_phaseI.log
/tmp/nnm_preinstallcheck_phaseII.log
/tmp/ovinstallparams.ini
/tmp/persistent_state
/tmp/postInstall
/tmp/postRemove
/tmp/preInstall
/tmp/preRemove
/tmp/preinstallcheck
/tmp/nnm-preupgrade.log
/tmp/nnm_pre_dialogcheck.log
/usr/share/apregid.com.hpe
```

2.5 Troubleshooting installation and initial startup

2.5.1 Installation problems

(1) Problem: NNMi installation requires more disk space than is currently available in the host system (Linux)

(a) Solution

When installing NNMi in Linux, you are not allowed to select the location where binary data is installed (`$OV_INST_DIR`) or the location where data files are installed (`$OV_DATA_DIR`). These locations are set as follows in the initial configuration:

- `OV_INST_DIR=/opt/OV`
- `OV_DATA_DIR=/var/opt/OV`

If there is insufficient disk space in either `/opt/OV` or `/var/opt/OV`, improve availability with either of the following methods:

1. If necessary, uninstall NNMi.
2. Create a symbolic link from the installation target to a partition that has sufficient disk space to install the binary data, and save the data files. The syntax for creating symbolic links is as follows:

   `ln -s` *large-disk* `/opt/OV`

   `ln -s` *large-disk* `/var/opt/OV`

   Important

   - Set the access permission for the parent directory at the installation site to `555` or higher.

3. Install NNMi.

(2) Problem: A message is displayed during installation indicating that the preinstallation procedure (phase II) has failed and the /tmp/nnm_preinstall_phaseII.log file needs to be checked for the details (Linux)

(a) Solution

The NNMi installation script automatically creates two groups (`nmsgrp` and `nmsdb`), two users (`nmsproc` and `nmsdbmgr`), and the corresponding `$HOME` directories. This operation might fail for either of the following reasons:

- Users and groups cannot be created because `useradd` or `groupadd` was disabled by the IT department.
- The root user cannot create a `$HOME` directory because the `$HOME` directory exists on NFS.

Installation stops whenever the NNMi installer is unable to create these groups, users, or directories. In such a case, you can create the users manually and restart the installation.

1. Create the `nmsproc` user in the `nmsgrp` group.
   Set the `$HOME` directory to any directory that exists.
2. Create the `nmsdbmgr` user in the `nmsdb` group.
   Set the `$HOME` directory to any directory that exists.

If you know that these operations will fail but you need to control user IDs, group IDs, or the locations of `$HOME`, you can first create the groups, users, and `$HOME` directories, and then start the installer.

When the `useradd` command is used to create a user, the default home directory will be `/home/`*user-name*.

2.5.2 Initial startup problems

(1) Problem: The user cannot run the NNMi command line tools on Linux NNMi management servers

(a) Solution

Check whether system environment variable `PATH` includes `/opt/OV/bin`. If it does not, add `/opt/OV/bin` to system environment variable `PATH`.

(2) Problem: JBoss port contention

(a) Solution

By default, JBoss Application Server uses several ports for communication with NNMi. These ports are commonly used by other applications as well.

To resolve any port contention, follow these steps:

1. As a user with administrator privileges (Windows) or root privileges (Linux), open the following file in any text editor:
   - Windows
     `%NnmDataDir%Conf\nnm\props\nms-local.properties`
     `%NnmDataDir%` is the data directory specified during installation.
   - Linux
     `/var/opt/OV/conf/nnm/props/nms-local.properties`
2. Modify the existing entries, replacing any conflicting port numbers with available port numbers.
3. Save the changes.
4. Execute the following commands to restart the NNMi services:

```
ovstop -c
ovstart -c
```

> **Note**
>
> For Windows, the `ovstop` and `ovstart` commands can be executed from the **Start** menu. For details about the ports used by NNMi, see the *nnm.ports Reference Page*.

(3) Problem: NNMi is not discovering nodes

(a) Solution

1. From the **Workspace** navigation panel, select the **Configuration** workspace.
2. From **Configuration**, open the **Seeds** view.
3. Check the values in the **Discovery Seed Results** column.

   If the status of many of the discovered nodes is something other than **Node created**, then the NNMi discovery process was not successful.

   If the status is **No SNMP response**, verify that you can ping the node, and that you can run the `nnmsnmpwalk.ovpl` command to obtain information from the node. For details, see the *nnmsnmpwalk.ovpl Reference Page*. If you cannot run these tools, check the following items:

   a. Ping the node to make sure it is responding.

   b. Make sure that the node has SNMP enabled.

   c. Make sure that the node has your local management server on its access list of SNMP agents.

   d. Be sure to configure the correct community strings for the nodes so that NNMi discovers them correctly. This information is listed on the **Communication Configuration** form on the **Default SNMPv1/v2 Community Strings** tab.

   e. Make sure that there are no Access Control Lists configured on your routers, switches, or firewalls that might be limiting discovery.

   For details, see *Configure Discovery* in NNMi Help.

(4) Problem: You cannot start the NNMi console when accessing a Windows NNMi management server

If you cannot start an NNMi console when pointing your browser to a Windows NNMi management server, a firewall might be blocking the HTTP port. To troubleshoot this problem, run the browser on the NNMi management server. If you can access the NNMi console from this browser, but remote browsers fail, you need to check your ports.

To remedy this problem, add the `nmsas.server.port.web.http` value shown in the `%NnmDataDir%conf\nnm\props\nms-local.properties` file to the list of allowed ports. For details, see the *nnm.ports Reference Page*.

`%NnmDataDir%` is the data directory specified during installation.

(5) Problem: The NNMi console does not open after a successful installation or upgrade of NNMi

Also, the following error message appears in latest copy of the `incidentActions.*.*.log` file (available in the `/var/opt/OV/log/nnm/public` directory on the NNMi management server):

```
SEVERE: com.hp.ov.nms.events.action.log.ActionLogger createActionServer:
```

```
Failed to get port number from /var/opt/OV/tmp/actionServer.port due to
java.io.FileNotFoundException.

/var/opt/OV/tmp/actionServer.port.lock (Permission denied) :
java.io.FileNotFoundException:

/var/opt/OV/tmp/actionServer.port.lock (Permission denied)
```

(a) Solution

1. Run the following commands on the NNMi management server:
   a. `/opt/OV/bin/ovstop`
   b. `chown root:root /var/opt/OV/tmp`
   c. `chmod 777 /var/opt/OV/tmp`
   d. `chmod g+s /var/opt/OV/tmp`
2. Look for the actionServer.port and actionServer.port.lock files in the /var/opt/OV/tmp directory. Delete those files if they exist.
3. Run the following command on the NNMi management server:
   `/opt/OV/bin/ovstart`

3 Getting Started with NNMi

This chapter provides information that you need to know before you begin using NNMi to manage your network. It includes a general overview of both how to access NNMi and how to specify network discovery settings. You can find more detailed information for operators and administrators in NNMi Help.

3.1 Accessing NNMi

Now that you have installed NNMi and completed post-installation configuration tasks, you can begin managing your network. All network monitoring and event-handling tasks can be accessed through the NNMi console, which opens in a Web browser.

To access the NNMi console, follow these steps:

1. Make sure that you are using a supported Web browser.
   See 1.1 Checking the hardware and software.
2. Enable the Web browser for JavaScript, pop-up windows from the NNMi management server, and to accept cookies from the NNMi management server.
   See 1.5.3 Enabling the Web browser for the NNMi console.
3. Enter the following URL into a Web browser window:
   `http://`*`fully-qualified-domain-name`*`:`*`port`*`/nnm/`
   where *fully-qualified-domain-name* represents the fully qualified domain name of the NNMi management server, and *port* is the port that JBoss Application Server uses for communicating with the NNMi console.
   If your NNMi management server has more than one domain name, NNMi chooses one during the installation process. To determine which fully qualified domain name NNMi is using, run the `nnmofficialfqdn.ovpl` script. For details, see the *nnmofficialfqdn.ovpl Reference Page*.
   If you cannot start an NNMi console when pointing your browser to an NNMi management server that is installed on a Windows operating system, you might have a Windows firewall on the NNMi management server that is blocking the http port. See (4) Problem: You cannot start the NNMi console when accessing a Windows NNMi management server.
4. In the NNMi sign-in window, enter your user account name and password, and then click **Sign In**.
   For details, see *About user accounts and roles* below.

About user accounts and roles

After installation, NNMi provides a special system account to be used to access NNMi for the first time. Do not use this system account for everyday use.

For everyday use, the NNMi administrator sets up an account for each user (or group of users) and assigns a pre-configured user role to each account. User roles determine who has access to the NNMi console, as well as which workspaces and actions are available to each user. NNMi provides the user roles listed below for NNMi console access. These roles are predefined by the program and cannot be modified:

- Administrator
- Operator level 2
- Operator level 1
- Guest

Before configuring NNMi sign-in access for your team, determine which pre-defined NNMi role is appropriate for each team member. The roles are hierarchical, meaning the higher level roles include all privileges of the lower-level roles in the hierarchy (Administrator is highest, Guest is lowest).

User accounts and roles, along with command-line access, are configured in the NNMi console. For details, see *Configuring Security* in NNMi Help.

NNMi provides an out-of-the-box https configuration using a self-signed certificate created during installation. For details about using a signed certificate from a Certificate Authority instead of the self-signed certificate, see 10. Working with Certificates for NNMi.

3.2 Accessing NNMi Help

NNMi Help describes how to use the NNMi console.

To access NNMi Help, click **Help** on the NNMi console menu bar, and then click one of the options above the first separator line on the menu.

> **Note**
>
> The NNMi console includes forms for entering information. The form name is in the upper left corner of the window. From any NNMi form, you can access the help information about that form. On the **Help** menu, click **Using the xyz form** where **xyz** is the title of the current form.

3.3 Configuring network discovery

As you begin to use NNMi to discover and manage your network, it is a good practice to start with a test network and configure NNMi to discover and manage a few nodes with only a few interfaces. The Quick Start Configuration Wizard (see 2.2 Using the Quick Start Configuration Wizard) provides an easy way to set up this type of small configuration. We recommend that you use the Quick Start Configuration Wizard immediately after installing NNMi.

As you become more familiar with NNMi, you will understand how its rich set of features applies to managing your network. You can expand the network topology that NNMi manages over time, systematically adding new discovery rules and putting new areas under management.

The topics in this section provide a brief overview of the configuration tasks that are required before initiating the discovery process. The checklist in the following table summarizes these tasks.

Table 3-1: Discovery configuration checklist

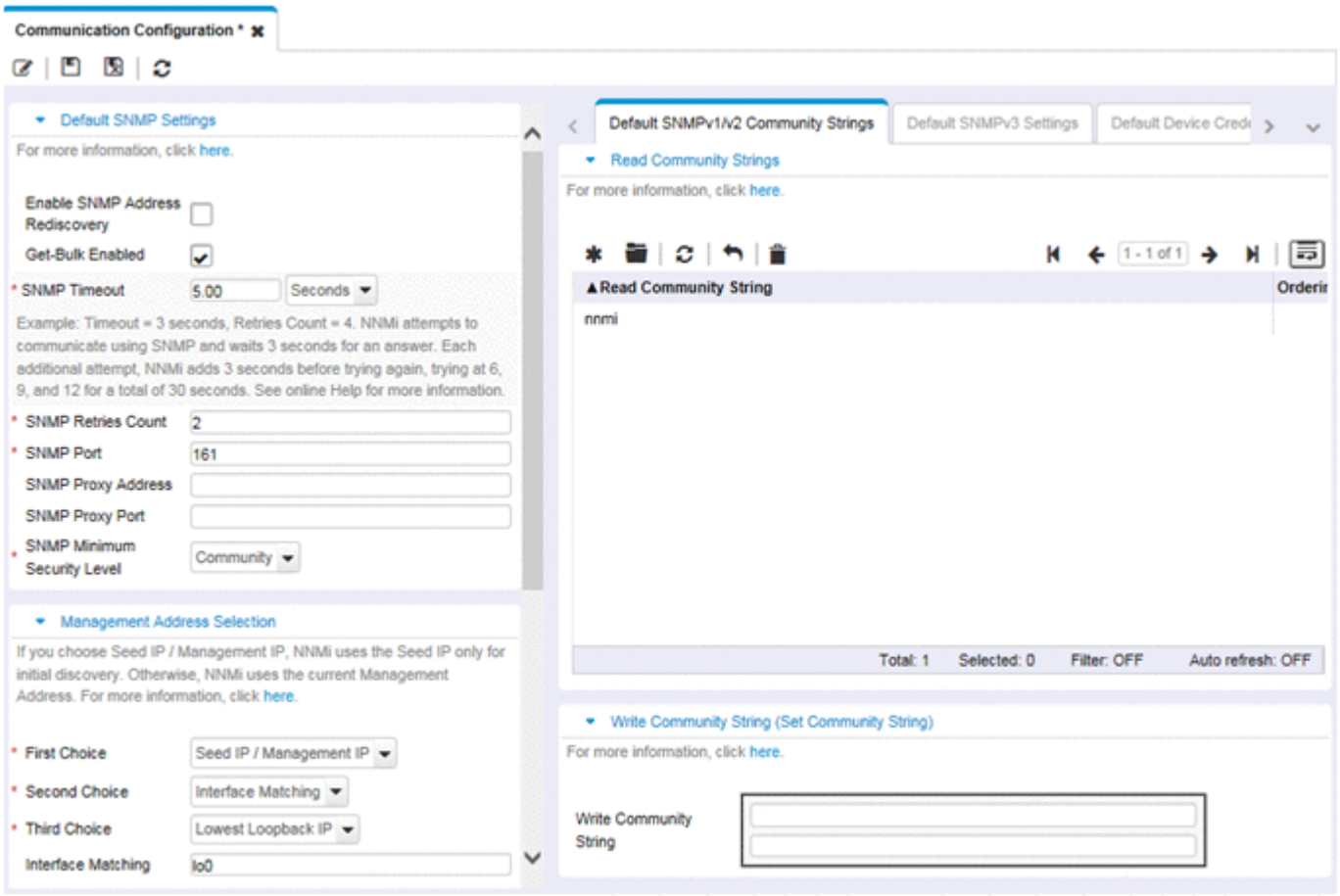
Completed? (y/n)	Task
	Verify that all nodes to be discovered are connected to the network and configured with a supported version of SNMP (SNMPv1, SNMPv2c, or SNMPv3).
	Obtain read-only community strings from your network administrator for the nodes that you plan to manage.
	Using the NNMi console, configure community strings as described in 3.3.1 Configuring community strings.
	Using the NNMi console, configure the spiral discovery process as described in 3.3.2 Configuring auto-discovery rules.
	Using the NNMi console, check the spiral discovery progress as described in 3.3.3 Checking discovery progress.

For details about the discovery process, see *Discovering Your Network* in NNMi Help.

3.3.1 Configuring community strings

To configure NNMi with community strings, follow these steps:

1. From the workspace navigation panel, select the **Configuration** workspace.
2. Open the **Communication Configuration** form, as shown here:



3. On the **Default SNMPv1/v2 Community Strings** tab, click the **New** icon.
4. On the **Default Read Community String** form, in the **Read Community String** box, enter a community string for one of the nodes in the discovery range, and then click the **Save and New** icon.
5. Repeat step 4 to enter all community strings for the nodes in the discovery range, and then click the **Save and Close** icon.
6. On the **Communication Configuration** form, click the **Save and Close** icon.

For details about setting up device community strings and loading community strings from a file, see *Configuring Communication Protocol* in NNMi Help.

3.3.2 Configuring auto-discovery rules

One of the most important network management tasks is keeping your view of the network topology up to date. NNMi maintains the topology through ongoing discovery of network nodes. The NNMi discovery process ensures that root cause analysis and the troubleshooting tools provide accurate information to resolve incidents. (See *Network discovery* in the *Note* below)

To configure auto-discovery rules, follow these steps:

1. From the workspace navigation panel, from the **Configuration** workspace, open **Discovery**.
2. Open the **Discovery Configuration** form.
3. Click the **Auto-Discovery Rules** tab, and then click the **New** icon.
4. On the **Auto-Discovery Rule** form, under **Basics**, enter the rule **Name** and **Ordering** information.

The order is a numerical value that specifies the priority of this rule in comparison to other auto-discovery rules. For details, click **Help** > **Using the Auto-Discovery Rule form**.

5. Under **Auto-Discovery Starting Point for this Rule**, select the appropriate auto-discovery actions for this rule.
6. On the **IP Ranges** tab, click the **New** icon.
7. On the **Auto Discovery IP Range** form, enter the **IP Range**, and leave the **Range Type** set to **Include in rule**, and then click the **Save and Close** icon.
8. On the **Auto-Discovery Rule** form, click the **Save and Close** icon.
9. Repeat steps 3 through 8 until you have added all of the rules that you want to use.
10. On the **Discovery Configuration** form, click the **Save and Close** icon to save all new auto-discovery rules to the NNMi database.
11. From the **Configuration** workspace, open **Discovery**, and then click **Seeds**.
12. Click the **New** icon.
13. On the **Discovery Seed** form, enter a host name or IP address, and then click the **Save and Close** icon.
14. Repeat steps 12 and 13 until you have added all host names or IP addresses for discovery seeds.

To monitor the progress of discovery, see 3.3.3 Checking discovery progress.

For details about configuring discovery, see *Configure Discovery* in NNMi Help.

Note

Network discovery

NNMi collects information about the devices in your network (such as switches and routers) and proactively manages any devices that are important to you and your team. There are two discovery modes to choose from:

- Discovery seeds: You provide a list of devices and maintain total control over which devices NNMi discovers and monitors.
- Auto-discovery rules: You provide a list of addresses and host names as discovery seeds, and NNMi uses this information as starting points for extensive automatic discovery. You set limits on the NNMi discovery process by providing IPv4 address ranges and MIB II sysObjectIDs.

After you choose a discovery mode, NNMi Spiral Discovery takes over. Using a wide range of protocols and techniques, NNMi gathers a wealth of information about your network inventory, ascertains the relationships between devices (such as subnets and VLANs), and accurately maps out the connectivity between those devices. The NNMi Causal Engine determines the current status of each device (plus each interface and address associated with that device) and proactively notifies you when any trouble or potential trouble is detected.

This dynamic discovery process continues over time. When things change in your network management domain, NNMi spiral discovery automatically updates information.

To learn more about network discovery, see *Discovering Your Network* in NNMi Help.

3.3.3 Checking discovery progress

After initiating the spiral discovery process, verify that the process is running correctly.

> **Note**
>
> Because spiral discovery is dynamic, NNMi discovers network nodes on a continuous basis. Whenever a new node is added to a discovery rule, NNMi discovers the node, collects topology information about the node, and begins to monitor the node.

There are several ways to gauge discovery progress. Perform any of the following actions to check the discovery progress:

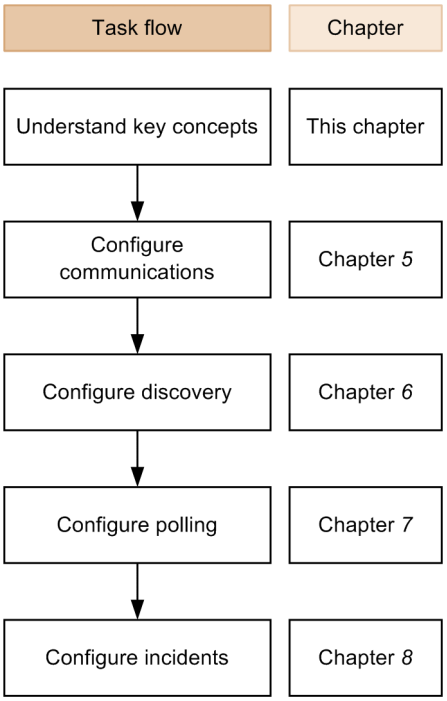
- During discovery, check the status of seeds by using **Configuration** > **Discovery** > **Seeds**. Review the status information in the **Discovery Seed Results** column. When discovery is nearing completion, the majority of the nodes have the **Node created** status.
- During discovery, check the discovery progress by using **Help** > **System Information**, and then click the **Database** tab. Check the **Database Object Counts** several times during a one-hour period. The numbers in the **Nodes**, **SNMP Agents**, **Interfaces**, **IP Addresses**, and **L2 Connections** fields will stabilize. If these numbers are no longer increasing in value over the sampling period, then discovery is complete.
- During discovery, from the NNMi console, in the **Inventory** workspace, select **Nodes**. Check the value in the **Total** field several times during a one-hour period. If this number is no longer increasing in value over the sampling period, then discovery is complete.
- During discovery, from the NNMi console, check the discovery progress by clicking **Tools** > **NNMi Self-Monitoring Graphs** > **Discovery Progress**.
- During discovery, from the NNMi console, check the discovery progress by clicking **Tools** > **Status Distribution Graphs** > **Node Status**.
- During discovery, from the NNMi console, in the **Topology Maps** workspace, click **Network Summary**. Watch the map grow in complexity during a one-hour period. If the map growth slows and then stops over the sampling period, discovery is complete.

  > **Note**
  >
  > If you suspect a problem with discovery, see (3) Problem: NNMi is not discovering nodes.

4 General Concepts for Configuration

This chapter provides an introduction to concepts for configuration. More details are provided later in this manual beginning in Chapter 5. This chapter also contains some best practices that apply to all NNMi configuration areas.

4.1 Task flow model



The chapters in *Part 2, Configuration* of this manual provide information that is relevant to the following task flow:

1. **Concepts** -- Gain a general understanding of the configuration area. The information in this guide supplements the information in NNMi Help.
2. **Plan** -- Decide how you want to approach the configuration. This is a good time to begin or to update your company's network management documentation.
3. **Configure** -- Use a combination of the NNMi console, configuration files, and command line interface to enter the configuration into NNMi. For specific procedures, see NNMi Help.
4. **Evaluate** -- Examine the results of your configuration on the NNMi console. Adjust the configuration as necessary to achieve the desired results.
5. **Tune** -- Optional. Adjust the configuration to improve NNMi performance.

4.2 Best practice: Save the existing configuration

It is a good idea to save a copy of the existing configuration before you make any major configuration changes. If you do not like the results of your configuration changes, it is easy to revert to your saved configuration.

Use the `nnmconfigexport.ovpl` command to save the current configuration. To recover a saved configuration, use the `nnmconfigimport.ovpl` command.

For details about how to use these commands, see the appropriate reference pages.

The `nnmconfigexport.ovpl` command does not retain SNMPv3 credentials. For details, see the *nnmconfigexport.ovpl Reference Page*.

4.3 Best practice: Use the Author attribute

Many NNMi configuration forms include the `Author` attribute.

As you use these forms to create or modify configurations, set in the `Author` attribute a value that identifies your organization. When you export the NNMi configuration, you can specify an author value to pull only those items that your organization has customized.

When you upgrade NNMi, the installer does not overwrite any configurations whose author value has been set by the user.

4.4 User interface model

Some NNMi console forms use a transactional approach to updating the database. The changes that you make in the NNMi console forms do not take effect until you save and close the forms on the NNMi console. If you close a form that contains unsaved changes, NNMi warns you about the unsaved changes and gives you a chance to cancel the close.

4.5 Ordering

Some NNMi console configuration forms include the `Ordering` attribute, which sets the priority for applying the configurations. For one configuration area, NNMi evaluates each item against the configurations from the smallest (lowest) ordering number to the next lowest ordering number, and so on, until NNMi finds a match. At that point, NNMi uses the information from the matching configuration and ceases to look for any more matches. (The communication configuration is an exception. NNMi continues to search for information at other levels to complete the communication settings.)

The `Ordering` attribute plays an important role in NNMi configuration. If you see unexpected discovery or status results, check the ordering of the configurations for that area.

Ordering numbers are also used in the following places, but with different meanings:

- For ordering menus and menu items, in which case you specify an order for applicable menus that is appropriate within the local context.
- For ordering topology maps on the **Node Group Map Settings** form, which sets the order of items in the **Topology Maps** workspace.

For specific information about how the `Ordering` attribute affects a given configuration area, see NNMi Help for that area.

Tip

- For each configuration area, apply low ordering numbers to the most restrictive configurations, and apply high ordering numbers to the least restrictive configurations.
- For each configuration area, all ordering numbers must be unique. During initial configuration, use ordering numbers with a standard interval to provide flexibility for future modifications to the configuration. For example, give the first three configurations the ordering numbers `100`, `200`, and `300`.

4.6 Node groups and interface groups

For node and interface groups, you can set a filter to narrow the information to be displayed in a view. For example, if the node group **Important Cisco router** is set and used as a filter, you can display only the applicable routers in the view.

Node groups can be used for any or all of the following purposes:

- Monitoring settings
- Incident payload filtering
- Table filtering
- Customizing map views
- Filtering the nodes passed from a regional manager to the global manager for the global network management feature

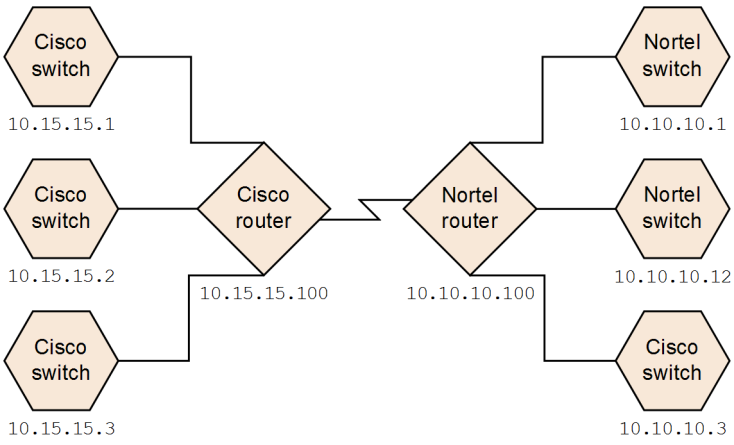
Interface groups can be used for any or all of the following purposes:

- Excluding interfaces from discovery
- Monitoring settings
- Incident payload filtering
- Table filtering

You can create a hierarchy of node groups based on any filterable attributes to control map view drill-down, monitoring, or both settings' inheritance.

4.6.1 Group overlap

Regardless of the intended uses for group definitions, the first step is to define which nodes or interfaces are members of a group. Because you can create groups for different purposes, each object can be included in multiple groups. Consider the following example:



- For monitoring purposes, you might want to set a polling interval of 3 minutes for all switches, regardless of vendor or location. You can do this with a device category filter.
- For maintenance purposes, you might want to group all Cisco switches so that you can place all of them `OUT OF SERVICE` together for an IOS upgrade. You can do this with a vendor filter.

- For visualization, you might want to group all devices on the `10.10.*.*` site into a container with propagated status. You can do this with an IP address filter.

The Cisco switch with IP address `10.10.10.3` would qualify for all three groups.

You want to find the balance between having a usably rich set of groups available for configuration and viewing, and overloading the list with superfluous entries that will never be used.

4.6.2 Node group membership

NNMi determines node group membership by comparing each discovered node to each of the configured node groups.

- All nodes specified on the **Additional Nodes** tab are members of the node group.

  > **Note**
  >
  > Avoid using the **Additional Nodes** tab to add nodes to a node group, because doing so consumes excessive resources on the NNMi management server.

- All nodes that are members of at least one node group specified on the **Child Node Groups** tab are members of the node group.
- Any node that matches one or more entries (if any exist) on the **Device Filters** tab and the filter specified on the **Additional Filters** tab is a member of the node group.

(1) Hierarchies/containment

You can create simple, reusable, atomic groups and combine them hierarchically for monitoring or visualization. Using hierarchical containers for nodes greatly enhances map views by providing cues about the location or type of object at fault. NNMi gives you complete control of the definition of the groups and their drill-down order.

You can create simple, reusable atomic groups first, and then specify them as child groups as you build up. Alternatively, you can specify your largest parent group first and create child groups as you go.

For example, a network might contain Cisco switches, Cisco routers, Nortel switches, and Nortel routers. You can create parent groups for Cisco devices and for all switches. Because the hierarchy is specified when you create the parent and designate its children, each child group, such as Cisco switches, can have multiple parents.

Hierarchies work well for the following situations:

- Types of nodes with similar monitoring needs
- Geographical locations of nodes
- Types of nodes to be taken `OUT OF SERVICE` together
- Groups of nodes by operator job responsibility

When you use groups in map views and table views, you see a (configurable) propagated status for the group.

> **Note**
>
> Keep in mind that as you use group definitions to specify monitoring configuration, hierarchy does not imply ordering for settings. The settings with the lowest ordering number apply to a node. By carefully incrementing ordering numbers, you can emulate inheritance concepts for settings.

An attempt to save a child node group with a circular reference node group set will fail with a warning.

(2) Device filters

During discovery, NNMi collects direct information through SNMP queries and derives information other than that through device profiles. For details, see 6.1.1 Device profiles and device attributes. By gathering the system object ID, NNMi can index through the correct device profile to derive the following information:

- Vendor
- Device category
- Device family within the category
- Device profile

These derived values, in addition to the device profile itself, are available for use as filters.

For example, you can group all objects from a specific vendor, regardless of device type and family. You can also group all devices of a type, such as routers, across vendors.

(3) Additional filters

With the additional filters editor, you can create custom logic to match fields, including:

- `hostname` (host name)
- `mgmtIPAddress` (management address)
- `hostedIPAddress` (address)
- `sysName` (system name)
- `sysLocation` (system location)
- `sysContact` (system contact)
- `capability` (unique key of the capability)
- `customAttrName` (custom attribute name)
- `customAttrValue` (custom attribute value)
- `isSnmpNode` (agent enabled)
- `isNnmSystemLocal` (NNMi management server)
- `sysOidNode` (system object ID)
- `devCategoryNode` (device category)
- `devVendorNode` (device vendor)
- `devFamilyNode` (device family)
- `nnmSystemName` (host name, case sensitive)

- `nodeName` (node name)
- `securityGroupName` (security group name)
- `securityGroupUuid` (security group UUID)
- `tenantName` (tenant name)
- `tenantUuid` (tenant UUID)

Filters can include the `AND`, `OR`, `NOT`, `EXISTS`, `NOT EXISTS`, and grouping (parentheses) operations. For details, see *Specify Node Group Additional Filters* in NNMi Help.

You can check capabilities by examining the node details from a device that has already been discovered.

(4) Additional nodes

It is better to use **Additional Filters** to qualify nodes for node groups. If the network contains critical devices that are too difficult to qualify using filters, add them to a group by individual host name. Only add nodes to a node group by individual host names as a last resort.

> **Note**
>
> Avoid using the **Additional Nodes** tab to add nodes to a node group, because doing so consumes excessive resources on the NNMi management server.

4.6.3 Node group status

NNMi determines the status of a node group using one of the following algorithms:

- Set the node group status to match the most severe status of any node in the node group. To use this approach, select the **Propagate Most Severe Status** check box on the Status Configuration form.
- Set the node group status using the thresholds set for each target status. For example, the default threshold for the target status of Minor is 20%. NNMi sets the status of the node group to Minor when 20% (or more) of the nodes in the node group have Minor status. To use this approach, clear the **Propagate Most Severe Status** check box on the **Status Configuration** form. You can change the percentage thresholds for the target thresholds on the **Node Group Status Settings** tab of this form.

Because status calculations for large node groups can be resource-intensive, the default for calculation of node group status is set to off for new installations of NNMi. You can enable status calculation with the **Calculate Status** check box on the **Node Group** form for each node group.

4.6.4 Interface groups

Interface groups filter interfaces within nodes by `ifType` or by other attributes, such as `ifAlias`, `ifDesc`, `ifName`, `ifIndex`, IP address, and so forth. Interface groups carry no hierarchy or containment, although you can further qualify membership based on the node group for the node hosting the interface.

Interface groups can be filtered on custom capabilities and attributes similarly to node groups.

Qualifications for interface groups are AND'd together within and across tabs.

Important

Under the following conditions, interfaces in an interface group are not always excluded initially during discovery:

- The interface group was created by filtering on one or more interface capabilities in the interface group definition.
- The interface group is specified in the **Excluded Interfaces** discovery configuration option. After the interface capabilities are applied to an interface in the interface group, that interface will be excluded when the exclusion filter is re-applied during a rediscovery.

For details about the interface capabilities provided by NNMi and the **Excluded Interfaces** discovery configuration option, see the NNMi online Help for Administer.

4.7 Node/interface/address hierarchy

NNMi assigns monitoring settings in the following manner:

1. Interface settings -- NNMi monitors each node's interfaces and IP addresses based on the first matching interface settings definition.

   The first match is the interface settings definition with the lowest ordering number.

2. Node settings -- NNMi monitors each node and each previously unmatched interface or IP address based on the first matching node settings definition.

   The first match is the node settings definition with the lowest ordering number.

   > **Note**
   >
   > Child node groups are included in the ordering hierarchy. If the parent node group has a lower ordering number (for example, *parent*=`10`, *child*=`20`), then the monitoring configuration specified for the parent node group also applies to the nodes in the child node group. To override a parent node group monitoring configuration, set the ordering number for the child node group to a number that is lower than the parent (for example, *parent*=`20`, *child*=`10`).

3. Default settings -- If no match is found for a node, interface, or IP address in step 1 or step 2, NNMi applies the default monitoring configuration settings.

4.8 Resetting the NNMi configuration and database

If you want to completely restart discovery and redo all of the NNMi configuration, or if the NNMi database has become corrupted, you can reset the NNMi configuration and database. This process deletes all of the NNMi configuration, topology, and incidents.

For details about the commands identified in this procedure, see the appropriate reference pages.

To redo the configuration:

1. (Optional) If you want to keep any of the current NNMi configuration, use the `nnmconfigexport.ovpl` command to output the NNMi configuration to an XML file.

   The `nnmconfigexport.ovpl` command does not retain SNMPv3 credentials. For details, see the *nnmconfigexport.ovpl Reference Page*.

2. (Optional) Use the `nnmtrimincidents.ovpl` command to archive the NNMi incidents.

   Specify the `-archiveOnly` option because the default is that the `nnmtrimincidents.ovpl` command does not archive incidents. For details, see the *nnmtrimincidents.ovpl Reference Page*.

3. Stop the NNMi services with the following command:

   ```
   ovstop -c
   ```

4. (Optional) Back up the existing database.

   Because this procedure deletes the database, before proceeding you might want to use the following command to back up the existing database:

   ```
   nnmbackup.ovpl -type offline -target backup-directory
   ```

5. Drop and re-create the NNMi database.

   ```
   nnmresetembdb.ovpl -nostart
   ```

6. Start the NNMi services with the following command:

   ```
   ovstart -c
   ```

   NNMi now has only the default configurations as if you had just installed the product on a new system.

7. Start configuring NNMi. Do one of the following:
   - Use the **Quick Start Configuration Wizard**.
   - Enter information into the **Configuration** workspace on the NNMi console.
   - Use the `nnmconfigimport.ovpl` command to import some or all of the NNMi configuration that you saved in step 1.

     Important

     If you use the `nnmconfigimport.ovpl` command to import a large number of settings (such as settings for 9,500 node groups and 10,000 incidents), consider using the `-timeout` option to adjust the import transaction's timeout value to be greater than the default value of 60 minutes (3,600 seconds). For details, see the *nnmconfigimport.ovpl Reference Page*.

4.9 The model files for the NNMi configuration files

The contents of the configuration file when installing NNMi are copied to the following folder as a model file.

- Windows: `%NnmInstallDir%support\JP1Model_13-00`
- Linux: `/opt/OV/support/JP1Model_13-00`

The model file has the extension "model". After customizing the configuration file, if you want to revert to the default settings, copy the model file and remove the extension "model".

Note

- In the NNMi model file, the default values are saved for the new installation, but in the case of the version upgrade, the settings that were changed before the version upgrade remain as they are.
- Since there are two types of server.properties supported by NNMi, the NNMi installer copies them as follows:

File path	Copy name
• Windows: `%NnmDataDir%nmsas\NNM\server.properties` • Linux: `/var/opt/OV/nmsas/NNM/server.properties`	server.properties.NNM.model
• Windows: `%NnmDataDir%nmsas\nms\server.properties` • Linux: `/var/opt/OV/nmsas/nms/server.properties`	server.properties.nms.model

5 NNMi Communications

NNMi uses both Simple Network Management Protocol (SNMP) and Internet Control Message Protocol (ICMP ping) to discover devices and to monitor device status and health. To establish viable communication in your environment, you configure NNMi with the access credentials and appropriate timeout and retry values for different devices and areas of your network. You can disable a protocol in some areas of your network to reduce traffic or to respect firewalls. The communication values that you configure form the foundation of NNMi discovery and state polling. NNMi applies the appropriate values for each device when making queries for discovery or polling. Thus, if you configure NNMi to disallow SNMP communication within some region of your network, neither NNMi discovery nor NNMi state polling can send SNMP requests to that region.

5.1 Concepts for communications

NNMi uses SNMP and ICMP primarily in a request-response manner. Responses to ICMP ping requests verify address responsiveness. Responses to SNMP requests for specific MIB objects provide more comprehensive information about a node.

> **Note**
>
> If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols. For example, SOAP protocol for VMware environments.

The following concepts apply to NNMi communications configuration:

- Levels of communication configuration
- Network latency and timeouts
- SNMP access control
- SNMP version preferences
- Management address preferences
- Polling protocols
- `nnmsnmp*.ovpl` commands

5.1.1 Levels of communication configuration

NNMi communication configuration provides the following levels:

- Specific nodes
- Regions
- Global defaults

At each level you can configure access credentials, timeout and retry values, management protocol enablement (for example, for ICMP and SNMP), and management protocol access settings (for example, SNMP). If you leave settings blank at one level, NNMi applies the next level of defaults.

When communicating with a given node, NNMi applies the configuration settings as follows:

1. If the node matches a specific node configuration, NNMi uses any communication values in that configuration.
2. If there is no such node as in 1 above, NNMi determines whether the node belongs to any regions. Because regions might overlap, NNMi uses the matching region with the lowest ordering number. NNMi uses the values specified for that region to fill in the blanks left from the applicable specific node setting (if any). The settings for additional regions with a higher ordering number are not considered.
3. If there is no such settings as in 1 and 2, NNMi uses the global default settings to fill in the remaining blanks.

The values used for management protocol communication with a particular device might be built up cumulatively until all required settings are determined.

5.1.2 Network latency and timeouts

Normal network latency influences the amount of time the NNMi management server must wait to get answers to ICMP and SNMP queries. Different areas of a network customarily have different turnaround times. For example, the local network where the NNMi management server resides could provide nearly instantaneous response, while responses from a device in a remote geographical region accessed through a dial-up wide area link would typically take much longer.

In addition, heavily-loaded devices might be too busy to respond to ICMP or SNMP queries immediately. When deciding which timeout and retry settings to configure, consider these latency concerns.

You can configure specific timeout and retry settings for both network regions and specific devices. The settings you choose determine how long NNMi waits for an answer and how many times NNMi requests data before abandoning the request when no answer is received.

For each request retry, NNMi adds the configured timeout value to the previous timeout value. Thus, the pause gets longer after each retry. For example, when NNMi is configured to use a timeout of five seconds and three retries, NNMi waits five seconds for a response to the first request. If there is no response, NNMi waits for 10 seconds for a response to the first request retry, 15 seconds for a response to the second request retry, and 20 seconds for a response to the third request retry before giving up until the next polling cycle.

5.1.3 SNMP access control

Communication with SNMP agents on managed devices requires access control credentials:

- SNMPv1 and SNMPv2c

  A community string in each NNMi request must match a community string configured in the responding SNMP agent. All communication passes through the network in clear text (no encryption).

- SNMPv3

  Communication with the SNMP agent complies with the user-based security model (USM). Each SNMP agent has a list of configured user names and their associated authentication requirements (the authentication profile). Formatting of all communication is controlled through configuration settings. NNMi SNMP requests must specify a valid user and follow the authentication and privacy controls configured for that user.

  - Authentication protocol uses no message authentication or uses hash-based message authentication code (HMAC) with your choice of HMAC-MD5-96, HMAC-SHA-1, HMAC128-SHA-224, HMAC192-SHA-256, HMAC256-SHA-384, or HMAC384-SHA-512.
  - Privacy protocol uses no encryption or uses a symmetric encryption protocol with your choice of DES-CBC, TripleDES, AES-128, AES-192, or AES-256.

    Because DES-CBC is regarded as a weak cipher, we recommend if you are using DES-CBC that you choose a stronger cipher. If you will be configuring SNMPv3 communication on a node managed by NNMi, we recommend that you not use DES-CBC.

  To change the encryption method:

  1. In the NNMi console, click the **Configuration** workspace.
  2. Expand the **Incidents** folder.
  3. Expand the **Trap Server** folder.
  4. Click **Trap Forwarding Configuration**.
  5. From the **Privacy Protocol** list, select a stronger encryption method.

NNMi supports the specification of multiple SNMP access control credentials for a region of your network (defined through IP address filters or host name filters). NNMi attempts communication with a device in that region by trying in parallel all configured values at a given SNMP security level. You can specify the minimum SNMP security level that NNMi is to use in that region. NNMi uses the first value returned by each node (response from the device's SNMP agent) for discovery and monitoring purposes.

In the default HA environment, the SNMP source address is set to the physical cluster node address. To set the SNMP source address to `NNM_INTERFACE` (the virtual IP address), edit the `ov.conf` file to set the `IGNORE_NNM_IF_FOR_SNMP` value to `OFF` (by default, it is `ON`).

5.1.4 SNMP version preferences

The SNMP protocol itself has evolved over the years from version 1 to version 2(c) and now version 3, with increasing security capabilities (among others). NNMi can handle any or a mix of all versions in your network environment.

The first SNMP response NNMi receives for a particular node determines the communication credentials and SNMP version used by NNMi for communication with that node.

The SNMP version selection for a node plays a role in NNMi accepting traps from that node:

- If the source node or source object of the incoming trap has been discovered by NNMi using SNMPv3, NNMi accepts incoming SNMPv1, SNMPv2c, and SNMPv3 traps.
- If the source node or source object of the incoming trap has been discovered by NNMi using SNMPv1 or multiple SNMPv2cs, NNMi discards incoming SNMPv3 traps.

  If these traps must be received, follow the procedure described in 21.8.1 Configuring NNMi to authenticate SNMPv3 traps for nodes that are either managed by using SNMPv2 or SNMPv1 or that are not discovered.

You specify the minimum level of SNMP version and security settings that are acceptable in each area of your network. The options for the **SNMP Minimum Security Level** field are as follows:

- **Community Only (SNMPv1 only)**

  NNMi attempts to communicate using SNMPv1 with the configured values for community strings, timeouts, and retries. NNMi does not try any SNMPv2c or any SNMPv3 settings.
- **Community Only (SNMPv1 or v2c)**

  NNMi attempts to communicate using SNMPv2c with the configured values for community strings, timeouts, and retries. If there is no response to any community string using SNMPv2c, NNMi attempts to communicate using SNMPv1 with the configured values for community strings, timeouts, and retries. NNMi does not try any SNMPv3 settings.
- **Community**

  NNMi attempts to communicate using SNMPv2c with the configured values for community strings, timeouts, and retries. If there is no response to any community string using SNMPv2c, NNMi attempts to communicate using SNMPv1 with the configured values for community strings, timeouts, and retries. If none work, NNMi tries SNMPv3.
- **No Authentication, No Privacy**

  For users with no authentication and no privacy, NNMi attempts to communicate using SNMPv3 with the configured values for timeouts and retries. If none work, NNMi tries users with authentication and no privacy followed by users with authentication and privacy, if necessary.
- **Authentication, No Privacy**

For users with authentication and no privacy, NNMi attempts to communicate using SNMPv3 with the configured values for timeouts and retries. If none work, NNMi tries users with authentication and privacy.

- **Authentication, Privacy**

  For users with authentication and privacy, NNMi attempts to communicate using SNMPv3 with the configured values for timeouts and retries.

5.1.5 Management address preferences

A node's *management address* is the address NNMi uses to communicate with the node's SNMP agent. You can specify the management address for a node (in the specific node settings), or you can let NNMi choose an address from the IP addresses associated with the node. You can fine-tune this behavior in the discovery configuration settings by excluding certain addresses from discovery. For details about how NNMi determines the management address, see *Node Form* in NNMi Help.

> **Note**
>
> To discover hypervisors NNMi requires the node name rather than the management address.

NNMi discovers and monitors devices on an ongoing basis. After the first NNMi discovery cycle, the **Enable SNMP Address Rediscovery** field controls NNMi behavior when previously discovered SNMP agents quit responding (for example, when you reconfigure the device's SNMP agent).

- If the **Enable SNMP Address Rediscovery** check box is selected, NNMi retries any configured values in search of one that works.
- If the **Enable SNMP Address Rediscovery** check box is cleared, NNMi reports the device as **Down** and does not attempt to find another communication configuration setting for that device.

The **Enable SNMP Address Rediscovery** check box is available at all levels of communication configuration.

The **Discover Any SNMP Device** and **Discover Non-SNMP Devices** auto-discovery rule configuration fields influence the way NNMi uses SNMP. For details, see *Configure Basic Settings for the Auto-Discovery Rule* in NNMi Help.

5.1.6 SNMPv3 traps and informs

When NNMi uses SNMPv3 to communicate with a device, it uses a discovery process to identify the device's engine ID, boot count, and engine time. NNMi then uses this information, together with the configured user and protocol details, to start sending messages to the device.

A device might not have the NNMi information when it needs to send a trap to NNMi, and because a trap is a single-packet transaction, it has no way to obtain the necessary information. In such a case, the device uses its own engine ID, boot count, and engine time in the trap, together with the user name and protocol details. These device details must be the same as those configured for the device in NNMi. You cannot configure multiple SNMPv3 users for a single device in NNMi.

An inform is an acknowledged packet, so this is more like an SNMP request that NNMi would make to the device except, this time, it is the device initiating the first packet and NNMi responding with an acknowledgment. The device, therefore, performs the discovery to NNMi to learn NNMi's engine ID, boot count, and engine time. The user name and protocol configuration that the device uses must match what is configured in the NNMi trap forwarding configuration; this is, in effect, NNMi's SNMPv3 agent configuration.

5.1.7 Polling protocols

You can prevent NNMi from using SNMP or ICMP in portions of your network (for example, when firewalls in your infrastructure prohibit ICMP or SNMP traffic).

Disabling ICMP traffic to the devices in an area of the network has the following results in NNMi:

- The optional auto-discovery rule Ping sweep feature cannot locate additional nodes in that region of your network. All nodes must either be seeded or available through answers to MIB object requests, such as neighbor's ARP cache, Cisco Discovery Protocol (CDP), or Extreme Discovery Protocol (EDP). Wide area network devices might be missed unless you seed every one of them.
- The State Poller cannot monitor devices that are not configured to respond to SNMP requests.
- Operators cannot use **Actions** > **Node Access** > **Ping** to check device reachability during troubleshooting.

Disabling SNMP traffic to the devices in an area of the network has the following results in NNMi:

- Discovery cannot gather any information about the devices except that they exist. All devices receive the **No SNMP** device profile.
- Discovery cannot find additional neighboring devices through queries. All devices must be directly seeded.
- Discovery cannot gather connectivity information from the devices, so they appear unconnected on NNMi maps.
- For devices with the **No SNMP** device profile, the State Poller respects the defaults of monitoring that device using only ICMP (ping).
- The State Poller cannot gather component health or performance data from the devices.
- The Causal Engine cannot contact the devices to perform neighbor analysis and locate the root cause of incidents.

5.1.8 nnmsnmp*.ovpl commands

The `nnmsnmp*.ovpl` commands look up the values for unspecified device communication settings in the NNMi database. This approach requires that the `ovjboss` process be running. If the `ovjboss` process is not running, an `nnmsnmp*.ovpl` command behaves as follows:

- For SNMPv1 and SNMPv2c agents, the command uses default values for any unspecified communication settings.
- For SNMPv3 agents, if you specify a user and password, the command uses default values for any unspecified communication settings. If you do not specify a user and password, the command fails.

5.2 Creating a communication plan

Evaluate the following items and create a communication plan:

- Default communication settings
- Communication configuration regions
- Specific node configurations
- Retry and timeout values
- Active protocols
- Multiple community strings or authentication profiles

5.2.1 Default communication settings

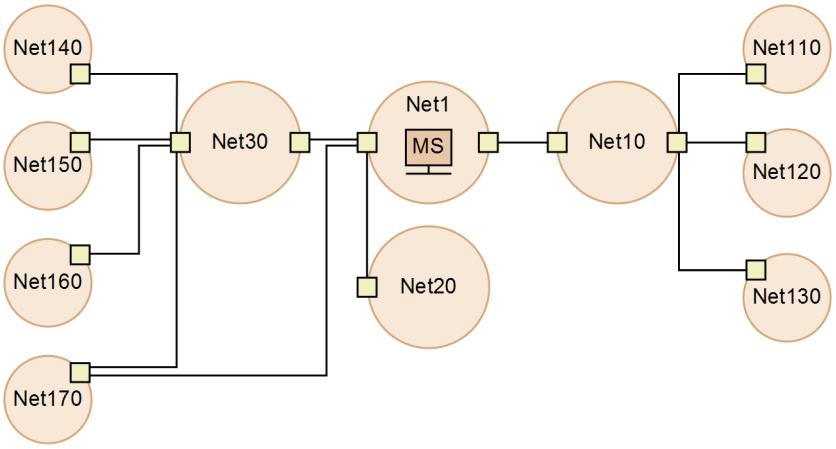
Because NNMi uses default values to complete any configuration settings that were not specified for the applicable region or specific node, set defaults to be reasonable for the majority of your network.

- Are there commonly-used community strings that NNMi has to try?
- What default timeout and retry values are reasonable in your network?
- Which SNMP traps are sent from network devices to NNMi?

5.2.2 Communication configuration regions

Regions represent areas of the network where similar communication settings make sense. For example, the local network around the NNMi management server usually returns responses very quickly. Areas of your network that are multiple hops away typically take longer to respond.

You do not need to configure each subnet or area of your network. You can combine areas into one region based on similar lag times. Consider the following network map:



For timeout and retry purposes, you might want to configure the following regions:

- Region A for Net 1
- Region B to include Net 10, Net 20, and Net 30

- Region C for the more distant outlying networks

You would decide how best to group Net 170, depending on whether traffic management configuration is set to prefer the one-hop path or the two-hop path from the NNMi management server.

Regions are also used to group devices with similar access credentials. If all routers in your network use the same community string (or a small set of possible community strings) and you can identify the routers with a naming convention (for example, `rtrnnn.yourdomain.com`), you can configure a region containing all routers so that they are handled similarly. If you cannot use a wildcard to group the devices, you can configure each as a specific node.

Plan your region configurations so that you can apply the same timeout and retry values and access credential configurations to all nodes in a region.

Region definitions can overlap, and a device might qualify for multiple regions. NNMi applies the settings from the region with the lowest ordering number (and no other matching regions).

5.2.3 Specific node configurations

For any device with unique communication configuration requirements, use the specific node settings to specify the communication settings for that node. Example uses of specific node settings include the following:

- A node that might not respond well to SNMPv2c/SNMPv3 `GetBulk` requests
- A node whose name does not match the name pattern of other similar nodes

You can enable or disable SNMP communication for a specific device. For details, see *Specific Node Settings Form (Communication Settings)* in NNMi Help.

5.2.4 Retry and timeout values

Configuring longer timeouts and more retries can result in more responses from devices that are busy or distant. This higher response rate eliminates false down messages. However, it also lengthens the time to determine that actual down devices require attention. Finding the balance for each area of your network is important and might require a period of testing and adjusting values in your environment.

To get an idea of the current lag time for each hop, execute the following commands:

- In Windows: Execute `tracert` for a device in each network area
- In Linux: Execute `traceroute` for a device in each network area

5.2.5 Active protocols

You can control the type of traffic NNMi generates when communicating with devices in your network by using communication and monitoring configuration settings. Use the communication settings when firewalls in your infrastructure prohibit ICMP or SNMP traffic. Use monitoring settings to fine-tune protocol usage when you do not need a particular subset of data about devices. If either communication settings or monitoring settings disable a protocol for a device, NNMi does not generate that type of traffic to the device.

> **Note**
>
> Disabling SNMP communication significantly compromises device management capabilities, such as troubleshooting, because the details of devices cannot be obtained.

Note whether each region or specific device needs to receive ICMP traffic.

You do not need to explicitly disable SNMP communication with devices for which you do not supply access credentials. By default, NNMi assigns those devices to the **No SNMP** device profile and monitors them using ICMP only.

If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols (for example, SOAP protocol for VMware environments).

5.2.6 Community strings and authentication profiles

Plan the community strings and authentication profiles to be tried for each area of your network. For the default and region settings, you can configure multiple community strings and authentication profiles to be tried in parallel.

> **Note**
>
> While trying probable community strings, NNMi queries might cause devices to generate authentication failures. Inform your operations department that authentication failures might safely be ignored while NNMi completes its initial discovery. Alternatively, you can minimize the number of authentication failures by configuring as tightly as possible your regions and the associated community strings and authentication protocols to try.

If your environment uses SNMPv1 or v2 and SNMPv3, determine the minimum acceptable security level for each region.

(1) SNMPv1 and SNMPv2 community strings

For regions where SNMPv1 or SNMPv2c access is acceptable, gather the community strings in use within the region and any unique community strings required by specific devices.

(2) SNMPv3 authentication profiles

For regions containing SNMPv3-accessible devices, determine the minimum acceptable default authentication profiles, the authentication profiles appropriate for each region, and the unique authentication credentials in use on specific devices (if any). Also determine the authentication and privacy protocols in use within your network. You can specify one authentication protocol and one privacy protocol for each specific node or region setting.

For SNMPv3 communication, NNMi supports the following authentication protocols:

- `HMAC-MD5-96`
- `HMAC-SHA-1`
- `HMAC128-SHA-224`
- `HMAC192-SHA-256`
- `HMAC256-SHA-384`

- HMAC384-SHA-512

For SNMPv3 communication, NNMi supports the following privacy protocols:

- DES-CBC
- TripleDES
- AES-128
- AES-192
- AES-256

5.3 Configuring communications

This section explains the following:

- Configuring SNMP proxy settings
- Using NETCONF for device support
- Discover and monitor VMware hypervisor-based virtual networks
- Discover and monitor Cisco ACI networks
- Multihomed NNMi Management Server

After reading the information in this section, see *Configuring Communication Protocol* in NNMi Help for specific procedures.

> **Note**
>
> It is a good idea to save a copy of the existing configuration before you make any major configuration changes. For details, see 4.2 Best practice: Save the existing configuration.

Configure the following areas of communication:

- Default settings
- Region definitions and their settings
- Specific node settings

  For specific nodes, you can enter node settings through the NNMi console or through a configuration file.

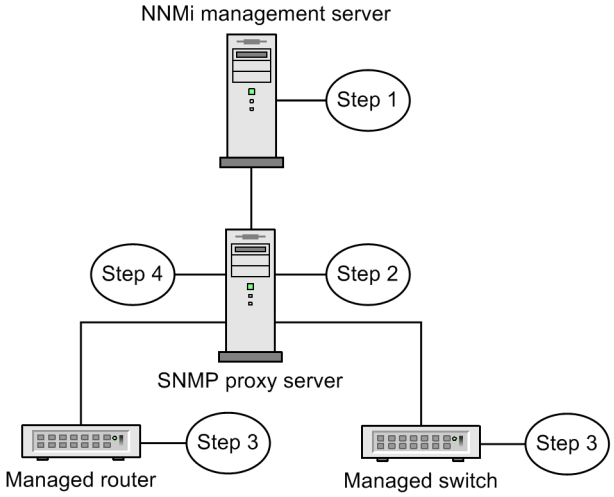
  > **Tip**
  >
  > Double-check the ordering numbers for the defined regions. If a node qualifies for membership in multiple regions, NNMi applies to that node the settings from the region with the lowest ordering number.

5.3.1 Configuring an SNMP proxy

Some networks use an SNMP proxy agent to communicate with network devices. The following diagram shows the SNMP communication steps NNMi uses if you configure an **SNMP Proxy Address** and an **SNMP Proxy Port** using **Configuration** > **Communication Configuration** from the NNMi console.

> **Tip**
>
> For the alternate method of configuring SNMP proxy settings from the command line, see the nnmcommunication.ovpl reference page.

Figure 5-1: Using proxy servers



1. The NNMi management server sends an SNMP request to the SNMP proxy address and SNMP proxy port to obtain information from the managed router and switch. The NNMi management server uses the special proxy varbind `SecurityPackAgentAddressOid` OID (`.1.3.6.1.4.1.99.12.45.1.1`) to encode the remote address and port of the managed router and switch, and then adds this varbind to the SNMP request.
2. The SNMP proxy server reads this special proxy varbind, determines the destination of the SNMP request, and then sends the SNMP request to the managed router and switch to obtain the information requested by the NNMi management server.
3. The managed router and switch respond to the SNMP proxy server (using the SNMP proxy address and SNMP proxy port) and return the requested information.
4. The SNMP proxy server responds to the NNMi management server (using the configured SNMP port).

   Note: NNMi supports SNMP proxy servers that support using the `SecurityPackAgentAddressOid` OID (`.1.3.6.1.4.1.99.12.45.1.1`). Use the following property to include this OID in SNMP requests for devices using SNMP proxy settings:

   ```
   com.hp.nnm.snmp.USE_PROXY_VARBIND=true
   ```

   The default setting for this property is `false`.
5. The SNMP proxy server forwards SNMP informs and traps from the managed devices to NNMi.

   NNMi supports the use of the following OIDs to determine the source of incoming traps forwarded from an SNMP proxy:

   - `TrapForwardingAddressTypeOid .1.3.6.1.4.1.11.2.17.2.19.1.1.2.0` (HP)
   - `TrapForwardingAddressOid .1.3.6.1.4.1.11.2.17.2.19.1.1.3.0` (HP)
   - `Rfc3584TrapAddressOid .1.3.6.1.6.3.18.1.3.0` (RFC 3584)
   - `Rfc3584TrapCommunityOid .1.3.6.1.6.3.18.1.4.0` (RFC 3584)

   When using NNMi with an SNMP proxy server, ask the proxy vendor if they support the OIDs in this list.

5.3.2 Using NETCONF for device support

NNMi relies primarily on the Simple Network Management Protocol (SNMP) as the method for collecting management information from supported devices. However, NNMi might also use the Network Configuration Protocol (NETCONF) for some specific vendor devices whose required management information is not reported when SNMP is used.

Currently, NNMi uses NETCONF to support Juniper Networks QFabric systems only.

The following sections provide a brief introduction to NETCONF and explain the configuration required for both the managed devices and NNMi in order to support such devices in NNMi.

(1) What is NETCONF?

NETCONF, like SNMP, is an Internet Engineering Task Force (IETF) standard for network management. NETCONF is defined by IETF Request for Comments (RFC) 4741 and 4742 (Version 1), later updated by RFC 6241 and 6242 (Version 1.1).

NETCONF is intended primarily for use as a device configuration mechanism, whereas SNMP is used most commonly for monitoring, polling, and fault notification. Both protocols report management information that is useful to NNMi.

NNMi uses NETCONF to collect information about devices during discovery or rediscovery (in other words, it collects read-only information). NNMi does not use NETCONF to modify the device configuration or to monitor status or provide performance metrics.

NETCONF is an XML-formatted command-and-response protocol that runs primarily over Secure Shell (SSH) transport. The NETCONF protocol is similar in some ways to the traditional device console Command Line Interface (CLI), except that the XML-formatted commands and results are designed for management applications, rather than human interaction with the devices.

Because NETCONF is a relatively new management protocol, it is not as widely available among device vendors as is SNMP.

Note the following in the case of a vendor who has implemented NETCONF in a device that NNMi is managing:

- NETCONF commands are generally more vendor specific and are not as well publicized as the many standard and vendor-specific MIBs in SNMP. Consequently, NNMi's capability to utilize NETCONF is still quite limited.
- Where a specific vendor implements NETCONF in its devices and reports the management information that NNMi needs, you must add that device-specific NETCONF support in NNMi.

For details, see (3) Enabling and configuring NETCONF in a managed device and (4) Configuring NETCONF device credentials in NNMi.

(2) NETCONF protocol operation

Details of NETCONF communication between NNMi and the managed devices are transparent to the NNMi user. However, the following overview might be helpful for troubleshooting:

1. A NETCONF client (management application, such as NNMi) establishes an SSH connection with the NETCONF server (subsystem) on a managed device.

   Valid SSH user name and password credentials must be specified by the client and authenticated by the device.
2. The client application and device exchange capabilities in the form of `<hello>` messages.
3. The client initiates requests to the device in the form of Remote Procedure Call (RPC) messages, including standard `<get>` or `<get-config>` operations, plus any vendor-specific operations that are defined for the device.
4. The device responds with the results of operations in the form of RPC reply messages.
5. When the client application is done sending requests and processing the responses, it sends a `<close-session>` RPC message to the device.
6. The device acknowledges with an `<ok>` RPC reply message.

7. Both sides then terminate the SSH connection.

(3) Enabling and configuring NETCONF in a managed device

Before NNMi can communicate with a managed device, it might be necessary to explicitly enable and configure NETCONF in that device. See your vendor's device configuration documentation for specific instructions.

In general, the following prerequisites must be satisfied on the managed device:

- Enable NETCONF on either the default NETCONF TCP port 830 or on the standard SSH TCP port 22.
- Configure SSH user name and password credentials on the device for NETCONF communication access.

NNMi requires only read-only access.

(4) Configuring NETCONF device credentials in NNMi

You must configure NETCONF SSH credentials in NNMi to match those configured in the managed device before NNMi can use NETCONF for communicating with that device.

If proper NETCONF credentials are not configured for a device, NNMi discovery proceeds (using SNMP only); however, the management information reported in NNMi for that device might be incomplete.

You use **Communication Configuration** in the NNMi console to configure NETCONF device credentials settings in the **Device Credentials** tab of the relevant **Specific Node Settings**, **Regions**, or **Default Device Credentials** for the device.

Important

You can configure only a single SSH user and password for each managed device. This means that the same set of credentials is used for both regular SSH and NETCONF sessions with that device.

Once configured, NNMi uses the new credentials during the next discovery cycle for the specified device (node).

For details about how to edit the NNMi **Communication Configuration** forms, see NNMi Help for Administer.

5.3.3 Discover and monitor VMware hypervisor-based virtual networks

(1) Prerequisites to Monitor Virtual Machines Hosted on Hypervisors

NNMi supports:

- Discovery and monitoring of supported hypervisors.
  On the hypervisor's node form, each virtual machine is listed on the Hosted Nodes tab.
- Discovery and monitoring of each virtual machine (routers, switches, nodes, etc.).
  On the virtual machine's node form, a Hosted On Node attribute shows the hypervisor's name.

The following table describes the pre-requisites for discovering hypervisors and the virtual machines

Table 5-1: Pre-Requisites for Monitoring hypervisor and its VMs

What you want to discover?	Prerequisite(s)	For more information
Hypervisor	The hypervisor must support SNMP communication and be accessible from NNMi using SNMP.	Not Applicable
	NNMi must be configured to communicate with the associated SNMP Agent (IP Address and Community String or SNMPv3 authentication).	To configure using NNMi user interface, see Help for Administer > Configuring Communication Protocol, see instructions for SNMP settings for Default, Regions, or Specific Nodes. To configure using command line interface (CLI), see the nnmcommunication.ovpl reference page, or the Linux manpage, for more information.
	NNMi must be configured to communicate with the hypervisor using HTTPS. **Note:** (VMware only) You must replace the VMware default certificate (localhost.localdomain) with a certificate that is generated using the hostname of the ESXi server. For more information, see the VMware documentation.	To configure using CLI, see "(3) Configuring NNMi to Communicate with Hypervisors Using HTTPS" . To configure using NNMi user interface, see Help for Administer > Configuring Communication Protocol, instructions for Trusted Certificate Settings for Default, Regions, or Specific Nodes.
Virtual Machines on the hypervisor	In addition to the SNMP requirements mentioned for hypervisors, you need to configure the hypervisor device credentials in NNMi to authenticate with the hypervisor's web-service.	To configure using NNMi user interface, see Help for Administer > Configuring Communication Protocol, instructions for Credential Settings for Default, Regions, or Specific Nodes. To configure using CLI, see nnmcommunication.ovpl reference page.

(2) Replacing the VMware Default Certificate

Important

The self-signed or CA-signed certificate must be generated using the fully qualified domain name as the hostname for the ESXi server.

By default, a VMware certificate uses `localhost.localdomain` as the hostname for the ESXi server.

It is necessary to replace the VMware default certificate with the certificate generated by using the host name of the ESXi server. For details about the procedure, see the VMware documentation.

(3) Configuring NNMi to Communicate with Hypervisors Using HTTPS

This section provides instructions to upload certificates by using the CLI. For upload instructions using NNMi user interface, see Help for Administer > Configuring Communication Protocol.

Note

- If you need to use HTTP to communicate with hypervisors, also see "(4) Enable HTTP to Communicate with Hypervisors".
- To enable NNMi to monitor VMs hosted on a hypervisor (such as VMWare ESXi) using HTTPS protocol, you must upload the hypervisor's trusted certificate to NNMi by using one of the following options:

- Upload trusted certificate using NNMi user interface.
- Upload trusted certificate by using command line interface (CLI).

- A Trusted Certificate is an SSL certificate that NNMi uses to establish trusted connection with hypervisors using HTTPS protocol. At Default and Region levels, it is a CA certificate that NNMi uses to trust hypervisors that use the certificates issued by the same CA. At Node level, it is the hypervisor's SSL certificate (self-signed or CA signed) generated by using FQDN as the subject name.

To upload a trusted certificate to NNMi, follow these steps:

1. Obtain the hypervisor's trusted certificate and copy it to a temporary location on the NNMi management server.

   Note

   (VMware only) You must replace the VMware default certificate (`localhost.localdomain`) with a certificate that is generated using the hostname of the ESXi server. For more information, see the VMware documentation.

2. Verify that the certificate is of the supported format. The supported trusted certificate file extensions are .pem, .crt, .cer and .der.
3. Execute the appropriate command to upload the certificate at the required level. From the following table, choose the command that meets your requirements:

Level	Purpose	Command
Default (Global)	To upload a trusted certificate at the default level for organizations that use certificates signed by the same CA on hypervisors globally.	nnmcommunication.ovpl addCertificate -default -cert <fully qualified path to the certificate file>
Region	To upload a trusted certificate for the region for organizations that use certificates signed by the same CA on hypervisors in a given region.	nnmcommunication.ovpl addCertificate -region <region name or UUID> -cert <fully qualified path to the certificate file>
Node	To upload an SSL certificate (CA-Signed or Self-Signed certificate) used on a specific hypervisor. **Note:** The self-signed or CA-signed certificate must be generated using the fully qualified domain name (FQDN) as the subject name.	nnmcommunication.ovpl addCertificate -nodeSetting <node name or UUID> -cert <fully qualified path to the certificate file>

   Sample Commands:

   - **Default:** `nnmcommunication.ovpl addCertificate -default -cert /tmp/new.pem`
   - **Region:** `nnmcommunication.ovpl addCertificate -region region1 -cert /tmp/region1.der`
   - **Node:** `nnmcommunication.ovpl addCertificate -nodeSetting node1 -cert /tmp/node1.crt`

4. Upon successful execution, the command output displays information about the uploaded certificate. Verify the certificate information.

Tip

- You can view or delete the uploaded certificates by using listCertificates and removeCertificate commands. See the nnmcommunication.ovpl reference page for more information.

- After a hypervisor is discovered, you can upload, replace, or delete a certificate directly on the Web Agent by using the command updateWebagentSettings. See the nnmcommunication.ovpl reference page for more information.

(4) Enable HTTP to Communicate with Hypervisors

By default. NNMi uses the HTTPS protocol to communicate with hypervisors.

If you need to use HTTP, add the required property to the `server.properties` file:

1. Navigate to the `server.properties` file:

   Windows: `%NnmDataDir%nmsas\NNM\server.properties`

   Linux: `$NnmDataDir/nmsas/NNM/server.properties`

2. Add the following lines:

```
#Determines whether http should be used to communicate with SOAP agents such as th
e VMware vSphere API.
#HP recommends this property only be enabled in demonstration or test environments
 and that HTTPS be
#configured for production environments.
nms.comm.soap.targetconfig.HTTP_ENABLED=true
```

3. Restart the NNMi management server:

   Run the `ovstop` command on the NNMi management server.

   Run the `ovstart` command on the NNMi management server.

To disable HTTP for hypervisor communication:

1. Navigate to the server.properties file:

   Windows: `%NnmDataDir%nmsas\NNM\server.properties`

   Linux: `$NnmDataDir/nmsas/NNM/server.properties`

2. Change the HTTP_ENABLED property value to false:

```
nms.comm.soap.targetconfig.HTTP_ENABLED=false
```

3. Restart the NNMi management server:

   Run the `ovstop` command on the NNMi management server.

   Run the `ovstart` command on the NNMi management server.

4. Follow the steps described in "(3) Configuring NNMi to Communicate with Hypervisors Using HTTPS".

5.3.4 Discover and monitor Cisco ACI networks

If you want to discover and monitor networks running on Cisco ACI, you must perform the following additional tasks:

Task 1: Create a read-only user in the Cisco APIC console

Create a Cisco APIC user with read-only privilege; the user must have read access to all REST APIs of Cisco APIC. This user will be used by NNMi to discover Cisco APIC systems. While creating the user, select **all** in the **Security Domain** section on the **Create Local User** page.

Task 2: Configure NNMi to communicate with Cisco APIC systems

For each Cisco APIC system that you want to discover, provide the access credentials by using the **Device Credentials** form. These credentials help NNMi connect with Cisco APIC systems. Also, to facilitate HTTPS communication between NNMi and Cisco APIC systems, you must upload Cisco ACI or CA-trusted certificates to the NNMi management server.

To have the system recognize a Cisco ACI node as a Cisco ACI node, it is necessary to ensure that each node is detected as an SNMP node.

Follow these steps to complete this task:

1. Identify one Cisco APIC system in each cluster that you want to discover. Make sure that the SNMP agent is enabled on every Cisco APIC system in all the clusters that you want to discover.

   Discovering only one Cisco APIC system in an APIC cluster enables NNMi to eventually discover all the Cisco APIC systems in the cluster.

2. Obtain all trusted certificates for use with Cisco APIC systems.

   You can use a set of certificates where each certificate is specific for a particular Cisco APIC system; you can use CA-signed certificates; you can use a combination of the two.

3. Configure NNMi to communicate with Cisco APIC systems by accessing the Cisco ACI APIs.

   a. Obtain the credentials that were created in **Task 1: Create a read-only user in the Cisco APIC console**.

   b. In the **Communication Configuration** form, go to the **Specific Node Settings** tab.

   > **Tip**
   >
   > You will be able to access the API of Cisco ACI and communicate with the Cisco APIC system regardless of whether you are using region settings, or are using the default settings.

   c. Add a new node.

   In the **Specific Node Settings** tab, click **New**, and then define a new node in the **Specific Node Settings** form.

   Or, double-click an existing node.

   d. In the **Specific Node Settings** form, go to the **Device Credentials** tab.

   e. Click **New**.

   f. Specify the SNMP v1 or v2c community string or SNMPv3 credentials in the **SNMPv1/v2 Community Strings** or **SNMPv3 Settings** tab.

   g. In the **Specific Node Device Credentials** form, select **Type** as **CiscoACI**, and then specify the credentials of the Cisco ACI user that you created in **Task 1: Create a read-only user in the Cisco APIC console**.

   h. Upload trusted certificates. Skip this step if you want to configure HTTP communication.

      a. In the **Specific Node Settings** form, go to the **Trusted Certificates** tab.

      b. Click **Upload Certificate**.

      The **Open** window appears.

      c. In the **Open** window, select a certificate, and then click **Open**.

      You can use any one of the following:

      - A CA-signed certificate to communicate with the Cisco APIC system

        You can use only the following certificate formats:

        - `.pem`
        - `.crt`

- `.cer`
- `.der`

i. Click **Save & Close**.

Task 3: Configure and run discovery

Configure NNMi to seed the Cisco APIC systems in the environment. While configuring seeding, specify fully qualified domain names or IP addresses of one Cisco APIC system in each cluster that you want to discover.

Wait for NNMi discovery to gather information. NNMi discovers the APIC clusters and all the Cisco ACI Leaf and Spine nodes managed by the discovered Cisco APIC systems.

> **Note**
>
> If the settings described in task 1 to task 3 are not specified and Cisco ACI nodes are detected, it is necessary to run configuration polls for the Cisco APIC nodes twice in order to monitor Cisco ACI network using this function.

5.3.5 Multihomed NNMi Management Server

When an NNMi management server is configured to have multiple IP addresses, managed nodes always use the IP address configured with the operating system on the NNMi management server. If you want to configure NNMi to use a non-default IP address while communicating and exchanging data with managed nodes, follow the procedure in this section.

1. Log on to the NNMi Management Server.
2. Open the following file with a text editor:
   - **Windows:** `%NnmDataDir%shared\nnm\conf\props\nms-communication.properties`
   - **Linux:** `/var/opt/OV/shared/nnm/conf/props/nms-communication.properties`
3. To set a non-default IPv6 address, uncomment the `com.hp.ov.nms.comm.snmp.sourceAddress.IPv6` property, and then set the property to an IPv6 address of your choice.
4. To set a non-default IPv4 address, uncomment the `com.hp.ov.nms.comm.snmp.sourceAddress.IPv4` property, and then set the property to an IPv4 address of your choice.

   > **Important**
   >
   > - If NNMi is installed in an HA cluster, you must reconfigure NNMi. The value of the `NNM_INTERFACE` property in the `ov.conf` file must match the value specified with the `com.hp.ov.nms.comm.snmp.sourceAddress.IPv4` property in the `nms-communication.properties` file. For the location of the `ov.conf` file, see 19.9.1 NNMi HA configuration files.
   > - If you change a file while the system is operating in High Availability (HA) mode, you must make the change on both nodes in the cluster. When you use NNMi in an HA configuration, if the change requires you to stop and restart the NNMi management server, you must place the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

5. Save the changes.
6. Execute the following commands to restart the NNMi services:

```
ovstop -c
ovstart -c
```

5.4 Evaluating communications

This section lists ways to evaluate the progress and success of the communication settings. Most of these tasks can be completed only after discovery has completed.

Consider the following:

- Are all nodes configured for SNMP?
  See 5.4.1 Checking all nodes for SNMP configuration.
- Is SNMP access currently available for a device?
  See 5.4.2 Checking SNMP access.
- Is the management IP address correct?
  See 5.4.3 Checking the management IP address for SNMP Devices.
- Is NNMi using the correct communication settings?
  See 5.4.4 Checking the communication settings.
- Do the State Poller settings agree with the communication settings?
  See 5.4.5 Checking whether the monitoring configuration matches the communication settings.

5.4.1 Checking all nodes for SNMP configuration

1. Open the **Nodes** inventory view.
2. Filter the **Device Profile** column to contain the string `No SNMP`.
   - For each device that you want to manage, configure communication settings for the specific node. Alternatively, you can expand a region to include the node and update the access credentials.
   - If the communication settings are correct, verify that the SNMP agent on the device is running and properly configured (including ACLs).

5.4.2 Checking SNMP access

1. Select the node in an inventory view.
2. Choose **Actions**, **Polling**, and then **Status Poll**, or choose **Actions**, **Polling**, and then **Configuration Poll**.
   If the results show any SNMP values, communication is operational.

You can also test communication from the command line with the `nnmsnmpwalk.ovpl` command. For details, see the *nnmsnmpwalk.ovpl Reference Page*.

5.4.3 Checking the management IP address for SNMP Devices

To determine which management address NNMi has selected for a device, follow these steps:

1. Select the node in an inventory view.
2. Choose **Actions**, **Configuration Details**, and then **Communication Settings**.

3. In the Communication Configuration window, verify that the management address of the SNMP agent listed in the **Active SNMP Agent Settings** list is correct.

5.4.4 Checking the communication settings

Missing or incorrect SNMP community strings can result in incomplete discovery or can negatively affect discovery performance.

To verify the communication settings configured for a device, use the `nnmcommconf.ovpl` command or follow these steps:

1. Select the node in an inventory view.
2. Choose **Actions**, **Configuration Details**, and then **Communication Settings**.

   NNMi evaluates all region and default settings by using a specific node match and ordering number to obtain the displayed value.
3. In the Communication Configuration window, verify that the values listed in the SNMP configuration settings table are the settings you want NNMi to use for this node.

   If the communication settings are not correct, use the source information in the SNMP configuration settings table as a starting point for fixing the problem. You might need to change the configuration or the ordering number of a region or specific node.

> **Note**
>
> For VMware communication, verify the active settings in the Web Agent form or use the nnmcommunication.ovpl listWebAgentSettings command.
>
> For more information, see the NNMi Help for Administer.

5.4.5 Checking whether the monitoring configuration matches the communication settings

Even if the communication settings permit protocol traffic to an area of your network, that type of traffic might be disabled in the monitoring settings. To determine whether the settings are being overridden:

1. Select the node in an inventory view.
2. Choose **Actions**, **Configuration Details**, and then **Monitoring Settings**.

If either the monitoring settings or the communication settings disable a type of traffic to the device, that traffic will not be sent from NNMi.

5.5 Tuning communications

Reducing authentication failures

If NNMi is generating too many authentication traps during discovery, configure smaller regions or specific nodes with smaller groups of access credentials for NNMi to try.

Tuning timeouts and retries

When NNMi attempts to contact a device using SNMP during discovery, the communication configuration determines whether NNMi can gather the necessary device information. When the communication configuration does not include the correct SNMP community strings, or if NNMi is discovering non-SNMP devices, NNMi uses the configured settings for SNMP timeouts and retries. In this case, large timeout values or a high number of retries can negatively affect the overall performance of discovery. If your network contains devices that you know respond slowly to SNMP/ICMP requests, consider using the **Regions** or **Specific Node Settings** tabs on the **Communication Configuration** form to fine-tune the timeout and retry values for just these devices.

Reducing default community strings

Having a large number of default community strings can negatively affect discovery performance. Instead of entering many default community strings, fine-tune the community string configuration for particular areas of your network by using the **Regions** or **Specific Node Settings** tabs on the **Communication Configuration** form.

6 NNMi Discovery

One of the most important network management tasks is keeping your view of the network topology current. NNMi discovery populates the topology inventory with information about the nodes in your network. NNMi maintains this topology information through ongoing spiral discovery, which ensures that root cause analysis and the troubleshooting tools provide accurate information regarding incidents.

This chapter provides information to help you configure NNMi discovery. For an introduction to how discovery works and for detailed information about how to configure discovery, see *Discovering Your Network* in NNMi Help.

6.1 Concepts of discovery

NNMi's default setting for discovering only routers and switches enables you to focus your network management on the critical or most important devices. In other words, target the backbone of the network first. In general, avoid managing end nodes (for example, personal computers or printers) unless the end node is identified as a critical resource. For example, database and application servers might be considered critical resources.

NNMi provides several ways to control the devices to be discovered and included in the NNMi topology. Your discovery configuration can be very simple, quite complex, or anywhere in between, depending on how your network is organized and what you want to manage with NNMi.

> **Important**
>
> NNMi does not perform any default discovery. You must configure discovery before any devices appear in the NNMi topology.

Each discovered node (physical or virtually hosted) counts toward the license limit, regardless of whether NNMi is actively managing that node. The capacity of your NNMi license might influence your approach to discovery.

When tracking license information, note the following:

- Consumption: NNMi discovers and manages nodes up to the NNMi licensed capacity limit (rounded up):
- VMware environments: Each device with a Device Profile of vmwareVM is equivalent to 1/10th node.
  All other devices are equivalent to one discovered node.

If the number of discovered nodes reaches or exceeds the licensed capacity limit, no new nodes are discovered unless one of the following occurs:

- Install a license extension.
- Review your configuration settings and limit NNMi discovery to only the important nodes in your network environment. Then, delete nodes and let NNMi rediscovery reset the managed inventory of nodes.

For details about the configuration for discovering many nodes, see NNMi Help.

Status monitoring considerations might also influence your choices. By default, the State Poller only monitors interfaces connected to devices NNMi has discovered. You can override this default for some areas of your network, and you can discover devices beyond the limits of your responsibility. (For details about State Poller, see 7. NNMi State Polling.)

NNMi provides two primary discovery configuration models:

- *List-based discovery* -- Uses a list of seeds to explicitly tell NNMi exactly which devices to add to the database for monitoring.
- *Rule-based discovery* -- Tells NNMi which areas of your network and device types to add to the database, gives NNMi a starting address in each area, and then lets NNMi discover the defined devices.

You can use any combination of list-based and rule-based discovery to configure the devices for NNMi to discover. Initial discovery adds these devices to the NNMi topology, and then spiral discovery routinely rediscovers the network to ensure that the topology remains current.

NNMi uses tenants to support networks containing overlapping address domains. Overlapping address domains might exist in the static network address translation (NAT), dynamic network address translation (NAT), or port address

translation (PAT) area in the network management domain. To handle such a network, NNMi uses seeded discovery to place overlapping address domains in different tenants. For details, see NNMi Help.

Important

- If you are using NNMi to manage VMware Hypervisor-Based Virtual Networks, see the "Tenants within Virtual Environments" help topic in the Help for Administer.
- If you plan to configure multi-tenancy, configure tenants before initiating network discovery.

6.1.1 Device profiles and device attributes

As NNMi discovers devices, it uses SNMP to gather some attributes directly. One of the key attributes is the MIB II system object ID (`sysObjectID`). From the system object ID, NNMi derives additional attributes, such as vendor, device category, and device family.

During discovery, NNMi collects the MIB II system groups and stores them in the topology portion of the database. System capabilities are visible on the **Node** form. However, these capabilities are not used by the monitoring configuration. NNMi uses the device category (from the device profile for the system object ID) to match devices into node groups. In node view tables, the **Device Category** column identifies the device category for each node.

Note

If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols (for example, SOAP protocol for VMware environments).

NNMi ships with a large number of device profiles for system object IDs that were available at the time of release. You can configure custom device profiles for the unique devices in your environment to map these devices to category, vendor, and so forth.

6.2 Planning discovery

Evaluate the following areas:

- Selecting your primary discovery approach
- Auto-discovery rules
- Node name resolution
- Subnet connection rules
- Discovery seeds
- Rediscovery interval
- Do-not-discover objects
- Interface discovery range

6.2.1 Selecting your primary discovery approach

Decide whether to do entirely list-based discovery, entirely rule-based discovery, or a combination of the two.

(1) List-based discovery

With list-based discovery, you explicitly specify (as a discovery seed) each node for NNMi to discover.

NNMi uses tenants to support networks containing overlapping address domains. Overlapping address domains might exist in the static network address translation (NAT), dynamic network address translation (NAT), or port address translation (PAT) area in the network domain management domain. To handle such a network, NNMi uses seeded discovery to place overlapping address domains in different tenants. For details, see NNMi Help.

Important

- If you are using NNMi to manage VMware Hypervisor-Based Virtual Networks, see the "Tenants within Virtual Environments" help topic in the Help for Administer.
- If you plan to configure multi-tenancy, list-based discovery is the recommended discovery approach.

Benefits of using list-based discovery only include:

- Provides very tight control over what NNMi manages
- Supports the specification of a non-default tenant at discovery time
- Simplest configuration
- Good for fairly static networks
- A good way to start using NNMi. You can add auto-discovery rules over time.

Disadvantages of using list-based discovery only include:

- NNMi does not discover new nodes as they are added to the network.
- You must provide a complete list of the nodes to be discovered.

(2) Rule-based discovery

With rule-based discovery, you create one or more auto-discovery rules to define the areas of the network for NNMi to discover and include in the NNMi topology. For each rule, you must provide one or more discovery seeds (by explicitly naming seeds or by enabling Ping sweep), and then NNMi discovers the network automatically.

Benefits of using rule-based discovery include:

- Good for large networks. NNMi can discover a large number of devices based on minimal configuration input.
- Good for networks that change frequently. New devices that are added to the network are discovered without administrator intervention (assuming that each such device is covered by an auto-discovery rule).

Disadvantages of using rule-based discovery include:

- It is easier to confront license limitations.
- Depending on the structure of your network, tuning auto-discovery rules can be complex.
- If auto-discovery rules are very broad and NNMi discovers many more devices than you want to manage, you might want to delete unneeded devices from the NNMi topology and node deletion can be time consuming.
- All non-seeded nodes receive the default tenant at discovery. If you want to use NNMi multi-tenancy, you must update the tenant assignment after discovery.

6.2.2 Creating auto-discovery rules

(1) Configuring auto-discovery rules

When you configure auto-discovery rules, you specify the following:

- Auto-discovery rule ordering
- What devices to exclude from discovery
- Whether to use Ping sweep
- What discovery seeds, if any, to use

(2) Auto-discovery rule ordering

The value of an auto-discovery rule's `Ordering` attribute affects discovery ranges in the following ways:

- IP address ranges

  If a device falls within two auto-discovery rules, the settings in the auto-discovery rule with the lowest ordering number apply. For example, if an auto-discovery rule excludes a set of IP addresses, then no other auto-discovery rules with higher ordering numbers process those nodes and the nodes within that range of addresses are not discovered unless they are listed as discovery seeds.
- System object ID ranges

  - If no IP address range is included in an auto-discovery rule, then the system object ID settings apply to all auto-discovery rules with higher ordering numbers.

  - If an IP address range is included in an auto-discovery rule, the system object ID range applies only within the auto-discovery rule.

(3) Excluding devices from discovery

- To prevent discovery of certain object types, you can create an auto-discovery rule with a low ordering number that ignores the system object IDs that you do not want discovered. Do not include an IP address range in this rule. By giving such an auto-discovery rule a low ordering number, the discovery process quickly passes by the objects that satisfy this rule.
- The **Ignored by rule** setting for an IP address range or a system object ID range affects that auto-discovery rule only. The devices included in an ignored range are available to be included in another auto-discovery rule.
- The addresses listed on the **Excluded IP Addresses** tab of the **Discovery Configuration** form apply to all auto-discovery rules. Unless they are configured as discovery seeds, these addresses are never added to the NNMi topology. (Discovery seeds are always discovered.)

> **Note**
>
> Some networks use routing protocols such as Hot Standby Router Protocol (HSRP) and Virtual Router Redundancy Protocol (VRRP) to provide router redundancy. When routers are configured in a router redundancy group (RRG), the routers in the RRG share a protected IP address (one active and one standby). NNMi does not support discovery and management of multiple RRGs configured with the same protected IP address. Each RRG must have a unique protected IP address.

(4) Ping sweep

You can use Ping sweep to locate devices within the IP address ranges of the configured auto-discovery rules. For initial discovery, you might want to enable Ping sweep for all rules. Doing so provides enough information to NNMi discovery that you do not need to configure discovery seeds.

> **Note**
>
> - Ping sweep works for subnets of 16 bits or smaller, for example, `10.10.*.*`.
>
> Ping sweeps are especially useful for discovering devices across a WAN that you do not control, such as an ISP network.
> - Because firewalls often regard Ping sweeps as attacks on the network, a firewall might block all traffic from a device that emits Ping sweeps.

> **Tip**
>
> Enable Ping sweep for small discovery ranges only.

(5) Discovery hints from SNMP traps

NNMi processes the source IP addresses of received SNMP traps as hints to auto-discovery rules. For details about SNMP trap incidents, see NNMi Help for Administer.

(6) Discovery seeds for auto-discovery rules

Provide at least one discovery seed per auto-discovery rule. The options for providing the seeds are listed below. Specify one or a combination of these discovery seeds.

- Enter seeds on the **Discovery Seed** form by clicking **Seeds** under **Discovery** in the **Configuration** workspace.

- Use the `nnmloadseeds.ovpl` command to load information from a seed file.
- Enable Ping sweep for the rule, at least for initial discovery.
- Configure a device to send SNMP traps to the NNMi management server.

(7) Best practices for auto-discovery rules

- Because NNMi automatically manages all discovered devices, use IP address ranges that closely match the areas of the network that you want to manage.

  - You can use multiple IP address ranges within an auto-discovery rule to restrict discovery.

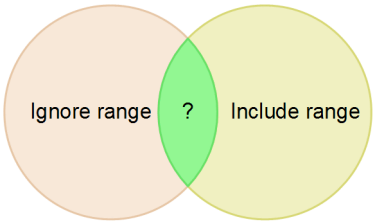
  - You can add a large IP address range to an auto-discovery rule and then exclude from discovery some IP addresses that are within that rule.
- The system object ID range specification is a prefix, not an absolute value. For example, the range `1.3.6.1.4.1.11` is the same as `1.3.6.1.4.1.11.*`.

(8) Examples

Discovery rule overlap

Figure 6-1 shows two discovery ranges that overlap. The circle on the left represents an IP address range or a system object ID range to be ignored by NNMi discovery. The circle on the right represents an IP address range or a system object ID range to be discovered and included in the NNMi topology. The overlapping region might be included or ignored by discovery, depending on the ordering of the auto-discovery rules.

Figure 6-1: Overlapping discovery ranges



Limit device type discovery

To discover all HP devices in your network that are not printers, create one auto-discovery rule with a range to include the HP enterprise system object ID (`1.3.6.1.4.1.11`). In this auto-discovery rule, create a second range to ignore the system object IDs of HP printers (`1.3.6.1.4.1.11.2.3 9`). Leave the IP address range unset.

6.2.3 Changing the order for node name resolution

By default, NNMi attempts to identify a node in the following order:

1. Short DNS name
2. Short `sysName`
3. IP address

> **Important**
>
> If you change a node's host name, there is a delay before NNMi data reflects the name change, because NNMi caches DNS names to enhance performance.

The following scenarios describe situations in which you might want to change the default order for node name resolution:

- If your organization is dependent on others to update the DNS configuration, you might set a policy for defining the `sysName` for each new device as it is added to the network. In such a case, you would set `sysName` as the first choice for node name resolution so that NNMi can discover a new device as soon as it is deployed in the network. (Maintain the `sysName` over the life of the device.)
- If your organization does not set or maintain the `sysName` for managed devices, select `sysName` as the third option for node name resolution.

Tip

- If you use the full or short DNS name as the primary naming convention, confirm that you have forward and reverse DNS resolution from the NNMi management server to all managed devices.

  When the full DNS name is the naming convention, labels on the topology maps can be long.
- NNMi selects the lowest loopback address as the management address for Cisco devices, so put DNS resolution on the lowest loopback address for each Cisco device.

6.2.4 Subnet connection rules

List-based discovery only

For list-based discovery, NNMi uses the subnet connection rules to detect connections that span a WAN. NNMi evaluates the subnet membership of the device it has discovered on each end of a probable connection (by examining their IP addresses and subnet prefixes) and looks at subnet connection rules for a match.

Rule-based discovery only

When auto-discovery rules are enabled and NNMi finds a device configured with a subnet prefix between `/28` and `/31`:

1. NNMi checks for an applicable subnet connection rule.
2. If a match is found, NNMi uses each valid address in the subnet as a hint and attempts discovery on that address.

Tip

Use the default connection rules. Modify them only if there is a problem.

6.2.5 Discovery seeds

This subsection explains the devices that are used as discovery seeds.

Tip

- One of the NNMi rules for selecting the preferred management IP address specifies using the first discovered IP address as the management address. You can influence NNMi by configuring the preferred IP address as the seed address.

- For Cisco devices, use a loopback address as the discovery seed, because loopback addresses are more reliably reachable than other addresses on a device. Ensure that DNS is correctly configured to resolve the device host name to the loopback address.

List-based discovery only

For list-based discovery, list all devices that you want NNMi to manage. You might be able to export this list from asset management software or from some other tool.

Because NNMi does not automatically add any devices to this list, ensure that the list includes every device for which you have responsibility or that influences your monitoring and status calculations.

Rule-based discovery only

Discovery seeds are optional for rule-based discovery.

If Ping sweep is enabled for an auto-discovery rule, you do not need to specify a seed for that rule.

For each auto-discovery rule with Ping sweep disabled, identify at least one seed. If a rule includes multiple IP address regions, you might need a seed in each routable region because routers do not keep ARP entries across WAN links.

Tip

For the most complete rule-based discovery, use routers, not switches, as discovery seeds because routers generally have much larger ARP caches than do switches. A core router connected to a network that you want to discover is an excellent choice for a discovery seed.

6.2.6 Rediscovery interval

NNMi rechecks the configuration information from each device in the database according to the configured rediscovery interval. In addition, NNMi collects the ARP cache from each router covered by an auto-discovery rule and looks for new nodes on the network.

Any change in the communication-related configuration of a device, such as interface renumbering, automatically triggers NNMi to update its data for that device and its neighbors.

The following changes do not trigger automatic rediscovery; devices are updated only at the configured rediscovery interval:

- Changes within a node (for example, firmware upgrade or system contact)
- New nodes added to the network

Select the rediscovery interval to match the level of change in the network. For a highly-dynamic network, you might want to use the minimum interval of 24 hours. For more stable networks, you can safely extend that period.

6.2.7 Do-not-discover objects

In NNMi, there are five ways that you can configure NNMi to disregard certain objects:

- On the **Communication Configuration** form, you can turn off ICMP communication, SNMP communication, or both at different levels: globally for communication regions, or for specific host names or IP addresses. For details about the impacts of disabling one or both of these protocols, see 5.1.7 Polling protocols.

- On the **Discovery Configuration** form, you can set up an auto-discovery rule that instructs NNMi to never gather hints from certain IP addresses or SNMP system object IDs. Nodes matching the criteria will still appear on the map and in the database, but spiral discovery will not extend to the neighboring devices beyond those IP addresses or object types.
- On the **Discovery Configuration** form, you can set up an auto-discovery rule that instructs NNMi to exclude from the database specific IP address ranges, IP addresses, or both. Spiral discovery does not display those addresses on any node's list of addresses or use those addresses when establishing connections between devices, so NNMi never monitors the health of those addresses.
- On the **Discovery Configuration** form, on the **Excluded IP Addresses** page, you can configure an excluded IP address filter to exclude a range of IP addresses from discovery.

  If all of a node's IP addresses are entered into the **Excluded IP Addresses** list after that node has already been discovered, NNMi does not delete the node. In addition, NNMi does not delete the entire history of a node unless the NNMi administrator intentionally deletes the node from the NNMi database.

  When an IP address range is excluded, any overlapping addresses in the static network address translation (NAT), dynamic network address translation (NAT), or port address translation (PAT) area in the network management domain are also excluded.

  NNMi uses tenants to support networks containing overlapping address domains. To handle such a network, NNMi uses seeded discovery to place overlapping address domains in different tenants. For details, see NNMi Help.
- On the **Discovery Configuration** form, on the **Excluded Interfaces** page, you can select specific types of interfaces to exclude from the discovery process. For details, see NNMi Help.

6.2.8 Interface discovery range

NNMi enables you to define a filter to specify a range of interfaces to be discovered. This is especially useful for discovering only subsets of interfaces when the node is large. When the **Excluded Interfaces** option is used, interfaces are filtered after information has been obtained from devices. On the other hand, when an interface discovery range is specified, information about interfaces that are not in the specified range is not requested from NNMi. Therefore, range-based discovery can improve discovery performance on large devices when only some of the interfaces are managed.

On the **Included Interface Ranges** tab of the **Discovery Configuration** form you use the system object ID prefix value and `ifIndex` value to define an interface range. For details, see NNMi Help.

6.3 Configuring discovery

This section lists configuration tips and provides some configuration examples. After reading the information in this section, see *Configure Discovery* in NNMi Help for specific procedures.

Because NNMi launches discovery from seeds as soon as you apply **Save and Close** to the **Discovery Seed** form, ensure that you do the following before you configure seeds:

- Complete all communication settings.
- Complete all auto-discovery rules (if any).
- Configure subnet connection rules.
- Configure name resolution preferences.
- Use **Save and Close** to save all the configuration forms and return to the console.

> **Note**
>
> If you perform rule-based discovery, it is advisable to save a copy of the existing configuration before you make any major configuration changes. For details, see 4.2 Best practice: Save the existing configuration.

6.3.1 Tips for configuring auto-discovery rules

- As you define a new auto-discovery rule, check each setting carefully. For a new rule, auto-discovery is enabled by default, IP address ranges are included by default, and system object ID ranges are ignored by default.

6.3.2 Tips for configuring seeds

When configuring seeds, note the following best practices:

- If you already have a file that lists the nodes to be discovered, format this information as a seed file and use the `nnmloadseeds.ovpl` command to import the node list into NNMi.
- In the seed file, specify IP addresses as a way of influencing the IP address that NNMi chooses as the management address. (If you use host names, DNS provides the IP address for each node.)
- Formats for the entries in the seed file are as follows:

```
IP_address # node name
IP_address2, "tenant-name-or-tenant-UUID" # node name
```

- For maintenance purposes, it is better to use only one seed file. Add nodes as needed and then rerun the `nnmloadseeds.ovpl` command. NNMi discovers the new nodes but does not re-evaluate the existing nodes.
- Removing a node from the seed file does not remove it from the NNMi topology. Delete the node directly on the NNMi console.
- Deleting a node from a map or inventory view does not delete the seed.
- If you want NNMi to rediscover a node, delete that node from a map or inventory view and from the **Seeds** view in the **Discovery** area of the **Configuration** workspace on the NNMi console, and then re-enter the node on the **Discovery Seed** form on the NNMi console, or run the `nnmloadseeds.ovpl` command.

Rule-based discovery only

Completely configure a discovery rule before you specify a seed for that rule. That is, click **Save and Close** on the **Discovery Configuration** form. (When you save the information on the **Discovery Seed** form, NNMi updates the seed configuration immediately.)

6.3.3 Discovering link aggregation

Link aggregation requires an NNMi Advanced license.

A Link Aggregation (LAG) protocol enables network administrators to configure a set of interfaces on a switch as one aggregator interface. Such a configuration creates an aggregator layer 2 connection to another device using multiple interfaces in parallel to increase bandwidth, the speed at which data travels, and redundancy.

For details, search for *link aggregation* in NNMi Help.

6.3.4 Discovering server-to-switch link aggregation (S2SLA)

Link aggregation requires an NNMi Advanced license.

Network administrators often need additional reliability and better resource usage between servers and switches. Many network administrators choose to use the Link Aggregation Configuration Protocol (LACP) because of its widespread use by network equipment providers. LACP is negotiated automatically after the IT engineer has bonded the ports on both sides of the server-to-switch configuration.

Network administrators often choose to use one of two types of switch-to-server connections to achieve the reliability and resource usage between servers and switches that they need:

- Option 1: Bond two or more ports on the server and connect them to the same number of ports on the switch. If a port on either the server or the switch fails, a backup port is activated.
- Option 2: Bond both the server and switch to provide the aggregate total bandwidth of all the ports in the aggregation.

NNMi provides a Discovering Server-to-Switch Link Aggregations (S2SLA) feature to help you manage switch-to-server connections. To ensure that NNMi can properly discover S2SLA information for a node, complete the following tasks:

- By default, Linux does not install Net-SNMP, which is its SNMP agent package. If Net-SNMP is missing from your NNMi management server, you must install it.
- The bonding interface on Linux can assume the MAC address of one of the aggregated interfaces, but it does not have to do so. The bonded interface can have a MAC address that does not belong to any of the server's interfaces.

> **Note**
>
> All interfaces in the aggregation use the same MAC address. A check of the SNMP interfaces table returns the same MAC for the aggregator and aggregated interfaces. The shared MAC is used in outbound packets. The access switch's FDB table shows this MAC as being heard over the switch's aggregated interface.

To view the original MAC addresses, use the following command:

```
cat /proc/net/bonding/bond0
```

6.4 Evaluating discovery

This section lists ways to evaluate the progress and success of discovery.

6.4.1 Following the progress of initial discovery

NNMi discovery is dynamic and ongoing; it is never complete, so you will never see a `discovery completed` message. The process of initial discovery and connection takes some time. The following items suggest ways to gauge the progress of initial discovery:

- On the **Database** tab of the System Information window, watch for the node count to reach the expected level and stabilize. This window does not refresh automatically. During initial discovery, open the System Information window several times.
- Under **Discovery** in the **Configuration** workspace, look at the **Seeds** tab. Refresh this tab until all seeds show the `Node created` result, which indicates that a device has been added to the topology database. This result does not indicate that NNMi has gathered all information from the device and processed its connectivity.
- Open the **Node** form for representative nodes. When the **Discovery State** field (located on the **General** tab) transitions to `Discovery Completed`, NNMi has gathered the node's basic characteristics as well as the node's ARP cache and discovery protocol neighbors, if applicable. This state does not indicate that NNMi has completed connectivity analysis for the device.
- In the **Nodes** inventory view, scan to see that key devices from different areas of your network are present.
- Open the **Layer 2 Neighbor View** for representative nodes to determine whether connectivity analysis has completed for that area.
- Review the **Layer 2 Connections** and **VLANs** inventory views to gauge the progress of Layer 2 processing.

6.4.2 Checking for discovery of all seeds

1. Open the **Seeds** view.
2. On the **Seeds** view, sort the list of nodes by the **Discovery Seed Results** column.

   For any node in an error state, consider the following:

   - Failed discovery due to an unreachable node or unresolved DNS name -- For these types of failures, verify network connectivity to the node and check for accurate DNS name resolution. To work around DNS issues, use the IP address to seed the node or include the host name in a `hostnolookup.conf` file.

     If a name cannot be resolved due to the IP address, include the corresponding IP address in the `ipnolookup.conf` file. For details, see the reference pages for `hostnolookup.conf` and `ipnolookup.conf`.
   - License node count exceeded -- This scenario occurs when the number of devices already discovered has reached your license limit. You can either delete some discovered nodes or purchase additional node pack licenses.

     When tracking license information, note the following:

     - Consumption: NNMi discovers and manages nodes up to the NNMi licensed capacity limit (rounded up):
     - VMware environments: Each device with a Device Profile of vmwareVM is equivalent to 1/10th node. All other devices are equivalent to one discovered node.
   - Node discovered but no SNMP response -- SNMP communication problems can occur for seeded devices as well as for devices that are discovered through auto-discovery. For details, see 5.4 Evaluating communications.

6.4.3 Checking for valid device profiles

1. Open the **Nodes** inventory view.
2. Filter the **Device Profile** column to contain the string `No Device Profile`.
3. If a node is discovered but has no device profile, add a new device profile (by choosing **Device Profiles** from **Configuration**), and then perform a configuration poll on the node to update its data.

6.4.4 Checking for discovery of all nodes

To avoid discovery problems, make sure that NNMi manages only nodes that use a unique IP address that does not appear for any other node in the management domain. For example, if a node suddenly disappears or gets merged with another node in the database, and it is part of a router redundancy group (RRG), there are special requirements. To manage a router that participates in an RRG, you must use a unique IP address (which is not a protected address) as the management address of the router, and SNMP must be enabled on that address. NNMi will not properly manage a router if it tries to use a protected IP address as the management address.

Examine the data in the **Nodes** inventory view. If any nodes do not have a management address, check the communication settings for those nodes as described in 5.4.1 Checking all nodes for SNMP configuration.

If any expected nodes are missing from the **Nodes** inventory view, check the following:

- For each missing node, verify that the discovery protocol (for example, CDP) is correctly configured.
- If a missing node is on a WAN, enable Ping sweep for the auto-discovery rule that includes that node.

6.4.5 Evaluating the auto-discovery rules (Rule-based discovery only)

If you see unexpected discovery results, re-evaluate the auto-discovery rules.

When NNMi discovery finds an address hint, it uses the first matching rule to determine whether to create a node. If no rules are matched, NNMi discovery discards the hint. The ordering number for auto-discovery rules determines the order in which the auto-discovery rule configuration settings are applied.

For each auto-discovery rule, check the following settings:

- **Discover Matching Nodes** must be enabled for auto-discovery to occur for the rule.
- Verify that the following settings are correct for the type of nodes you want discovered for the rule:
  - **Discover Any SNMP Device**
  - **Discover Non-SNMP Devices**

  Remember that only routers and switches are discovered by default and non-SNMP nodes are not discovered. If **Discover Any SNMP Device** is enabled, NNMi discovers all SNMP devices. If **Discover Non-SNMP Devices** is enabled, NNMi also discovers non-SNMP devices. Enabling these settings without considering your environment can result in NNMi discovering more nodes than intended.

(1) IP address ranges

The IP address of a discovery hint must match an **Include in rule** entry in the IP address range list. If there are no included IP address ranges in an auto-discovery rule, then all address hints are considered a match. (For this case, see

6.3.1 Tips for configuring auto-discovery rules.) Additionally, the hint must not match any entry marked **Ignored by rule**. If all checks successfully match, this rule's configuration is used for handling the hint.

- If there is no discovery of some devices you expected to discover, check your configured IP ranges to ensure that the IP addresses for those devices are included in a range and not ignored by a rule with a lower ordering number.
- If you are discovering more devices than you want, modify the include ranges or add ignored ranges for the IP addresses of the devices that you do not want discovered. Also, determine if **Discover Any SNMP Device** is enabled.

(2) System object ID ranges

The system object ID (OID) from a discovery hint must match an **Include in rule** entry in the system object ID ranges list. If there are no included system object ID ranges in an auto-discovery rule, then all object IDs are considered a match. Additionally, the OID must not match any entry marked **Ignored by rule**. If all checks successfully match, this rule's configuration is used for handling the hint.

- Use the system object ID ranges to either expand auto-discovery to include more than the default routers and switches, or to exclude specific routers and switches.
- Each node must match both the IP address range and the system object ID range specified before it is discovered and added to the topology database.

6.4.6 Evaluating connections and VLANs

NNMi creates Layer 2 connections and VLANs as a separate step after devices are added to the topology. Give NNMi plenty of time for initial discovery before evaluating connections and VLANs.

To evaluate Layer 2 connectivity, create a node group for each network area of interest, and then display a topology map for that node group. (In the **Node Groups** inventory, select a node group, and then click **Actions**, **Maps**, and then **Node Group Map**.) Look for any nodes that are not connected to the other nodes in this map.

To evaluate VLANs, from the **VLANs** inventory view, open each **VLAN** form, and then examine the list of ports for that VLAN.

6.4.7 Rediscovering a device

To verify that the device has been deleted:

1. Perform a configuration poll of the device.
2. Delete the device.

If the device is a seed, delete the seed, and then re-add the seed.

6.5 Tuning discovery

For general discovery performance, fine-tune the discovery configuration to discover only critical and important devices.

- Filter by IP address range, system object ID, or both.
- Limit discovery of non-SNMP devices and any SNMP devices (devices that are not switches or routers).
- To delete one or more nodes from the NNMi database on the command line, use the `nnmnodedelete.ovpl` command. This command deletes nodes, but not seed definitions, from the NNMi database. To delete one or more seed definitions from the NNMi database on the command line, use the `nnmseeddelete.ovpl` command.
- There are special discovery circumstances that might be remedied by suppressing discovery protocol collections. For details, see 21.24 Suppressing the use of discovery protocols for specific nodes.

6.5.1 Deleting unresponsive objects

You can control the deletion of the following unresponsive objects by specifying the number of days to wait after an object has become unresponsive:

- Unresponsive nodes
- Connections that are down

To delete unresponsive nodes, perform the following steps:

1. In the **Configuration** workspace, click **Discovery**, and then **Discovery Configuration**.
2. In the **Delete Unresponsive Objects Control** area, enter the numbers of days for the system to wait before deleting the applicable objects.

   A value of zero (`0`) indicates that no objects are to be deleted. After the specified waiting period, the unresponsive objects are deleted from the database.

> **Note**
>
> When Delete Unresponsive Nodes is enabled, NNMi does not delete virtual machine nodes under any of the following circumstances:
>
> - The VM does not support an SNMP agent
> - The VM does not have any IP addresses because VMware tools not installed
> - The IP address fault monitoring for the VM is not configured
>
> For more information, see the "Configure Whether to Delete Unresponsive Nodes" help topic in the Help for Administer.

7 NNMi State Polling

This chapter provides information to help you expand and fine-tune network monitoring by configuring the NNMi State Poller service. This chapter supplements the information in NNMi Help. For an introduction to how monitoring works and for detailed information about how to configure monitoring, see Monitoring Network Health in NNMi Help.

7.1 Concepts for state polling

This section provides a brief overview of network monitoring, including the order that the State Poller uses to evaluate polling groups. After reading the information in this section, continue to 7.2 Planning state polling for more specific information.

As with network discovery, focus network monitoring on the critical or most important devices in the network. NNMi can only poll devices in the topology database. You can control which network devices NNMi monitors, the type of polling to use, and the interval at which to poll.

You can use the interface and node settings on the **Monitoring Configuration** form to refine status polling of devices, and to set different polling types and intervals for different classes, types of interfaces, and types of nodes.

You can configure State Poller data collection to be based on an ICMP (ping) response, or to be based on SNMP data. NNMi automatically handles internally the mapping from the type of data collection you enable to the actual MIB objects, significantly simplifying configuration.

> **Note**
>
> If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols (for example, SOAP protocol for VMware environments).

As you plan the polling configuration, carefully consider how to set up interface groups and node groups for the State Poller service. If you are new to the concept of groups, see 4.6 Node groups and interface groups and 4.7 Node/interface/address hierarchy.

7.1.1 Order of evaluation

Because an interface or node might qualify for multiple groups, the State Poller applies the configured polling interval and polling type in a well-defined order of evaluation. For each object in the discovered topology, the State Poller performs evaluation as follows:

1. If the object is an interface, State Poller looks for a qualifying interface group.

   Groups are evaluated from the lowest order number to the highest. The first matching group is used and evaluation stops.
2. If no interface group has captured the object, node groups are evaluated from the lowest order number to the highest.

   The first matching group is used and evaluation stops. Any contained interface that has not qualified for an interface group on its own characteristics inherits the polling settings from its hosting node.
3. For devices that are discovered but not included in any node or interface settings definitions, the global monitoring settings (on the **Default Settings** tab of the **Monitoring Configuration** form) establish the monitoring behavior.

7.2 Planning state polling

This section provides information to plan for State Poller configuration, including a polling configuration checklist; and more detailed information to help you plan for monitoring, decide how to create polling groups, and determine what types of data to capture during the polling process.

7.2.1 Polling checklist

You can use the checklist below to plan for State Poller configuration.

☐ What can NNMi monitor?

☐ What are the logical groups for monitored items, based on object type, location, relative importance, or other criteria?

☐ How often does NNMi need to monitor each group?

☐ What data needs to be collected to capture information about the monitored item? This might include:

-- ICMP (ping) response

-- SNMP fault data

-- Additional SNMP component health data

> **Note**
>
> If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols (for example, SOAP protocol for VMware environments).

(1) Example polling configuration

To help you understand the polling configuration process, consider this example. Assume that your network contains the latest proxy servers from ProximiT. You must ensure that these devices can be reached, but you do not require SNMP monitoring of the proxy servers.

1. What can NNMi monitor?

   Because you can only monitor what has been discovered, you configure auto-discovery rules to ensure that NNMi's database contains your proxy servers. For details about configuring discovery, see 6. NNMi Discovery.

2. What are the logical groups for monitored items?

   It makes sense to group the ProximiT proxy servers together and apply the same monitoring settings to all of them. Because you are not doing interface (SNMP) monitoring for the devices, you do not need any interface groups.

   You can also use this node group to filter views, to check the status of the proxy servers as a group, and to put the group out of service to update firmware.

3. How often does NNMi need to monitor each group?

   For your service level agreements, a five-minute polling interval for the proxy servers is sufficient.

4. What data needs to be collected?

   Here is where the monitoring configuration differs from other groups. For our proxy server example, you enable ICMP fault monitoring and disable SNMP fault polling monitoring. Without SNMP fault monitoring for the group, component health monitoring will not apply.

5. Which SNMP traps are sent from my network devices to NNMi?

   NNMi uses some SNMP traps to poll devices as the traps are received without waiting for the next polling interval.

   For more detailed planning information concerning these configuration choices, see the following topics:

   - 7.2.2 What Can NNMi Monitor?
   - 7.2.3 Stop Monitoring
   - 7.2.4 Interfaces to Unmonitored Nodes
   - 7.2.5 Extending Monitoring
   - 7.2.6 Creating node and interface groups
   - 7.2.7 Planning polling intervals
   - 7.2.8 Planning the data to be collected
   - 7.2.9 Deciding which SNMP traps to send to NNMi

7.2.2 What Can NNMi Monitor?

The State Poller Service monitors each discovered interface, address, and SNMP agent that is designated to be actively monitored in your management domain. State Poller can also be configured to provide Card, Chassis, Node Sensor, Physical Sensor, and Router Redundancy Group monitoring.

> **Note**
>
> In most cases, polling only connected interfaces provides sufficiently accurate root-cause analysis. Extending the set of monitored interfaces can impact polling performance.

If NNMi is monitoring a hypervisor network environment, it will also monitor additional objects, including the following:

- Hypervisors
- Virtual Machines (VMs) that are hosted on hypervisors
- Virtual Switches
- Uplinks (represented as interface objects)

> **Tip**
>
> - Ensure that VMware Tools is installed on your virtual machines and then use the Virtual Machines Node Group provided by NNMi to enable fault polling for the IP addresses associated with your VMs. This is a recommended practice to ensure that NNMi can identify any VM nodes where the underlying Virtual Machine has been deleted or moved to a hypervisor NNMi does not manage. For more information about enabling fault polling, see "Default Settings for Monitoring" in the NNMi Help for Administer.
> - Use the Virtual Machines Node Group provided by NNMi to enable fault polling for the IP addresses associated with your Virtual Machines (VMs). This is a recommended practice to ensure that NNMi can identify any VM nodes where the underlying Virtual Machine has been deleted or moved to a hypervisor that NNMi does not manage. For more information, see “Default Settings for Monitoring” and “Configure Whether to Delete Unresponsive Nodes” in the NNMi Help for Administer.

For more information about monitoring, see the NNMi help. Also see "7.2.5 Extending Monitoring".

7.2.3 Stop Monitoring

The NNMi management modes are used to set devices or interfaces to **UNMANAGED** or **OUT OF SERVICE**. **UNMANAGED** is considered to be a permanent situation; you will never care to know the status of the object. **OUT OF SERVICE** is for temporary situations where one or more objects will be offline and down incidents would be superfluous.

Consider the management mode as an overlay across all group settings. Regardless of its group, polling interval, or type, the State Poller does not communicate with an object when its status is set to **UNMANAGED** or **OUT OF SERVICE**.

> **Tip**
>
> Some of the devices, interfaces, or both you choose to discover and place in the database do not need to be polled. Note those objects which you will permanently set to **UNMANAGED**.
>
> You might want to create one or more node groups to enable you to set management modes more easily.

7.2.4 Interfaces to Unmonitored Nodes

Sometimes, you need to know the status of an interface that connects to a device you do not manage directly. For example, you want to know whether the connection to an application or Internet server is up, but you might not be responsible for maintaining that server. If you do not include the server in the discovery rules, NNMi sees the interface that faces the server as unconnected.

There are two ways to monitor the status of an important interface that connects to an unmonitored node:

- Discovering the unmonitored node

  When you add an unmonitored node to the NNMi topology, NNMi sees the interfaces connecting the node to the rest of the topology as `CONNECTED`. Then NNMi can poll these interfaces according to the monitoring configuration. NNMi discovers the node as **Managed**. For nodes that you do not want NNMi to monitor, you will need to set the mode to **Not Managed**.

  > **Note**
  >
  > Each discovered node counts toward the license limit, regardless of whether NNMi is actively managing that node.

- Polling the unconnected interface

  You can create a node group containing the network devices that provide connectivity for undiscovered nodes. Then enable polling of unconnected interfaces for the node group.

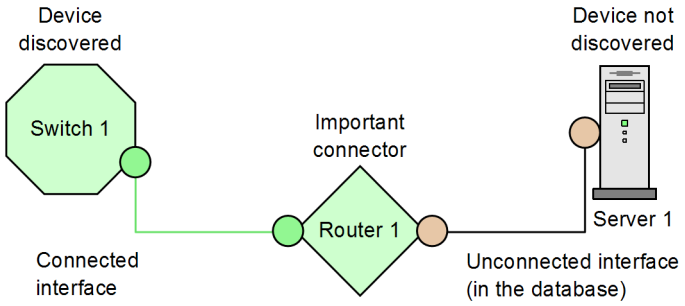
  NNMi polls all interfaces on the devices in the node group, which can add a lot of traffic for a device with many interfaces.

7.2.5 Extending Monitoring

You can extend the monitoring to include the following:

- Unconnected interfaces.

By default, the only unconnected interfaces that NNMi monitors are those that have IP addresses and are included in the `Routers` node group.

> **Note**
>
> NNMi defines an unconnected interface as an interface that is not connected to another device discovered by NNMi, as shown below.
>
> 
>

- Interfaces, such as router interfaces, that have an IP address
- ICMP polling for devices that do not support SNMP
  By default, ICMP polling is enabled for the `Non-SNMP Devices` node group.

7.2.6 Creating node and interface groups

You must set up node and interface groups before configuring monitoring settings. Therefore, you must consider polling requirements while configuring node and interface groups. Ideally, node and interface groups are configured so that you can monitor important devices frequently, and you can check on non-critical devices less frequently (if at all).

> **Tip**
>
> Configure one set of node and interface groups for network monitoring. Configure a different set of node groups for network visualization through maps.

These groups are defined through the **Configuration** workspace, **Object Groups** folder, and then **Node Groups** option, or through the **Configuration** workspace, **Object Groups** folder, and then **Interface Groups** option. By default, they are the same groups that are used to filter incident, node, interface, and address views. To create a separate set of node or interface filters for configuring monitoring settings, open a node or interface group and select the **Add to View Filter List** check box on the **Node Group** or **Interface Group** form. Click **Save and Close** to save the definition.

You can set polling types and polling intervals at a node group level or interface group level on the **Node Settings** and **Interface Settings** tabs of the **Monitoring Configuration** form.

Determine the criteria by which you want to group interfaces, devices, or both by similar polling needs. Here are some factors to consider in your planning:

- Which area of your network contains these devices? Are there timing constraints?
- Do you want to differentiate polling intervals or data gathered by device type? By interface type?
- Does NNMi provide pre-configured groups you can use?

Tip

You can create group definitions for objects that are likely to go `OUT OF SERVICE` at the same time, whether by location or some other criterion. For example, you could put all your Cisco routers into `OUT OF SERVICE` mode while you apply an IOS upgrade.

(1) Interface groups

Based on your criteria, determine the interface groups you wish to create. Remember that interface groups are evaluated first (see 7.1 Concepts for state polling). Interface groups can reference node group membership, so to implement your plan you might end up configuring node groups before interface groups.

Preconfigured interface groups

NNMi has several useful interface groups already configured for you to use. These interface groups include the following:

- All interfaces with an IFType related to ISDN connections
- Interfaces for voice connections
- Interfaces for point-to-point communication
- Software loopback interfaces
- VLAN interfaces
- Interfaces participating in link aggregation protocols

You can use existing groups, modify them, or create your own.

Interface groups have two types of qualifiers: node group membership for the hosting node, and IFType or other attribute for the interface. You can choose to combine these as follows:

- All interfaces on nodes in a node group are grouped regardless of IFType; do not select any IFTypes or attributes (such as name, alias, description, speed, index, address, or other IFType attributes).
- All interfaces of certain IFTypes or set of attributes are grouped, regardless of the node on which they reside.
- Only interfaces of a certain IFType or attributes that reside on a particular group of nodes are grouped.

(2) Node groups

After planning interface groups, plan node groups. Not all node groups created for monitoring make sense for filtering views, so you can configure them independently.

Preconfigured node groups

A default collection of node groups is provided to simplify your configuration tasks. These node groups are based on device categories derived from the system object ID during the discovery process. The node groups provided by default include the following:

- Routers
- Networking infrastructure devices (such as switches or routers)
- Windows systems
- Devices for which you do not have the SNMP community string
- Important nodes. This is used internally by the Causal Engine to provide special handling for devices in the shadow of a connector failure. For details, see *Node Groups As Predefined View Filters* in NNMi Help.

- Virtual Machines

You can use existing groups, modify them, or create your own.

You can qualify the definition of related nodes using the following node attributes:

- IP address(es) on the node
- Host name wildcard convention
- Device Profile derivatives, such as category, vendor, and family
- MIB II `sysName`, `sysContact`, `sysLocation`

Find a balance by creating a rich set of groups for configuration and viewing without overloading the list with superfluous entries that will never be used.

> **Tip**
>
> You can create simple, reusable, atomic groups and combine them into hierarchical clusters for monitoring or visualization. Group definitions can overlap, such as *All routers* and *All systems with IP address ending in 100*. Nodes will probably qualify for multiple groups as well.

Interaction with device profiles

When each device is discovered, NNMi uses its system object ID to index it into the list of available device profiles. The device profile is used to derive additional attributes of the device, such as vendor, product family, and device category.

As you configure node groups, you can use these derived attributes to categorize devices to apply monitoring settings. For example, you might want to poll all switches regardless of vendor throughout your network on a certain polling interval. You can use the derived device category `Switch` as the defining characteristic of your node group. All discovered devices whose system object ID maps to the category `Switch` will receive the configured settings for the node group.

> **Tip**
>
> If NNMi is managing a hypervisor network environment, you might want to create a Node Group that contains only Virtual Machines (VMs). These nodes are identified using the vmwareVM device profile. You can also use this Node Group to occasionally check for VMs that are no longer hosted on a hypervisor. After selecting this Node Group, filter by Hosted On = null to identify these VMs. You can also use this Node Group to enable fault polling for the IP addresses associated with your VMs, which is also a best practice to ensure your VMs continue to be monitored even when its associated hypervisor has been deleted.

7.2.7 Planning polling intervals

You select for each object group a polling interval that NNMi uses to collect data. The interval can be as short as one minute or as long as days, as best matches your service level agreements.

Tip

Shorter intervals enable you to become aware of network problems earlier; however, polling too many objects in too short an interval can cause a backlog in the State Poller. Find the best balance between resource use and intervals for your environment.

Note

The Causal Engine performs a status poll of each node every 24 hours and updates status, conclusion, and incident information as needed. This status poll does not affect the timing of the polling interval configured for the device.

7.2.8 Planning the data to be collected

The State Poller service uses polls to gather status information about the monitored devices in your network. Polling can be done using ICMP, SNMP, or both.

ICMP (ping)

ICMP address monitoring uses ping requests to verify the availability of each managed IP address.

SNMP Polling

SNMP monitoring verifies that each monitored SNMP agent is responding to SNMP queries.

- The State Poller is highly optimized to collect configured SNMP information from each monitored object with one query at each interval. When you save configuration changes, the State Poller recalculates the group membership of each object and reapplies the configured interval and set of data to collect.
- SNMP monitoring issues SNMP queries for all monitored interfaces and components, requesting the current values from the MIB II interface table, the HostResources MIB, and vendor-specific MIBs. Some values are used for fault monitoring.

Web Polling

If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols. For example, SOAP protocol for VMware environments.

SNMP component health data

You might enable or disable component health monitoring at the global level. Component health monitoring for faults follows the fault polling interval settings for the device.

Gathering additional data at each poll does not affect the time to execute the poll. However, additional data stored for each object can increase the memory requirements for State Poller.

Tip

Batching your monitoring configuration changes is less disruptive to State Poller ongoing operation.

7.2.9 Deciding which SNMP traps to send to NNMi

NNMi uses the following SNMP traps to poll devices when these SNMP traps are received rather than waiting for the next polling interval:

- CempMemBufferNotify
- CiscoColdStart
- CiscoEnvMonFanNotification
- CiscoEnvMonFanStatusChangeNotif
- CiscoEnvMonRedundantSupplyNotification
- CiscoEnvMonSuppStatusChangeNotif
- CiscoEnvMonTemperatureNotification
- CiscoEnvMonTempStatusChangeNotif
- CiscoEnvMonVoltageNotification
- CiscoEnvMonVoltStatusChangeNotif
- CiscoFRUInserted
- CiscoFRURemoved
- CiscoLinkDown
- CiscoLinkUp
- CiscoModuleDown
- CiscoModuleUp
- CiscoModuleStatusChange
- CiscoRFProgressionNotif
- CiscoRFSwactNotif
- CiscoWarmStart
- HSRPStateChange
- IetfVrrpStateChange
- Rc2kTemperature
- RcAggLinkDown
- RcAggLinkUp
- RcChasFanDown
- RcChasFanUp
- RcChasPowerSupplyDown
- RcChasPowerSupplyUp
- Rcn2kTemperature
- RcnAggLinkDown
- RcnAggLinkUp
- RcnChasFanDown
- RcnChasFanUp
- RcnChasPowerSupplyDown
- RcnChasPowerSupplyUp

- `RcnSmltIstLinkDown`
- `RcnSmltIstLinkUp`
- `RcSmltIstLinkUp`
- `RcVrrpStateChange`
- `SNMPColdStart`
- `SNMPLinkDown`
- `SNMPLinkUp`
- `SNMPWarmStart`

To force NNMi to poll devices when these traps are received, configure your network devices to send these traps to NNMi.

> **Note**
>
> For details about these SNMP trap incident configurations, from the NNMi console, navigate to the **Configuration** workspace and select **Incidents** > **SNMP Trap Configuration**.

Also see (5) Discovery hints from SNMP traps.

7.3 Configuring state polling

This section provides configuration tips and provides some configuration examples. After reading the information in this section, see *Configure NNMi Monitoring Behavior* in NNMi Help for specific procedures.

> **Note**
>
> It is a good idea to save a copy of the existing configuration before you make any major configuration changes. For details, see 4.2 Best practice: Save the existing configuration.

7.3.1 Configuring the interface groups and node groups to be monitored

For details about the reasons for using node groups and interface groups for polling, see 7.2.6 Creating node and interface groups in the previous section.

You can use the NNMi console or CSV files to create node groups and interface groups. For example, if node group information is located on a Microsoft Excel worksheet, save this information as a CSV file, and then use the `nnmloadnodegroups.ovpl` command to add the file to NNMi. Similarly, you can add interface group information to NNMi by using the `nnmloadinterfacegroups.ovpl` command. For details, see the reference pages for `nnmloadnodegroups.ovpl` and `nnmloadinterfacegroups.ovpl`.

To create groups of nodes and interfaces on the NNMi console, use the **Configuration** workspace. For details, see *Creating Groups of Nodes or Interfaces* in NNMi Help.

Examples:

To configure a node group for ProximiT proxy servers:

1. From **Configuration**, open **Object Groups** > **Node Groups**, and then click **New**.
2. Name the group Proxy Servers and select the **Add to View Filter List** check box.
3. On the **Additional Filters** tab, select the `hostname` attribute, and set the operator to `like`.
4. For the node's host name, enter `prox*.yourdomain.com`, and then click **Save and Close**.

   For value, enter the wildcard as `prox*.example.com`.

   If you had configured a device profile and device category for the ProximiT devices, you could use the **Device Filters** tab to access the **Device Category** selector and base the group on the Proxy Server category you created.
5. Click **Save and Close** on the group definition.

> **Note**
>
> You must configure node groups before you can reference them in your interface group configuration.

7.3.2 Configuring interface monitoring

State Poller analyzes interface group membership before node groups. For each of the interface groups you created, as well as any pre-existing ones you want to use, open the **Monitoring Configuration** form and the **Interface Group**

Settings tab to create a custom set of instructions for how you want State Poller to handle that group. Your instructions will include the following:

- Enabling or disabling fault monitoring
- Setting the fault polling interval
- Selecting whether NNMi will monitor unconnected interfaces (or unconnected interfaces hosting IP addresses) in the group

You can configure different settings for each interface group. Remember that the State Poller evaluates the list in order from the lowest ordering number to the highest ordering number.

> **Tip**
>
> Double-check your order numbers, keeping in mind that an object that qualifies for multiple groups has settings applied from the group with the lowest order number.

7.3.3 Configuring node monitoring

If an object does not qualify for any configured interface group, State Poller evaluates the object for membership in node groups. Settings are applied to the first node group match from the lowest ordering number to the highest ordering number.

For each node group, open the **Monitoring Configuration** form, and then open the **Node Settings** tab. Create a custom set of instructions for how you want State Poller to handle that group. Your instructions can include the following:

- Enabling or disabling fault monitoring
- Setting the fault polling interval
- Selecting whether NNMi will monitor unconnected interfaces (or unconnected interfaces hosting IP addresses) in the group

You can configure different settings for each interface group.

> **Tip**
>
> Double-check the order numbers, keeping in mind that an object that qualifies for multiple groups has settings applied from the group with the lowest order number.

7.3.4 Specifying the default settings for monitoring

State Poller applies the settings from the **Default Settings** tab for any object that does not match a defined interface setting or node setting. Review the settings on this tab to ensure they match your environment at the default level. For example, you would rarely poll all unconnected interfaces as a default setting.

Note

Be sure you **Save and Close** all **Monitoring Configuration** forms all the way back to the console for your changes to be implemented.

7.4 Evaluating state polling

This section lists ways to evaluate the progress and success of the monitoring settings.

7.4.1 Verifying the configuration for network monitoring

You can determine the settings that NNMi uses for monitoring a given node or interface, and you can initiate a status poll of a node at any time.

To verify the configuration for network monitoring, use the following checks:

- (1) Is the interface or node a member of the right group?
- (2) Which settings are being applied?
- (3) Which data is being collected?

(1) Is the interface or node a member of the right group?

You can verify which interfaces or nodes belong to a group by selecting one of the following in the **Configuration** workspace:

- **Node Groups**
- **Interface Groups**

Follow the instructions in Help to show the members of the group. Keep in mind that an object can be a member of multiple groups, and that another group might have a lower ordering number.

Alternatively, you can see the full list of groups to which the object belongs by opening the object (interface or node) and clicking the **Node Groups** or **Interface Groups** tab. This list is alphabetical by group name and does not reflect the ordering numbers that determine which settings are applied.

If the object is not a member of a group:

1. Retrieve the device profile for the node in the **Inventory** view.
2. Review the attribute mapping for the device profile by choosing **Configuration**, and then **Device Profiles**.
3. Review the attribute requirements for the node group definition.

   If you have a mismatch, you can adjust the category derived in the **Device Profile** to force that type of device to qualify for your node group. You might need to choose **Actions**, **Polling**, and then **Configuration Poll** to update the attributes for the node so that it qualifies.

(2) Which settings are being applied?

To check the monitoring configuration in effect for a specific node, interface, or address, select that object in the appropriate **Inventory** view, and select **Actions**, **Configuration Details**, then **Monitoring Settings**. NNMi opens the current monitoring settings.

Check the values for **Fault SNMP Polling Enabled** and **Fault Polling Interval**. If these values are not as expected, look at the value for **Node Groups** or **Interface Groups** to see which ordered group match applied.

You might need to check the settings for the object to ensure traffic has not been disabled for it; you do this by choosing **Actions**, **Configuration Details**, and then **Communication Settings**.

(3) Which data is being collected?

You can initiate a status poll of a specific device to validate that the expected types of polls (SNMP, ICMP) are being performed for that device.

> **Tip**
>
> If Web Agents are configured (in addition to SNMP Agents), NNMi can use additional protocols.
>
> For example, SOAP protocol for VMware environments.

Select a node, and then click **Actions** > **Polling** > **Status Poll**. NNMi performs a real-time status check of the device. The output shows the types and results of the polls being performed. If the types of polls are not what you expect, check the monitoring settings for the node and the respective global, interface, or node settings of the monitoring configuration.

7.4.2 Evaluating the performance of status polling

Evaluate the performance of status polling in your environment by using the information in the State Poller health check to quantify and assess the operation of the State Poller service.

State Poller health information tells you whether the Status Poller is able to keep up with polling requests.

(1) Is the State Poller keeping up?

At any time, you can check the current health statistics about the State Poller service on the **State Poller** tab of the System Information window, as described in the following table.

Table 7-1: State Poller health information

Information	Description
Status	Overall status of the State Poller service
Poll counters	• Collections requested in last five minutes • Collections completed in last five minutes • Collections in process • Collection request delays
Time to execute skips in last five minutes	The number of regularly scheduled polls that did not complete within the configured polling interval. A non-zero value indicates that the polling engine is not keeping up or that targets are being polled faster than they can respond. • What to watch for: If this value continues to increase, there are problems communicating with the target or NNMi is overloaded. • Action to take: Look in the `nnm.log` file for messages for the classes beginning with the string `com.hp.ov.nms.statepoller` to determine the targets for the skipped polls. If the skipped polls are for the same targets, change the configuration to poll these targets at a less frequent rate or to increase the timeout for these targets. If the skipped polls are for different targets, check the NNMi system performance, especially the available memory for `ovjboss`.
Stale collections in last five minutes	A stale collection is a collection that has not received a response from the polling engine for at least 10 minutes. A healthy system will never have any stale collections. • What to watch for: If this value increases consistently, there is a problem with the polling engine. • Action to take: Look in the `nnm.log` file for messages for the classes beginning with the string `com.hp.ov.nms.statepoller` to determine the targets for the stale collections. If the stale collections are for a single target, unmanage the target until you can resolve the problem.

Information	Description
Stale collections in last five minutes	If the stale collections are for different targets, check the performance of the NNMi system and the NNMi database. Stop and restart NNMi.
Poller result queue length	• What to watch for: Makes sure that this value is close to `0` most of the time. If it is greater than `0`, take the following action: • Action to take: If this queue size is very large, `ovjboss` might be running out of memory.
State mapper queue duration	• What to watch for: Make sure that this value is close to `0` most of the time. If it is greater than `0`, take the following action: • Action to take: If this queue size is very large, check the performance of the NNMi system and the NNMi database.
State updater queue time	• What to watch for: Make sure that this value is close to `0` most of the time. If it is greater than `0`, take the following action: • Action to take: If this queue size is very large, check the performance of the NNMi system and the NNMi database.
State updater exceptions	What to watch for: This value should be `0`.

7.5 Tuning state polling

The performance of state polling is affected by the following key variables:

- The number of devices and interfaces to be polled
- The type of polling configured
- The frequency of polling each device

These variables are driven by your network management needs. If you are experiencing performance issues with status polling, consider the following configurations:

- Because polling settings for individual nodes are controlled through their membership in node groups and interface groups, make sure that the groups contain nodes or interfaces with similar polling requirements.
- If you are polling unconnected interfaces or interfaces that host IP addresses, check the configurations to make sure you are only polling the interfaces that are necessary. To maintain the most specific control and to select the smallest subset of interfaces to poll, enable these pollings on the **Node Settings** or **Interface Settings** form (not in **Default Settings** on the **Monitoring Configuration** form).
- Remember that polling unconnected interfaces monitors all unconnected interfaces. To monitor only those unconnected interfaces that have IP addresses, enable polling of interfaces that host IP addresses.

Regardless of the monitoring configuration, status polling is dependent on network responsiveness and might be impacted by overall system performance. Although status polling with default polling intervals does not introduce much network load, if the performance of the network link between the server and the polled device is poor, status polling performance is poor. You can configure larger timeouts and a smaller number of retries to reduce the network load, but these configuration changes only go so far. Timely polling requires adequate network performance and sufficient system resources (CPU, memory).

Enabling or disabling component health monitoring has no effect on the timeliness of polling. It simply gathers additional MIB objects at the schedule time. However, disabling component health monitoring might reduce the amount of memory used by the State Poller.

8 NNMi Incidents

NNMi provides a large number of default incidents and correlations. The default incidents enable you to display incidents immediately on the NNMi console. The correlations enable you to reduce the number of incidents to be managed. This chapter provides information to help you fine-tune network management by configuring NNMi incidents. This chapter supplements the information in NNMi Help. For an introduction to NNMi incidents and for detailed information about how to configure incidents, see Configuring Incidents in NNMi Help.

8.1 Concepts for incidents

NNMi collects network status information from the following sources:

- The NNMi Causal Engine, which analyzes the health of your network and provides an ongoing health status reading for each device. The Causal Engine also extensively evaluates and determines the root cause of network problems whenever possible.
- SNMP traps from network devices. The NNMi Causal Engine uses this information as symptoms during its analysis.

NNMi converts this network status information into incidents that provide useful information for managing the network. NNMi provides many default incident correlations that reduce the number of incidents for network operators to consider.

You can customize the default incident correlations and create new incident correlations to match the network management needs of your environment.

The incident configurations on the NNMi console define the incident types that NNMi can create. If no incident configuration matches a received SNMP trap, that information is discarded. NNMi always discards an incoming trap when the management mode of the source object is set to **Not Managed** or **Out of Service** in the NNMi database or the device is not monitored by fault polling.

`nnmtrapconfig.ovpl -dumpBlockList` outputs information about the current incident configuration, including SNMP traps that were not passed into the incident pipeline because of nonexistent or disabled incident configurations.

Additionally, NNMi discards SNMP traps from network devices that are not in the NNMi topology. For details about changing this default behavior, see *Handle Unresolved Incoming Traps* in NNMi Help.

For details, see *How NNMi Gathers Incidents* in NNMi Help.

8.1.1 Incident lifecycle

The following table describes the stages of an incident's lifecycle.

Table 8-1: NNMi incident lifecycle

Lifecycle state	Description	State set by	Incident used by
None	The NNMi event pipeline receives input from all sources and creates incidents as needed.	Not applicable	• NNMi
Dampened	The incident is in a holding place waiting to be correlated with another incident. The purpose of this waiting period is incident reduction in the incident viewers. The dampening interval can vary by incident type. For details, see 8.1.7 Incident suppression, enrichment, and dampening.	NNMi	• NNMi
Registered	The incident is visible in incident views. The incident is forwarded to any configured destinations (Northbound or global manager).	NNMi A user can also set this state in an incident view.	• Users • Lifecycle transition actions

Lifecycle state	Description	State set by	Incident used by
In progress	The incident has been assigned to someone who is investigating the problem. The network administrator defines the specific meaning of this state.	User	• Users • Lifecycle transition actions
Completed	Investigation of the problem indicated by the incident is complete and a solution is in place. The network administrator defines the specific meaning of this state.	User	• Users • Lifecycle transition actions
Closed	NNMi has determined that the problem reported by this incident no longer constitutes a problem. For example, when you remove an interface from a device, all incidents related to that interface are automatically closed.	User or NNMi	• Users • Lifecycle transition actions

8.1.2 Trap and incident forwarding

The following table summarizes the ways to forward traps and incidents from the NNMi management server to another destination.

Table 8-2: Supported ways to forward traps and NNMi incidents

Item	NNMi trap forwarding	NNMi Northbound interface trap forwarding	Global network management trap forwarding
What to forward	SNMP traps from network devices	• SNMP traps from network devices • NNMi management events	SNMP traps from network devices
Forwarding format	SNMPv1, SNMPv2c, or SNMPv3 traps, as received (SNMPv3 traps can be converted to SNMPv2c traps)	SNMPv2c traps created from NNMi incidents	NNMi incidents
Added information	In most cases, NNMi adds varbinds to identify the original source object. NNMi does not ever modify SNMPv1 traps.	NNMi adds varbinds to identify the original source object.	Any information added to the incident by the regional manager processes is retained in the forwarded incident.
Where to configure	**Incidents** > **Trap Server** > **Trap Forwarding Configuration** in the **Configuration** workspace	**Northbound Interface** in the **Integration Module Configuration** workspace	**Forward to Global Managers** tab on an **SNMP Trap Configuration** form or syslog configuration.
Notes	--	--	Forward the remote incidents that are visible in the global manager incident views. Forwarded incidents participate in correlations on the global manager.
For details	*Configure Trap Forwarding* in NNMi Help	--	*Configure Forward to Global Manager Settings for an SNMP Trap Incident (NNMi Advanced)* in NNMi Help

Legend:

--: Not applicable

8.1.3 Received SNMP traps

You can use either of the following approaches to forward to another application the SNMP traps that NNMi receives from managed devices:

- Use the NNMi SNMP trap forwarding mechanism.
- Use the NNMi Northbound interface SNMP trap forwarding mechanism.

The approach to trap identification by the receiving application varies as follows:

- Windows (all) and Linux (without original trap forwarding)

  This description applies to the default and to the SNMPv3-to-SNMPv2c conversion forwarding options.

  The NNMi SNMP trap forwarding mechanism on a Windows NNMi management server enriches each SNMP trap before forwarding it to the trap destination. The trap appears to originate from the NNMi management server. (This information also applies to a Linux NNMi management server for which the original trap forwarding option is not selected on the **Trap Forwarding Destination** form.)

  To ensure the correct association between the trap-sending device and the event in the receiving application, the rules for these traps must be customized for the enriched varbinds. Interpret the value from the `originIPAddress` (`.1.3.6.1.4.1.11.2.17.2.19.1.1.3`) varbind. The `originIPAddress` value is a byte string of generic type `InetAddress`, either `InetAddressIPv4` or `InetAddressIPv6`, as determined by the value of the `originIPAddressType` (`.1.3.6.1.4.1.11.2.17.2.19.1.1.2`) varbind. The rule must read the `originIPAddressType` varbind to determine the type of Internet address value (`ipv4(1)` or `ipv6(2)`) in the `originIPAddress` varbind. The rule might also need to convert the `originIPAddress` value to a display string.

  For details about the varbinds that NNMi adds to forwarded traps, see *Trap Varbinds Provided by NNMi* in NNMi Help, RFC 2851, and the following file:

  - Windows: `%NNM_SNMP_MIBS%\Vendor\Hewlett-Packard\hp-nnmi.mib`

  - Linux: `$NNM_SNMP_MIBS/Vendor/Hewlett-Packard/hp-nnmi.mib`

- Linux with original trap forwarding

  A Linux NNMi management server can forward traps in the same format in which NNMi receives them. Each trap appears as if the managed device sent it directly to the trap destination, so existing trap processing configured in the receiving application will work without modification.

- NNMi Northbound interface (all operating systems)

  The NNMi Northbound interface enriches each SNMP trap before forwarding it to the trap destination. The trap appears to originate from the NNMi management server. To ensure the correct association between the trap-sending device and the event in the receiving application, the rules for these traps must be customized for the enriched varbinds.

  The `nnmiIncidentSourceNodeHostname` (`1.3.6.1.4.1.11.2.17.19.2.2.21`) and `nnmiIncidentSourceNodeMgmtAddr` (`1.3.6.1.4.1.11.2.17.19.2.2.24`) varbinds identify the original source object.

8.1.4 MIBs

NNMi requires that the following management information base (MIB) files be loaded into the NNMi database:

- All MIB variables used in MIB expressions for the Custom Poller feature, line graphs, or both
- Sensors that NNMi monitors for health (for example, fan or power supply)

NNMi requires that the management information base (MIB) files, or the traps defined in the MIB files, be loaded into the NNMi database.

8.1.5 Custom incident attributes

NNMi uses custom incident attributes (CIAs) to attach additional information to incidents.

- For an SNMP trap incident, NNMi stores the original trap varbinds as CIAs for the incident.
- For a management event incident, NNMi adds pertinent information (for example, `com.hp.ov.nms.apa.symptom`) as CIAs for the incident.

You can use incident CIAs to narrow the scope of configurations such as incident lifecycle transition actions, suppression, deduplication, and enrichment. You can also use CIAs to narrow the availability of the application menu items for an incident view or form.

To determine the CIAs that NNMi adds for any given incident, open a sample incident from an incident view, and look at the information on the **Custom Attributes** tab.

(1) CIAs added to closed management event incidents

When the NNMi Causal Engine determines that the conditions that caused a management event incident no longer apply, NNMi sets that incident's lifecycle state to `CLOSED` and adds the CIAs listed in the table below to the incident. NNMi console users can see this information in the **Correlation Notes** field of the **Incident** form. Lifecycle transition actions can use the values of the CIAs directly.

Table 8-3: Custom incident attributes for a closed incident

Name	Description
`cia.reasonClosed`	The reason that NNMi canceled or closed the incident. This reason is also the conclusion name, such as `NodeUp` or `InterfaceUp`. When this field is not set, it means that an NNMi console user closed the incident. To determine the NNMi expected values of a `cia.reasonClosed` CIA, see *How NNMi Closes Incidents* in NNMi Help.
`cia.incidentDurationMs`	The duration, in milliseconds, of the outage, as measured by NNMi from when the status goes down to when it comes back up. This value is the difference between the `cia.timeIncidentDetectedMs` and `cia.timeIncidentResolvedMs` CIAs. It is a more accurate measurement than comparing the down and up incident timestamps.
`cia.timeIncidentDetectedMs`	The timestamp, to the millisecond, when the NNMi Causal Engine first detected the problem.
`cia.timeIncidentResolvedMs`	The timestamp, to the millisecond, when the NNMi Causal Engine detected that the problem has been resolved.

NNMi adds the CIAs listed in Table 8-3 to most primary and secondary root cause incidents. For example, a `NodeDown` incident can have `InterfaceDown` and `AddressNotResponding` incidents as secondary root causes. When NNMi closes the `NodeDown` incident, NNMi also closes the secondary incidents and adds the CIAs with values for each incident context to the secondary incidents.

NNMi does not add the CIAs listed in Table 8-3 to the following default management event incident types:

- Incidents that an NNMi console user closes manually
- Incidents that NNMi closes in response to an object being deleted from the NNMi database
- `IslandGroupDown` incidents
- `NnmClusterFailover`, `NnmClusterLostStandby`, `NnmClusterStartup`, and `NnmClusterTransfer` incidents
- Incidents in the following families:
  Correlation
  License
  NNMi health
  Trap analysis

8.1.6 Incident reduction

NNMi provides the following customizable correlations for reducing the number of incidents that network operators see on the NNMi console:

- Pairwise correlation
  Logically related incidents that need not be displayed in the **Incident** view (such as `CiscoLinkUp` following `CiscoLinkDown`) are managed as related incidents. Specifically, when an interface changes from `LinkDown` to `LinkUp`, the corresponding `LinkDown` and `LinkUp` messages are suppressed.
- Deduplication correlation
  When multiple copies of an incident are received within the specified time window, correlate the duplicates under a deduplication incident. The time window restarts for each newly received duplicate incident. In this way, NNMi correlates the duplicate incidents until it has not received any duplicates for the entire duration of the correlation time window.
- Rate correlation
  When the specified number of copies on an incident are received within the specified time window, correlate the duplications under a rate incident. NNMi generates the rate incident when the specified number of incidents has been received, regardless of how much time remains in the time window.

8.1.7 Incident suppression, enrichment, and dampening

NNMi provides a rich feature set for deriving the most value from incidents. For each incident type, you can use the following incident configuration options to define specifically whether an incident is of interest:

- Suppression
  An incident that matches the suppression configuration does not appear in the NNMi console incident views. Incident suppression is useful for incidents (such as `SNMPLinkDown` traps) that are important for some nodes (routers and switches, for example) but not for others.

- Enrichment

  When an incident matches the enrichment configuration, NNMi changes one or more incident values (for example, severity or message) according to the contents of the incident. Incident enrichment is useful for processing traps (for example, `RMONFallingAlarm`) that carry the distinguishing information in the trap varbinds (payload).

- Dampening

  When an incident matches the dampening configuration, NNMi delays activity (such as refreshing the display of the incident view or execution of an action) for that incident for the duration of the dampening interval. Incident dampening provides time for the NNMi Causal Engine to perform root cause analysis on the incident, which is useful for providing fewer, more meaningful incidents on the NNMi console.

For each incident type, NNMi provides the following levels of configuration for suppression, enrichment, and dampening:

- Interface group settings

  Specify incident behavior when the source object is a member of an NNMi interface group. You can specify different behavior for each interface group.

- Node group settings

  Specify incident behavior when the source object is a member of an NNMi node group. You can specify different behavior for each node group.

- Default settings

  Specify default incident behavior.

The following is the procedure for determining the behavior of a specific incident for any incident configuration area (suppression, enrichment, or dampening):

1. Check the interface group settings:
   - If the source object matches any interface group settings, carry out the behavior defined in the match with the lowest ordering number and stop looking for a match.
   - If the source object does not match any interface group settings, go to step 2.
2. Check the node group settings:
   - If the source object matches any node group settings, carry out the behavior defined in the match with the lowest ordering number and stop looking for a match.
   - If the source object does not match any node group settings, go to step 3.
3. Perform the actions defined in the default settings, if any.

8.1.8 Lifecycle transition actions

A lifecycle transition action is an administrator-provided command that runs when an incident lifecycle state changes to match the action configuration. An incident action configuration is specific to one lifecycle state for one incident type. The action configuration identifies the command to run when this incident type transitions to the specified lifecycle state. The command can include arguments that pass incident information to the action code.

The action code can be any `Jython` file, script, or executable that runs correctly on the NNMi management server. The action code can be specific to one incident type or it can process many incident types. For example, you might create action code that pages a network operator when NNMi creates a `ConnectionDown`, `NodeDown`, or `NodeOrConnectionDown` incident. You would configure three incident actions, one for the **Registered** lifecycle state for each of these incident types.

Similarly, the action code can be specific to one lifecycle state change or it can respond to several lifecycle state changes. For example, you might create action code that generates a trouble ticket when NNMi creates an `InterfaceDown` incident and closes the trouble ticket when the `InterfaceDown` incident is canceled. You would configure two incident actions for the `InterfaceDown` incident, one for the **Registered** state and one for the **Closed** state.

Each action configuration can include a payload filter based on CIAs that limits when the action is to run. For additional filtering, you can use incident enrichment to add a CIA to the incident. NNMi determines the value of that attribute from the incident source. For example, if you have added a custom attribute to some nodes, you can add this information to the incident as a CIA and then base the payload filter for an incident action on this attribute value.

8.2 Planning incidents

Make decisions in the following areas:

- SNMP traps to be processed
- Incidents to be displayed
- How NNMi responds to incidents

8.2.1 Planning the SNMP traps to be processed

Identify the device traps that are of interest in your network and plan an incident configuration for each trap. NNMi can process traps without the MIB being loaded into NNMi.

NNMi's `nnmincidentcfg.ovpl -loadTraps` script enables you to automate creation and updating of SNMP trap incident configurations by using MIB files. If the MIB file contains `TRAP-TYPE` or `NOTIFICATION-TYPE` macros, you can obtain the information required for incident configurations.

Decide whether you want to see traps from devices that are not in the NNMi topology.

8.2.2 Planning the incidents to be displayed

The default set of incidents is a good place to start. You can expand and reduce the incident set over time.

Plan which incidents can be reduced though deduplication, rate configuration, and pairwise correlation.

For details, see NNMi Help for Administer.

8.2.3 Planning how NNMi responds to incidents

Plan a lifecycle status that determines the actions to be taken by NNMi when certain incidents occur. For example, an action might be sending a message via email to a network operator.

For details, see NNMi Help for Administer.

8.3 Configuring incidents

For details about how to configure incidents, see *Configuring Incidents* in NNMi Help.

> **Note**
>
> It is a good idea to save a copy of the existing configuration before you make any major configuration changes. For details, see 4.2 Best practice: Save the existing configuration.

8.3.1 Configuring incident suppression, enrichment, and dampening

Note the following about configuring incident suppression, enrichment, and dampening:

- For each interface group, node group, or default setting, you can specify a payload filter that further refines when the configuration is applicable.
- Configure interface group settings on the **Interface Settings** tab of an incident configuration form.
- Configure node group settings on the **Node Settings** tab of an incident configuration form.
- Configure default settings on the **Suppression**, **Enrichment**, and **Dampening** tabs of an incident configuration form.

8.3.2 Configuring lifecycle transition actions

Note the following about configuring lifecycle transition actions:

- By default, NNMi runs actions at the following location:

  Windows:

  ```
  %NnmDataDir%shared\nnm\actions
  ```

  Linux:

  ```
  $NnmDataDir/shared/nnm/actions
  ```

  If an action is not at this location, specify the absolute path to the action in the **Command** field of the **Lifecycle Transition Action** form.

  > **Important**
  >
  > `Jython` files must be placed in the `actions` directory.

- Each time you make a change to the action configuration, NNMi rereads the actions directory for `Jython` files and loads them into NNMi.
- Actions are enabled as a group for an incident type.
- For details about the NNMi information that you can pass to an action, see *Valid Parameters for Configuring Incident Actions (SNMP Trap Incident)* in NNMi Help.

8.3.3 Configuring trap logs

NNMi can record all incoming SNMP traps in a log file (text or CSV file). The traps are recorded at the following location:

- Windows: `%NnmDataDir%log\nnm`
- Linux: `$NnmDataDir/log/nnm`

Use the `nnmtrapconfig.ovpl` script to configure the trap log file. You can select the following formats:

- `CSV` (default): Traps are recorded in CSV format (`trap.csv`).
- `LOG`: Traps are recorded in text format (`trap.log`).
- `BOTH`: Traps are recorded in both CSV and text formats (two log files).
- `OFF`: Traps are not recorded.

For example, to record traps in the `BOTH` mode, use the following command:

```
nnmtrapconfig.ovpl -setProp trapLoggingMode BOTH -persist
```

When the `-persist` argument is used, all trap server properties remain enabled, even after the trap service has been restarted. When the `-persist` argument is not used, all trap server properties are enabled only until the service is stopped.

Traps are written to a rolling log file. When the log file reaches the defined maximum size (defined by the `nnmtrapconfig.ovpl` script), the file is renamed to `trap.`*format*`.old`, and a new file replaces the existing file.

For details, see the *nnmtrapconfig.ovpl Reference Page*. Also see *Configure Trap Logging* in NNMi Help.

8.3.4 Configuring incident logs

You can configure incident logs so that incoming incident information will be written in the `incident.csv` file. This feature is useful for tracking and archiving incident logs.

To configure and enable incident logs, navigate to **Incident Logging Configuration** in the **Incident Configuration** area in the **Configuration** workspace. For details, see NNMi Help.

8.3.5 Configuring trap server properties

Use the `nnmtrapconfig.ovpl` script to configure trap server properties (`nnmtrapserver.properties`).

You must use the `nnmtrapconfig.ovpl` script to edit the `nnmtrapserver.properties` file. You must not edit this file directly.

The trap server properties are set to the following default values.

Table 8-4: Trap server properties and their default values

Trap server property	Default value
com.hp.ov.nms.trapd.udpPort	162
com.hp.ov.nms.trapd.rmiPort	1,097
com.hp.ov.nms.trapd.trapInterface	All interfaces
com.hp.ov.nms.trapd.recvSocketBufSize	53,248 kilobytes
com.hp.ov.nms.trapd.pipeline.qSize	50,000 traps
com.hp.ov.nms.trapd.connectToWinSNMP	false
com.hp.ov.nms.trapd.blocking	true
com.hp.ov.nms.trapd.blockTrapRate	50 traps/second
com.hp.nms.trapd.unblockTrapRate	50 traps/second
com.hp.ov.nms.trapd.overallBlockTrapRate	150 traps/second
com.hp.nms.trapd.overallUnblockTrapRate	150 traps/second
com.hp.ov.nms.trapd.analysis.minTrapCount	100 traps
com.hp.ov.nms.trapd.analysis.numSources	10 sources
com.hp.ov.nms.trapd.analysis.windowSize	300 seconds (5 minutes)
com.hp.nms.trapd.updateSourcesPeriod	30 seconds
com.hp.nms.trapd.notifySourcesPeriod	300 seconds
com.hp.ov.nms.trapd.hosted.object.trapstorm.enabled	false
com.hp.ov.nms.trapd.hosted.object.trapstorm.threshold	10 traps/second
com.hp.ov.nms.trapd.database.fileSize	100 megabytes
com.hp.ov.nms.trapd.database.fileCount	5 files
com.hp.ov.nms.trapd.database.qSize	300,000 traps
com.hp.ov.nms.trapd.discohint.cacheSize	5,000 entries
com.hp.ov.nms.trapd.discohint.cacheEntryTimeout	3,600 millisecond

For details, see the *nnmtrapconfig.ovpl Reference Page*.

8.4 Batch loading incident configuration

You can use the two scripts `nnmincidentcfgdump.ovpl` and `nnmincidentcfgload.ovpl` in conjunction with batch loading of incident configuration.

8.4.1 Using nnmincidentcfgdump.ovpl to create an incident configuration file

In NNMi, you can use the `nnmincidentcfgdump.ovpl` script to create or update an incident configuration and then use the `nnmincidentcfgload.ovpl` script to load the incident configuration into the NNMi database. The files are created in a non-XML format.

You can edit the files by referencing the explanation of formats stored in the following directory:

- Windows: `%NnmInstallDir%examples\nnm\incidentcfg`
- Linux: `/opt/OV/examples/nnm/incidentcfg`

To create an incident configuration file, use the following sample syntax:

```
nnmincidentcfgdump.ovpl -dump file-name -uuid -u NNMi-admin-user-name -p NNMi-admin-password
```

For details, see the *nnmincidentcfgdump.ovpl Reference Page*.

8.4.2 Using nnmincidentcfgload.ovpl to load the incident configuration

In NNMi, you can use the `nnmincidentcfgload.ovpl` script to load the incident configuration from a formatted configuration file into the NNMi database.

For details about the required format, see the following directory:

- Windows: `%NnmInstallDir%examples\nnm\incidentcfg`
- Linux: `/opt/OV/examples/nnm/incidentcfg`

To validate the incident configuration file before loading it into the NNMi database, use the following sample syntax:

```
nnmincidentcfgload.ovpl -validate file-name -u NNMi-admin-user-name -p NNMi-admin-password
```

To load the incident configuration, use the following sample syntax:

```
nnmincidentcfgload.ovpl -load file-name -u NNMi-admin-user-name -p NNMi-admin-password
```

Note the following:

- NNMi updates all settings that have a matching name or similar key identifier.

Use the `nnmincidentcfgdump.ovpl` script to create a non-XML file from the existing incident configuration file. If necessary, you can then edit this file before you load it into the NNMi database.

NNMi also overwrites the code values (such as incident families) associated with these settings.

- NNMi adds all incident settings that have key identifiers that are not in the NNMi database.
- NNMi does not change any existing incident setting that does not have a matching key identifier in the export file.
- NNMi resolves any unique object ID (UUID) if it is not provided in the configuration file.
- If NNMi cannot resolve a UUID, that UUID is created.

> **Important**
>
> If you change a file while the system is operating in High Availability (HA) mode, you must make the change on both nodes in the cluster. When you use NNMi in an HA configuration, if the change requires you to stop and restart the NNMi management server, you must place the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

For details, see the reference page for the `nnmincidentcfgload.ovpl` command.

8.5 Evaluating incidents

This section lists ways to evaluate the incident configuration:

- Verify that NNMi receives traps from all managed devices in the network.
  If NNMi is not receiving traps, check the firewall configuration on the NNMi management server.

  > **Note**
  >
  > Some anti-virus software includes a firewall that is configured separately from the system firewall.

- Verify that the most important traps are converted to incidents.
- Verify that incident actions run at the correct lifecycle state transitions.
- Verify that NNMi is handling incidents as expected.
  The **Incident Configuration Reports** menu under **Actions** contains several options for testing an existing incident against the current configuration of that incident type. Using one of these menu items does not change the incidents currently on the NNMi console.

8.6 Tuning incidents

You can use any of the following methods to reduce the number of incidents in the NNMi console incident views:

- Disable the incident configuration for any incident types that are not needed on the NNMi console.
- Set the management mode of the network objects that you do not need to monitor to **Not Managed** or **Out of Service**. NNMi discards all incoming traps from these nodes and their interfaces.
- Set NNMi to not monitor some network objects. NNMi discards all incoming traps from source objects that are not monitored.
- Identify additional criteria for or relationships between incoming incidents. When these criteria or relationships occur, NNMi modifies the flow of incidents by recognizing the criteria or patterns of incoming management events or SNMP traps and nesting related incidents as correlated children.

8.6.1 Enabling incidents for undefined traps

By default, NNMi drops SNMP traps with no incident definition.

To generate SNMP traps with no incident definition as `UndefinedSNMPTrap` incidents:

1. Open the following file with a text editor:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Look for the following line:

   ```
   #!com.hp.nnm.events.allowUndefinedTraps=false
   ```

   Edit this line as follows:

   ```
   com.hp.nnm.events.allowUndefinedTraps=true
   ```

3. (Optional) Specify an incident severity.
   Look for the following line:

   ```
   #!com.hp.nnm.events.undefinedTrapsSeverity=NORMAL
   ```

   Substitute a defined severity value for `YourSpecifiedSeverity`:

   ```
   com.hp.nnm.events.undefinedTrapsSeverity=YourSpecifiedSeverity
   ```

   The valid values are `NORMAL`, `WARNING`, `MINOR`, `MAJOR`, and `CRITICAL`.
4. (Optional) Specify the incident nature.
   Look for the following line:

   ```
   #!com.hp.nnm.events.undefinedTrapsNature=INFO
   ```

   Substitute an incident nature for `YourSpecifiedNature`:

   ```
   com.hp.nnm.events.undefinedTrapsNature=YourSpecifiedNature
   ```

   The valid values are `ROOTCAUSE`, `SECONDARYROOTCAUSE`, `SYMPTOM`, `SERVICEIMPACT`, `NONE`, and `INFO`.
5. (Optional) Specify whether to issue an UndefinedSNMPTrap incident multiple times.

You can choose to generate an UndefinedSNMPTrap incident only once per each trap OID, or generate an UndefinedSNMPTrap incident every time NNMi receives a trap.

By default, it is generated only once. To change to generate each time, search for the next line.

```
#!com.hp.nnm.events.allowMultipleUndefinedTrapIncidents=false
```

Edit this line to read as follows:

```
com.hp.nnm.events.allowMultipleUndefinedTrapIncidents=true
```

6. Save the changes.
7. Execute the following commands to restart NNMi:

```
ovstop
ovstart
```

8. Review the list of `UndefinedSNMPTrap` incidents.

   You must specify incident definitions for those SNMP traps that you want to display as incidents. For details, see NNMi Help.

8.6.2 Interpreting and displaying the MIB data for SNMP traps correctly

NNMi does not always know which character set to use to interpret the MIB data for SNMP traps.

The result is that NNMi displays garbled strings from MIB data (such as `sysDescription` and `sysContact`) for SNMP traps.

The solution is use the following procedure to specify the correct character set to be used by NNMi to interpret MIB data strings:

> **Note**
>
> In the case of new installation and Japanese environment, the following is set by default.
>
> - UTF-8, EUC_JP, windows-31j, Shift_JIS

1. Open the file with a text editor:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. If the following line is found and commented out (#! com.hp.nnm.sourceEncoding =), remove the comment symbol (#!):

```
#!com.hp.nnm.sourceEncoding=
```

3. Edit the `com.hp.nnm.sourceEncoding` property.

   Add to the `com.hp.nnm.sourceEncoding` property the character sets supported in your environment as a comma-separated list, using the examples shown in the `nms-jboss.properties` file.
4. Save the changes.
5. Execute the following commands to restart NNMi:

```
ovstop
ovstart
```

If NNMi is to display MIB data in hexadecimal without using a character set, do the following:

1. Open the following file with a text editor:
   - Windows: `%NnmDataDir%shared\nnm\conf\nnmvbnosrcenc.conf`
   - Linux: `$NnmDataDir/shared/nnm/conf/nnmvbnosrcenc.conf`
2. Add a combination of traps `OID` and `VarBind OID`.

   Add a combination of traps `OID` and `VarBind OID` for the target MIB data using the examples shown in the `nnmvbnosrcenc.conf` file.

   NNMi displays specified MIB data in hexadecimal by using the custom attribute values in the incident form.
3. Save the changes.
4. Execute the following commands to restart NNMi:

```
ovstop
ovstart
```

9 NNMi Console

This chapter explains how to use the NNMi console to configure the functions of NNMi.

9.1 A practical example of using node groups

This section explains how to configure node groups by way of a practical example.

Node groups to be configured:

`My Network`: A top level container node group containing other node groups

`USA`: An intermediate container node group containing other node groups

`Colorado`: A node group containing nodes located in Colorado

In this example, `Colorado` is the only node group that contains nodes.

Note the following:

- It is a best practice to design your node group map layout ahead of time.
- It is a best practice to configure one set of node and interface groups for network monitoring. Configure a different set of node groups for network visualization through maps.
- NNMi provides more than one way to configure node groups and node group maps. After you become familiar with the steps described in this document, you might find more efficient ways to create subsequent node groups and node group maps.

This section guides you through the following steps for configuring node groups and node group maps.

Creating node groups

- Step 1: Create the `My Network` node group.
- Step 2: Create the `USA` node group.
- Step 3: Create the `Colorado` node group using filters.
- Step 4: View the node group members to check the node group filter results.
- Step 5: Set up the node group hierarchy for the `My Network` node group.
- Step 6: Establish the node group hierarchy for the `USA Node` group.

Parent node groups might not contain any nodes, and instead they might contain only child node groups in the definition. In this example, the `My Network` and `USA` node groups are parent node groups that contain only child node groups.

Configuring the node group maps

- Step 1: Create the node group maps.
- Step 2: View the node group maps.
- Step 3: Configure node group status.
- Step 4: Configure node group map ordering.
- Step 5: Add a background image to a node group map.

9.1.1 Creating node groups

We begin by creating the node groups and then we add them to the node group maps.

(1) Step 1: Creating the My Network node group

To create the `My Network` node group:

1. Navigate to the **Configuration** workspace.
2. From **Object Groups**, select **Node Groups**.
3. Click the **New** icon.
4. In the **Name** attribute, enter `My Network`.
5. In the **Notes** attribute, enter `This is the top level Node Group`.
6. Click **Save and Close** to save this configuration.

(2) Step 2: Creating the USA node group

1. Navigate to the **Configuration** workspace.
2. From **Object Groups**, select **Node Groups**.
3. Click the **New** icon.
4. In the **Name** attribute, enter `USA`.
5. Click **Save and Close** to save this configuration.

(3) Step 3: Create the Colorado node group using filters.

To create the `Colorado` node group, use the Filter Editor to establish a filter to select the nodes.

> **Note**
>
> When possible, use the **Additional Filters** tab rather than specifying a list of nodes using the **Additional Nodes** tab. Using a node group filter enables NNMi to automatically place a node into the correct node group as new nodes are added to the network.

1. Navigate to the **Configuration** workspace.
2. From **Object Groups**, select **Node Groups**.
3. Click the **New** icon.
4. In the **Name** attribute, enter `Colorado`.
5. Choose the **Additional Filters** tab.
6. Click **OR** to specify that you want NNMi to match a node if the node matches either of the host name values you enter.
7. In the Filter Editor's **Attribute** field, select **hostname**.
8. Selecting **hostname** specifies that NNMi match the host name values when determining whether a node belongs to this node group.
9. In the **Operator** field, select **like**.
   Selecting **like** enables you to use wildcard characters in the search.
10. In the **Value** field, enter a value that represents the devices you want the node group to contain. For example, `cisco*.ntc.example.com` represents devices named `cisco`*value*`.`*network-domain*.
11. Click **Append**.

12. In the **Attribute** field, select **hostname**.
13. In the **Operator** field, select **like**.
14. In the **Value** field, enter a wildcard that represents the remaining device names you want to add to the `Colorado` node group.

    For this example, use `cisco?*`.
15. Click **Append**.
16. Click **Save** to save the node group without closing the window.

(4) Step 4: Checking the node group filter results

To test the node group filter, you can view the members of the node group you just created.

From the **Actions** menu, choose **Node Group Details**, and then **Show Members** to launch a view containing all of the nodes in the node group.

> **Note**
>
> Examine the node group filter definition results until you are confident the node group filter is correct.

(5) Step 5: Setting up the node group hierarchy for the My Network node group

Establish a hierarchy for the node groups, starting with the top level node group, `My Network`.

1. In the **Configuration** workspace, select **Object Groups**, and then the **Node Groups** option to view a list of the node groups you created.
2. Navigate to the `My Network` node group, and then click **Open**.
3. Click the **Child Node Groups** tab.
4. Click the **New** icon.
5. In the **Child Node Group** attribute, click the **Lookup** icon and select **Quick Find**.

   > **Important**
   >
   > Use **Quick Find** to select an object, such as a node group, when it already exists.
6. Select **USA** as the child node group.
7. Click **OK**.
8. Click **Save and Close** to save your changes and close the **Node Group Hierarchy** form.
9. Click **Save and Close** to save your changes and close the **Node Group** form.

(6) Step 6: Establishing the node group hierarchy for the USA Node group

Establish `Colorado` as a child node group of the `USA` node group. Repeat the same steps described in (5) Step 5: Setting up the node group hierarchy for the My Network node group to make the `Colorado` node group a child of the `USA` Node Group.

You are ready to create the node group maps for the node groups that you created.

9.1.2 Configuring the node group maps

Follow the steps in this subsection to configure a node group map for a node group that has been created.

(1) Step 1: Creating the node group maps

To create a node group map for a node group, use the **Actions** menu.

1. Open the node group for which you want to create a map:

   a. In the **Configuration** workspace, select **Object Groups**, and then the **Node Groups** option to view a list of the node groups you created.

   b. Navigate to the node group you want and click the **Open** icon.
2. From the **Actions** menu, choose **Maps**, and then **Node Group Map** to display a node group map.
3. Position the nodes and node group map icons.
4. Click the **Save Map** icon to create the node group map.

   > **Note**
   >
   > Always use **Save Map** to create a node group map, even if you have not changed any of the node positions. **Save Map** creates the node group map.

   A dialog box appears for confirming that you are satisfied with the created node group map.
5. Click **OK**.
6. Repeat steps 1 through 5 for each node group you created.

(2) Step 2: Viewing the node group maps

To view the node group maps:

1. Navigate to the **Topology Maps** workspace.
2. Select **Node Group Overview**.
3. Select the top level map **My Network**.
4. Navigate to a child node group map by double-clicking its icon.
5. Use the hierarchy link at the top of the map to return to the previous map.

(3) Step 3: Configuring node group status

NNMi enables you to configure how status is calculated for a node group. When you configure node group status, you determine which of the following methods NNMi is to use:

- Use the most severe status applicable to the nodes in the node group.
- Use a calculation based on a specified percentage.

> **Note**
>
> **Status Configuration** is a global configuration. By default, NNMi uses the most severe status among the nodes in the node group.

1. Navigate to the **Configuration** workspace.

2. Select **Status Configuration**.
3. Examine the **Status Configuration** form to become familiar with the default percentages.

   If you wish to use percentages, you must clear the **Propagate Most Severe Status** check box, and then save your changes.

(4) Step 4: Configuring node group map ordering

Node group map ordering is used to help determine the order in which maps open under the **Topology Maps** workspace. In this example, use node group map ordering to specify that the `My Network` node group map appears first in the list in the **Topology Maps** workspace.

1. Navigate to the **Configuration** workspace.
2. Select **User Interface**, and then **Node Group Map Settings**.

> **Note**
>
> As shown in the following example, the default **Topology Maps Ordering** value is `50` for all user-defined maps.
>
> To instruct NNMi to list `My Network` as the first map under the **Topology Maps** workspace, change the **Topology Maps Ordering** value to a number that is less than the **Topology Maps Ordering** value for any other maps in the list (for example 5).

3. Open the `My Network` node group map.
4. In the **Topology Maps Ordering** attribute, change the value to `5`.
5. Click **Save and Close** to save your changes and close the form.

You can also specify whether the map is to be displayed initially on the NNMi console. To do so, use the **User Interface Configuration** option from the **Configuration** workspace.

1. Navigate to the **Configuration** workspace.
2. From **User Interface**, click **User Interface Configuration**.
3. In the **Initial View** attribute, use the drop-down menu to select the workspace **First Node Group in Quick Access Maps folder**.

   This will make the `My Network` map the initial view. To verify the initial view, sign out of NNMi and sign back in. The `My Network` map will be the view you see on the NNMi console.

(5) Step 5: Adding a background image to a node group map

To include a background graphic with a map, use the **Node Group Map Settings** form for the selected node group map.

At first, place a background image file (e.g. `user.png`) in the following as a preparation.

- Windows: `%NnmDataDir%shared\nnm\www\htdocs\images`
- Linux: `$NnmDataDir/shared/nnm/www/htdocs/images`

1. Navigate to the **Configuration** workspace.
2. Click **User Interface**.
3. Click **Node Group Map Settings**.

4. Open the `My Network` node group map.
5. Navigate to the **Background Image** tab.
6. Click **http://MACHINE:PORT/nnmdocs/images/**.
   NNMi opens a list of graphics.
7. Right-click the **user.png**.
8. Copy the link location.
9. Close the directory listing window.

> **Note**
>
> Paste the "`/nnmdocs/images/filename`" part of copied link (`/nnmdocs/images/user.png`) into the **Background Image** attribute.
>
> Make note of the **Background Image Scale** value in case you want to change it later.

10. Click **Save and Close** to save your changes.
11. Navigate to **Quick Access Maps** in the workspace **Topology Maps** and select **My Network** to view your new map with the background graphic.

9.1.3 Deleting node groups

To delete the created `Colorado` node group:

1. Navigate to the **Configuration** workspace.
2. From **Object Groups**, click **Node Groups**.
3. From the list, select the `Colorado` node group, and then click the **Open** button.
   The `Colorado` node group is selected and its contents are displayed.
4. Click the **Delete Node Group** button.
   A dialog box appears that warns the user that if the node group is deleted, all objects contained in that node group and its references will be deleted.
5. Click **OK** to delete the node group.

9.2 Reducing the maximum number of nodes displayed in a Network Overview map

The **Network Overview** map opens a map containing up to 250 of the most highly connected nodes in the Layer 3 network. If this map contains too many nodes, it might respond slowly when moving nodes or it might become too complex for practical viewing. You can change the maximum number of nodes displayed in the **Network Overview** map as shown in the following example.

Example: Suppose you want to reduce the maximum number of nodes displayed in the **Network Overview** map from 250 to 100.

To do this, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Look for the following line:

   ```
   #!com.hp.nnm.ui.networkOverviewMaxNodes=250
   ```

   Specify the maximum value for the displayed node as follows:

   ```
   com.hp.nnm.ui.networkOverviewMaxNodes=100
   ```

   Important

   Make sure to remove the `#!` characters at the beginning of the line.
3. Save your changes.
4. Execute the following commands to restart NNMi:

   ```
   ovstop
   ovstart
   ```

9.3 Reducing the number of displayed nodes on a node group map

If you configure a node group map so that it contains hundreds of nodes, the map for that node group might show many small node icons instead of the detailed node icons you expect. To view the map with better detail, you would need to use the zoom feature. Using the zoom feature might slow the NNMi console performance when displaying maps.

The remedy is to limit the number of displayed nodes, displayed end points, or both, by doing the following:

1. On the NNMi console, click **Configuration**.
2. Click **User Interface Configuration** located beneath **User Interface**.
3. Select the **Default Map Settings** tab.
4. Modify the value shown in the **Maximum Number of Displayed Nodes** field.
5. Modify the value shown in the **Maximum Number of Displayed End Points** field.
6. Click **Save and Close**.

For details, see *Define Default Map Settings* in NNMi Help.

9.4 Configuring Gauges in the Analysis Pane

The **Gauges** tab in the analysis pane shows real-time SNMP gauges that display State Poller and Custom Poller SNMP data. These gauges display data for nodes, interfaces, custom node collections, and for node components of type CPU, Memory, Buffers, or Backplane.

You can configure the gauges by editing the following properties file:

- Windows: `%NNM_PROPS%\nms-ui.properties`
- Linux: `$NNM_PROPS/nms-ui.properties`

For each property that you want to set, if present, be sure to remove the comment characters (# !) located at the beginning of the line.

> **Note**
>
> The properties discussed in the sections that follow apply to ALL nodes (in other words, it is not possible to apply the properties to separate Node Groups).

> **Tip**
>
> Make a backup copy of the nms-ui.properties file before making any changes. Be sure to place the backup copy in a directory other than the directory containing the properties file you are editing. See also the comments within the nms-ui.properties file for more information.

9.4.1 Disabling the Analysis pane

To disable the Analysis pane from the NNMi console:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Locate the line that contains the following property:

   ```
   #!com.hp.nnm.ui.analysisPaneDisabled = true
   ```

   To disable the Analysis pane, delete #! at the beginning of the line, as shown below:

   ```
   com.hp.nnm.ui.analysisPaneDisabled = true
   ```

3. Save the changes.
4. Restart NNMi by executing the following commands:

   ```
   ovstop
   ovstart
   ```

9.4.2 Limiting the Number of Gauges Displayed

Set the maximum number of gauges to be displayed by editing the following line and providing the desired value:

```
com.hp.nnm.ui.maxGaugePerAnalysisPanel =
```

Tip

A higher number of gauges affects performance when the analysis pane is displayed. A fewer number of gauges results in larger size gauges.

9.4.3 Setting the Refresh Rate for Gauges in the Analysis Pane

Set the refresh interval (in seconds) for gauges displayed in the analysis pane by editing the following property value:

```
com.hp.nnm.ui.analysisGaugeRefreshSecs =
```

Tip

Setting the value to “0” results in gauges never refreshing. A refresh rate faster than 10 seconds causes some SNMP agents to cache their values for short periods of time, causing repeated results.

9.4.4 Eliminating Gauges from the Display

Define the gauges that you do NOT want displayed (for all gauge views) by editing the following line and providing a list of gauges to eliminate from the display:

```
com.hp.nnm.ui.analysisGaugeNoDisplayKeyPatterns =
```

Note the following:

- Remove the comment character from all related lines
- You cannot have comments within a list of gauges
- Ensure that no blank lines exist within the list of gauges
  A blank line terminates the entries at the location of the blank line
- The default settings for this property are those in the comments
  These settings must be included if this configuration is being extended or amended; otherwise, an unexpected amount of gauges will appear.

9.4.5 Controlling the Order of Displayed Node Gauges

To control the order in which node gauges are displayed, edit the following line:

```
com.hp.nnm.ui.analysisGaugeNodeComponentKeys =
```

Note the following:

- Wildcards are not supported in this property setting
- Ensure that the list does not contain comments or empty lines
- The default settings for this property appear as comments. These settings must be included if this configuration is being extended or amended; otherwise, the order will not match what you configured.

9.4.6 Controlling the Order of Displayed Interface Gauges

To control the order in which interface gauges are displayed, edit the following line:

```
com.hp.nnm.ui.analysisGaugeInterfaceKeys =
```

Note the following:

- Wildcards are not supported in this property setting.
- Ensure that the list does not contain comments or empty lines.
- The default settings for this property are those in the comments. These settings must be included if this configuration is being extended or amended; otherwise, the order will not match what was anticipated.

9.4.7 Controlling the Order of Displayed Custom Poller Gauges

To control the order in which Custom Poller gauges are displayed, edit the following line:

```
com.hp.ov.nnm.ui.analysisGaugeCustomPolledInstanceKeys =
```

Note

There is no default setting for this attribute.

9.4.8 Understanding how Gauge Properties are Applied

Gauge properties are applied in the following order:

1. The list of all possible gauges is retrieved from State Poller.
2. The analysisGaugeNoDisplayKeyPatterns is first applied to remove the specified gauges from the list.
3. The analysisGaugeNodeComponentKeys, analysisGaugeInterfaceKeys, or analysisGaugeCustomPolledInstanceKeys is applied, as appropriate, to order the list of displayed gauges.
4. Finally the maxGaugePerAnalysisPanel is applied to truncate the displayed list.

9.4.9 Troubleshooting Gauge Problems

This section includes information for troubleshooting the following gauge problem:

(1) Too Many Gauges Are Displayed

If you have too many gauges, do one of the following:

- Limit the number of gauges displayed using the maxGaugePerAnalysisPanel property
  See 9.4.2 Limiting the Number of Gauges Displayed for more information.
- Use the analysisGaugeNoDisplayKeyPatterns property to remove the gauges that are not wanted
  See 9.4.4 Eliminating Gauges from the Display for more information.

9.5 Configuring Map Label Scale Size and Borders

The NNMi Administrator can make the following adjustments to a map view using the nms-ui. properties file:

- The scale value for node and port labels as a map is re-sized using the Zoom feature.
- The largest relative scale factor that can be used to determine the difference in size between nodes or ports and their labels on a map.
- Whether labels for nodes and ports are surrounded with a black rectangle.

> **Note**
>
> By default labels for nodes and ports are surrounded with a black rectangle to improve readability when labels overlap.

The following table describes the properties to change.

> **Tip**
>
> Each scale adjustment property value is multiplied with the actual scale factors used by NNMi. For example, if you change the labelScaleAdjust value to .50, then the labels as seen on the map are one half of their normal size.

Table 9-1: Properties to Change in the nms-ui.properties File

Property	Default Value	Description
com.hp.nnm.ui.labelScaleAdjust	1.0	Adjusts the scale size of the map labels for nodes and ports
com.hp.nnm.ui.omitLabelRectangle	true	Determines whether to use a black rectangle to surround the node and port labels. **Note:** To turn rectangles off, set the value to false.

> **Note**
>
> To implement your changes, re-open or change your map view.

9.6 Configuring Auto-Collapse Thresholds for Loom and Wheel Diagrams

As NNMi administrator, you can configure the point at which Loom and Wheel diagrams initially auto-collapse

Nodes (hiding the interfaces) and Switches (hiding the ports) for better readability if the diagram is sufficiently complex. You can achieve this by adjusting the following properties in the nms-ui.properties file.

Table 9-2: Auto-Collapse Thresholds for Wheel and Loom

Property	Description
com.hp.nnm.ui.wheelAutoCollapseThreshold	Use this property to specify the number of labels required around the perimeter before the Wheel Diagram automatically collapses.
com.hp.nnm.ui.loomAutoCollapseThreshold	Use this property to specify the number of labels required throughout the diagram before the Loom Diagram automatically collapses.

To configure auto-collapse thresholds, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Uncomment the required property, if required. See the comments in the nms-ui.properties file for details.
3. Update the threshold value as required and save your changes.
4. Reopen the diagram in NNMi console to implement your changes.

9.7 Customizing device profile icons

In NNMi, you can customize the icons that are associated with device profiles or specific nodes. These icons are displayed in table views and menu items. They are also displayed as foreground images in the NNMi topology map.

You can edit icons from the **Icons** option located in the **User Interface** folder in the **Configuration** workspace.

To edit or delete icons from the command line, use the `nnmicons.ovpl` command. For details, see the *nnmicons.ovpl Reference Page* or NNMi Help.

9.8 Overriding the refresh rate of table views

NNMi enables the NNMi administrator to override from the NNMi console the default refresh rate of table views.

The recommended minimum refresh rate is 30 seconds. Performance might be affected adversely if the refresh rate is set to less than 30 seconds.

To override the default refresh rate of NNMi table views:

1. Check the `viewInfoId` parameter in the URL of the view whose refresh rate is to be changed.
   a. Open the view whose refresh rate is to be changed.
   b. Click **Show View in New Window**.
   c. Make a note of the value of the `viewInfoId` parameter in the URL.
   Example:

   ```
   viewInfoId=allIncidentsTableView
   ```

2. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
3. Add to `nms-ui.properties` a line in the following format for specifying the view and its refresh rate in seconds:

   ```
   com.hp.ov.nms.ui.refreshViewSecs.VIEWKEYWORD = SECS
   ```

   Important

   - `VIEWKEYWORD` is the `viewInfoId` parameter in the view's URL.
   - `SECS` is the refresh rate (seconds).
   - Make sure that there are no extra spaces at the end of the command line.

   For example, to change the refresh rate of the **All Incidents** view, to 120 seconds, add the following line to `nms-ui.properties`:

   ```
   com.hp.ov.nms.ui.refreshViewSecs.allIncidentsTableView = 120
   ```

4. Save the changes.
5. To check the new refresh rate, open a different view, and then return to the view whose refresh rate was changed.

10 Working with Certificates for NNMi

A certificate identifies the Web server to the browser. This certificate can be self-signed or signed by a CA (Certificate Authority). The `nnm-key.p12` file stores private keys and certificates with their corresponding public keys. The `nnm-trust.p12` file contains certificates from other parties with whom you expect to communicate or certificates from Certificate Authorities that you trust to identify other parties. NNMi includes a self-signed certificate in both of these files (`nnm-key.p12` and `nnm-trust.p12`). To use certain NNMi features, NNMi management servers need to share their certificates with one another. This chapter contains configuration instructions for copying these certificates among NNMi management servers and using the `nnmcertmerge.ovpl` script to merge these certificates into the `nnm-key.p12` and `nnm-trust.p12` files.

10.1 About NNMi Certificates

> **Caution**
>
> NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. Environments upgraded from an older version of NNMi continue to use a JKS repository to store certificates.
>
> In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

This section describes useful terminology to help you work with certificates.

Table 10-1: Certificate Terminology

Concept	Description
Keystore and Truststore	**Truststore :** NNMi truststore is the file in which you store public keys from sources that you want NNMi to trust. In a newly installed instance of NNMi 11-50 or later version, the name of the truststore file is `nnm-trust.p12`. **Caution** On a management server where NNMi was upgraded to 11-50 or later version from an older version, the truststore file name is `nnm.truststore`. You can, however, perform additional steps (described in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore) to migrate the `nnm.truststore` file to the `nnm-trust.p12` file. **Keystore :** NNMi keystore is the file in which you import NNMi server's private key. In a newly installed instance of NNMi 11-50 or later version, the name of the keystore file is `nnm-key.p12`. **Caution** On a management server where NNMi was upgraded to 11-50 or later version from an older version, the keystore file name is `nnm.keystore`. You can, however, perform additional steps (described in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore) to migrate the `nnm.keystore` file to the `nnm-key.p12` file. These files are located at: • Windows: `%NNM_DATA%\shared\nnm\certificates\` • Linux: `$NNM_DATA/shared/nnm/certificates/`
Default NNMi certificates	NNMi is installed with a self-signed certificate generated using default properties. You can replace the default certificate with another self-signed or CA-signed certificate.
Tools	Certificates are generated and managed using the nnmkeytool.ovpl utility (which uses Java's Keytool utility). Additionally, NNMi provides the nnmmergecert.ovpl utility to merge certificates to establish trust within NNMi systems. This program is used in HA, Failover, and Global Network Management setups.
Supported encryption algorithms	NNMi accepts certificates generated using RSA algorithm. DSA algorithm is not supported.
Self-Signed Certificate	A Self-Signed certificate is typically used for establishing secure communication between your server and a known group of clients. NNMi installs with a self-signed certificate generated using default properties. **Note:** NNMi instances configured to use a self-signed certificate will display a warning message when users try to access NNMi web console in a web browser.

Concept	Description
CA-Signed Certificate	Signed server certificate that you receive in response to the Certificate Signing Request will contain the NNMi certificate that is CA signed and one or more CA certificates (if there is more than one CA certificate, this is also known as the certificate chain). **Note:** These certificates might be in a single file or in a two separate files.
Root CA Certificate	Identifies the certificate authority that is trusted to sign certificates for servers and users.
Intermediate CA Certificate	A certificate signed by either a root or intermediate CA that is itself an authority, rather than a server or user. **Note:** The list of certificates from the NNMi server certificate to the root CA certificate, including any intermediate CA certificates, is known as the certificate chain.

10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore

Prior to the version 11-50, NNMi used to provide a Java KeyStore (JKS) repository to store certificates. NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system.

However, when you upgrade an older version of NNMi to 11-50 or later version, the PKCS #12 file-based certificate management does not immediately come into effect and NNMi continues to use the JKS repository for certificate management.

With additional configuration tasks, you can configure the upgraded NNMi management server to use the new technique of PKCS #12 file-based certificate management.

To configure the upgraded NNMi management server to use PKCS #12 file-based certificate management:

1. Log on to the NNMi management server as root or administrator.
2. Run the following command to migrate to the new keystore file:

   Windows:

   ```
   %NnmInstallDir%bin\nnmkeytool.ovpl -importkeystore -srckeystore
   %NnmDataDir%shared\nnm\certificates\nnm.keystore -destkeystore
   %NnmDataDir%shared\nnm\certificates\nnm-key.p12 -srcstoretype JKS -deststoretype P
   KCS12 -srcprovidername SUN -destprovidername SunJSSE -alias <src_alias>
   ```

   Linux:

   ```
   /opt/OV/bin/nnmkeytool.ovpl -importkeystore -srckeystore
   /var/opt/OV/shared/nnm/certificates/nnm.keystore -destkeystore
   /var/opt/OV/shared/nnm/certificates/nnm-key.p12 -srcstoretype JKS -deststoretype P
   KCS12 -srcprovidername SUN -destprovidername SunJSSE -alias <src_alias>
   ```

   Caution

   After running the command, you will be asked to input a password three times, as follows:

   "Enter the password of the output destination keystore", "Re-enter the new password", "Enter the password of the source keystore". Enter `nnmkeypass` in response to all of these requests.

   The new certificate management technique enables you to retain only a single certificate in the keystore at a time. In this instance, <src_alias> is the alias of the certificate in the old keystore file that you want to migrate.

   For the certificate alias included in the previous keystore file, specify the setting value `com.hp.ov.nms.ssl.KEY_ALIAS` set in the following file.

   - Windows: `%NNM_CONF%\nnm\props\nms-local.properties`
   - Linux: `$NNM_CONF/nnm/props/nms-local.properties`

   Note

   In Application Failover Environmens, <src_alias> is the alias of the certificate of the server executing the command.

3. Run the following command to migrate to the new truststore file:

Windows:

```
%NnmInstallDir%bin\nnmkeytool.ovpl -importkeystore -srckeystore
%NnmDataDir%shared\nnm\certificates\nnm.truststore -destkeystore
%NnmDataDir%shared\nnm\certificates\nnm-trust.p12 -srcstoretype JKS -deststoretype
 PKCS12 -srcprovidername SUN -destprovidername SunJSSE
```

Linux:

```
/opt/OV/bin/nnmkeytool.ovpl -importkeystore -srckeystore
/var/opt/OV/shared/nnm/certificates/nnm.truststore -destkeystore
/var/opt/OV/shared/nnm/certificates/nnm-trust.p12 -srcstoretype JKS -deststoretype
 PKCS12 -srcprovidername SUN -destprovidername SunJSSE
```

Caution

After running the command, you will be asked to input a password three times, as follows:

"Enter the password of the output destination keystore", "Re-enter the new password", "Enter the password of the source keystore". Enter `ovpass` in response to all of these requests.

4. Open the `server.properties` file from the following location with a text editor:
   - Windows: `%NnmDataDir%nmsas\nms`
   - Linux: `/var/opt/OV/nmsas/nms`
5. Delete the existing content of the file.
6. Add the following content to the file:

```
nmsas.server.security.keystore.type=PKCS12
nmsas.server.security.keystore.file=${com.hp.ov.DataDir}/shared/nnm/certificates/n
nm-key.p12
nmsas.server.security.keystore.cred=nnmkeypass
nmsas.server.security.truststore.file=${com.hp.ov.DataDir}/shared/nnm/certificates
/nnm-trust.p12
nmsas.server.security.truststore.cred=ovpass
nmsas.server.security.keystore.alias=
nms.comm.soap.https.PROTOCOLS=TLSv1.2
```

7. Save the file.
8. Open the `nms-local.properties` file from the following location with a text editor:
   - Windows: `%NnmDataDir%conf\nnm\props`
   - Linux: `/var/opt/OV/conf/nnm/props`
9. Modify the values of all the javax parameters:

Parameter	Value
javax.net.ssl.trustStore	${NnmDataDir}/shared/nnm/certificates/nnm-trust.p12
javax.net.ssl.trustStoreType	PKCS12
javax.net.ssl.keyStore	${NnmDataDir}/shared/nnm/certificates/nnm-key.p12
javax.net.ssl.keyStoreType	PKCS12

10. Save the file.
11. Delete the `nnm.keystore` and `nnm.truststore` files from the following directory.
    - Windows: `%NnmDataDir%shared\nnm\certificates`

- Linux: `/var/opt/OV/shared/nnm/certificates`

12. Restart NNMi.

10.3 Using Certificates with the PKCS #12 Repository

Prior to the version 11-50, NNMi used to provide a Java KeyStore (JKS) repository to store certificates. NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system.

However, when you upgrade an older version of NNMi to 11-50 or later version, the PKCS #12 file-based certificate management does not immediately come into effect and NNMi continues to use the JKS repository for certificate management.

This section provides you with the procedures to work with certificates in a new installation of NNMi or an environment where the certificate repository is migrated to the PKCS #12 format.

Note

Since NNMi 13-00, the Subject Alternative Name (SAN) is added to the NNMi self-signed certificate for the new installation.

If you upgraded NNMi from NNMi 12-60 or earlier, the self-signed certificates of NNMi doesn't have a SAN. If you are using self-signed certificate of NNMi for SSL communication to NNMi and need to replace it with a self-signed certificate with a SAN, please see the *Release Notes*.

In addition, some browsers, such as Microsoft Edge and Google Chrome, may use a SAN for certificate authentication. If you use a CA-signed certificate, ask the CA signing authority to issue a certificate with a SAN added as necessary.

10.3.1 Generating a Self-Signed Certificate

Caution

NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. Environments upgraded from an older version of NNMi continue to use a JKS repository to store certificates.

In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

To generate a self-signed certificate, follow these steps:

1. Change to the directory on the NNMi management server that contains the `nnm-key.p12` and `nnm-trust.p12` files:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`
2. Save a backup copy of the `nnm-key.p12` file.
3. Delete the existing `nnm-key.p12` file.
4. Generate a private key from your system.

Use the `nnmkeytool.ovpl` command to generate this private key:

a. Run the following command exactly as shown:

- Windows:

```
%NnmInstallDir%bin\nnmkeytool.ovpl -genkeypair -validity 36500 -keyalg rsa -k
eystore nnm-key.p12 -storetype PKCS12 -storepass nnmkeypass -alias <alias_nam
e> -ext SAN=DNS:<FQDN>
```

- Linux:

```
$NnmInstallDir/bin/nnmkeytool.ovpl -genkeypair -validity 36500 -keyalg rsa -k
eystore nnm-key.p12 -storetype PKCS12 -storepass nnmkeypass -alias <alias_nam
e> -ext SAN=DNS:<FQDN>
```

Note

The alias, referred to as `<alias_name>` in this example, identifies this newly-created key. Although the alias can be any string, we recommends you use the fully-qualified domain name (FQDN) followed by a suffix to help you easily identify the right version. For example, you can use alias name as `myserver.mydomain-<number>` or `myserver.mydomain-<date>`.

In the <FQDN> field, enter the FQDN of your system (the FQDN used to access the NNMi console with a browser).

b. Enter the requested information.

Note

When prompted for your first and last name, enter the FQDN of your system (the FQDN used to access the NNMi console with a browser).

A self-signed certificate is generated.

For obtaining CA-signed certificates, you need to additionally generate and submit a CSR file to a CA. For more information, see 10.3.2 Generating a CA-Signed Certificate.

10.3.2 Generating a CA-Signed Certificate

Caution

NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. Environments upgraded from an older version of NNMi continue to use a JKS repository to store certificates.

In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

To obtain and install a CA-signed certificate, follow these steps:

1. Generate a self-signed certificate. For details, see 10.3.1 Generating a Self-Signed Certificate.
2. Run the following command to create a CSR (Certificate Signing Request) file:

- Windows:

```
%NnmInstallDir%bin\nnmkeytool.ovpl -keystore nnm-key.p12 -certreq -storetype PKC
S12 -storepass nnmkeypass -alias <alias_name> -ext SAN=DNS:<FQDN> -file CERTREQF
ILE
```

- Linux:

```
$NnmInstallDir/bin/nnmkeytool.ovpl -keystore nnm-key.p12 -certreq -storetype PKC
S12 -storepass nnmkeypass -alias <alias_name> -ext SAN=DNS:<FQDN> -file CERTREQF
ILE
```

Note

- In the command above, <alias_name> and <FQDN> correspond to the alias you had provided at the time of generating the certificate and the FQDN of your system.
- To print the contents of CERTREQFILE, run the following command.
  - Windows:

```
%NnmInstallDir%bin\nnmkeytool.ovpl -printcertreq -file CERTREQFILE -
storetype PKCS12
```

  - Linux:

```
$NnmInstallDir/bin/nnmkeytool.ovpl -printcertreq -file CERTREQFILE -
storetype PKCS12
```

3. Send the CSR to your CA signing authority which signs and returns the certificate files. For information on different types of CA certificates, see (1) Types of CA-Signed Certificates.

Caution

When you use the custom UI integration of JP1/IM3 Intelligent Integrated Management Base with browsers such as Microsoft Edge or Google Chrome, and use SSL for communication to the consoles, the system FQDN must be set in the Subject Alternative Name (SAN) of the NNMi certificate, and the browser must be accessed using that FQDN.

Therefore, when you use the custom UI integration of JP1/IM3 Intelligent Integrated Management Base, request the CA signing authority to issue a certificate with the SAN added when sending the CSR, and be sure to add the SAN to the certificate.

For more information about JP1/IM3 Intelligent Integrated Management Base, refer to 26.1 Integration with JP1/IM3 Intelligent Integrated Management Base.

The CA signing authority returns one of the following:

- A single signed server certificate file (referred to as `myserver.crt` file in this section). The single file contains the server certificate (the NNMi certificate that is CA-signed), one or more intermediate CA certificates, and the root CA certificate. All the certificates in this single file form a certificate chain.
- A set of two files that includes a signed server certificate file (referred to as `myserver.crt` file in this section) and a separate file containing the CA certificates (referred to as the `myca.crt` file). The `myserver.crt` file contains either a single server certificate or a certificate chain, but NOT the root CA certificate, which remains in the `myca.crt` file.

> **Note**
>
> If your CA returns the certificates in other forms, contact the CA provider for more information about how to obtain the separate certificate chain and root CA certificate. NNMi supports PEM (Privacy Enhanced Mail) format certificates only. Please get PEM format certificates.

4. Prepare the certificate files.

   The certificate chain must be imported to the keystore file and the root CA certificate must be imported to the truststore file.

   - If you received a single file from step 3

     Copy the root CA certificates from that file into a separate `myca.crt` file.

   - If you received a set of two files from step 3

     Add the `myca.crt` (the root CA certificate) file content to the end of the `myserver.crt` file and also remove any extra intermediate certificates from the `myca.crt` file, if it has any. This should result in one file, `myserver.crt`, containing the full certificate chain and one file, `myca.crt`, containing the root CA certificate.

5. Copy the files containing these certificates to a location on the NNMi management server. For this example, copy the files to the following location:

   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`

6. Change to the directory on the NNMi management server that contains the keystore and truststore files:

   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`

7. Run the following command to import the certificate into the keystore file:

   - Windows:

     ```
     %NnmInstallDir%bin\nnmkeytool.ovpl -importcert -trustcacerts -keystore nnm-key.p
     12 -storetype PKCS12 -storepass nnmkeypass -alias <alias_name> -file <path_to_my
     server.crt>
     ```

   - Linux:

     ```
     $NnmInstallDir/bin/nnmkeytool.ovpl -importcert -trustcacerts -keystore nnm-key.p
     12 -storetype PKCS12 -storepass nnmkeypass -alias <alias_name> -file <path_to_my
     server.crt>
     ```

> **Note**
>
> In the above command,
>
> - `<path_to_myserver.crt>` corresponds to the full path of the location where you have stored the CA-signed server certificate.
> - `<alias_name>` corresponds to the alias you had provided at the time of generating the certificate.

8. When prompted to trust the certificate, enter: `y`

   Example output for importing a certificate into the keystore

   The output from the command is of the form:

   ```
   Owner: CN=NNMi_server.example.com
   Issuer: CN=NNMi_server.example.com
   ```

```
Serial number: 494440748e5
Valid from: Tue Oct 28 10:16:21 MST 2008 until: Thu Oct 04 11:16:21 MDT 2108
Certificate fingerprints:
MD5: 29:02:D7:D7:D7:D7:29:02:29:02:29:02:29:02:29:02
SHA1: C4:03:7E:C4:03:7E:C4:03:7E:C4:03:7E:C4:03:7E:C4:03
Trust this certificate? [no]: y
Certificate was added to keystore
```

9. Run the following commands to import the root certificate into the truststore file:

   - Windows:

     ```
     %NnmInstallDir%bin\nnmkeytool.ovpl -import -alias <alias_name> -storetype PKCS12
      -keystore nnm-trust.p12 -file <path_to_myca.crt> -storepass ovpass
     ```

   - Linux:

     ```
     $NnmInstallDir/bin/nnmkeytool.ovpl -import -alias <alias_name> -storetype PKCS12
      -keystore nnm-trust.p12 -file <path_to_myca.crt> -storepass ovpass
     ```

   Note

   In the above command,

   - `<path_to_myca.crt>` corresponds to the full path of the location where you have stored the root certificate.
   - `<alias_name>` corresponds to the alias you had provided at the time of generating the certificate.

10. Examine the contents of the truststore:

    - Windows:

      ```
      %NnmInstallDir%bin\nnmkeytool.ovpl -list -keystore nnm-trust.p12 -storetype PKCS
      12 -storepass ovpass
      ```

    - Linux:

      ```
      $NnmInstallDir/bin/nnmkeytool.ovpl -list -keystore nnm-trust.p12 -storetype PKCS
      12 -storepass ovpass
      ```

    Example truststore output

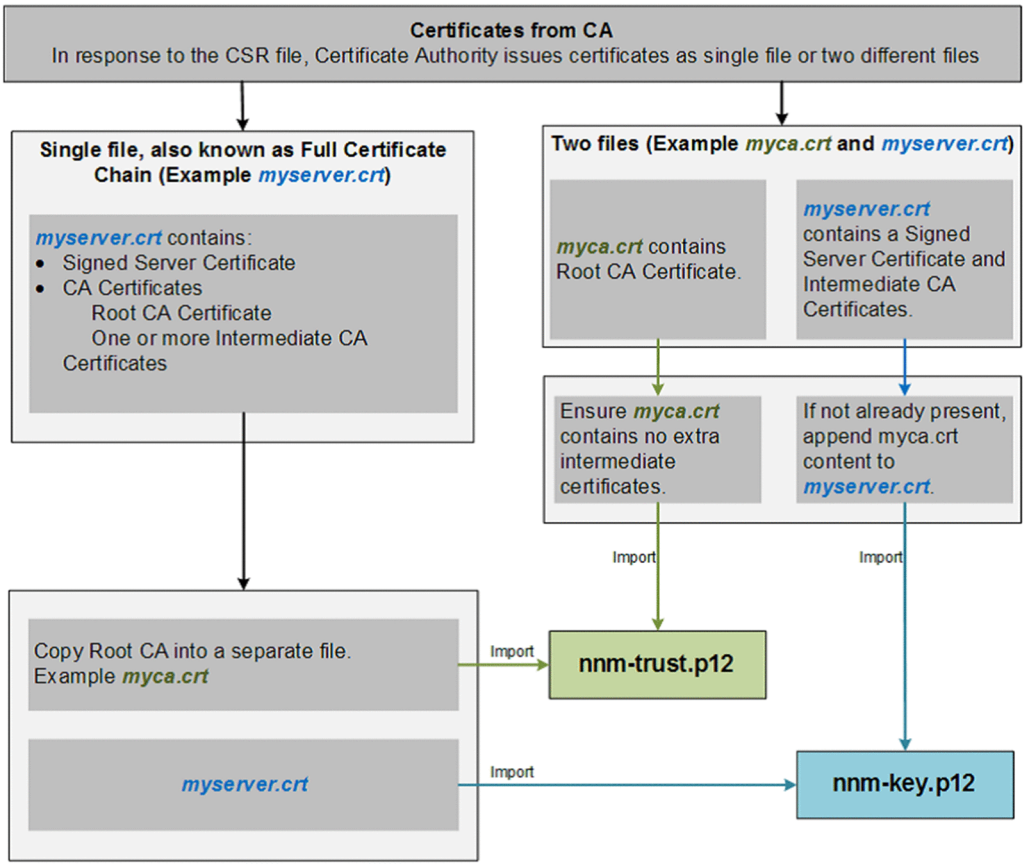
    The truststore output is of the form:

    ```
    Keystore type: PKCS12
    Keystore provider:BCFIPS
    Your keystore contains 1 entry
    nnmi_ldap, Nov 14, 2008, trustedCertEntry,
    Certificate fingerprint (MD5):29:02:D7:D7:D7:D7:29:02:29:02:29:02:29:02:29:02
    ```

    Tip

    The truststore can include multiple certificates.

(1) Types of CA-Signed Certificates



Note

If your CA returns the certificates in other forms, contact the CA provider for instructions about obtaining the certificate chain and the Root CA Certificate.

The Certificate Authority (CA) should provide you with one of the following:

- A signed server certificate file containing the server certificate (the NNMi certificate that is CA signed) and one or more CA certificates. This section refers to the signed server certificate as `myserver.crt` file.

  A CA Certificate can be either of the following:

  - Root CA Certificate: Identifies the authority that is trusted to sign certificates for servers and users.
  - Intermediate CA Certificate: A certificate signed by either a root or intermediate CA that is itself an authority, rather than a server or user.

  Note

  The list of certificates from the NNMi server certificate to the root CA certificate, including any intermediate CA certificates, is known as the certificate chain.

- A signed server certificate and a separate file containing one or more CA certificates. This section refers to the signed server certificate as `myserver.crt` file and the CA certificates as `myca.crt` file. The `myserver.crt` file should contain either a single server certificate or a certificate chain, but NOT the root CA certificate, which would be in the `myca.crt` file.

To configure NNMi with the new certificate, you must import the certificate chain into the `nnm-key.p12` file and the root CA Certificate into the `nnm-trust.p12` file. Use the `myserver.crt` file when importing the server certificate into the `nnm-key.p12` file and the `myca.crt` file when importing the CA certificate into the `nnm-trust.p12` file.

> **Note**
>
> If your CA returns the certificates in other forms, contact the CA provider for instructions about obtaining the separate certificate chain and root CA Certificate.

When provided with one file that contains a full certificate chain, copy the root CA certificate from that file into the `myca.crt` file. Use the `myca.crt` file to import into the `nnm-trust.p12` file so that NNMi trusts the CA that issued the certificate.

When provided two files, add the `myca.crt` file content to the end of the `myserver.crt` file, if the file does not include it, and also remove any extra intermediate certificates from the `myca.crt` file, if it has any. This should result in one file, `myserver.crt`, containing the full certificate chain and one file, `myca.crt` file, containing the root CA Certificate.

> **Note**
>
> When using a CA, only the root CA certificate is generally added to the `nnm-trust.p12` file. Adding intermediate CA or server certificates to the `nnm-trust.p12` file will cause those certificates to be explicitly trusted and not checked for additional information, such as revocation. Only add additional certificates to the `nnm-trust.p12` file if your CA requires it.

The following examples show what the files received from a CA signing authority might look like:

Separate server and CA certificate files:

```
-----BEGIN CERTIFICATE-----
Sample/AVQQKExNQU0EgQ29ycG9yYXRpb24gTHRkMRAwDgYDVQQLEwdOZXR3b3JseGVSZXZvY2F0aW9uTGlzd
D9iYXNlP29iamVjdENsYXNzPWNSTERpc3RyaWJ1dGlw
.....................................................................
.....................................................................
TZImiZPyLGQBGRYDaW50MRIwEAYKCZImiZPyLGQBGRYCc2cxEzARBgNVBAMTCmNbpSo6o/76yShtT7Vrlfz+m
XjWyEHaIy/QLCpPebYhejHEg4dZgzWWT/lQt==
-----END CERTIFICATE-----
```

Combined server and CA certificates in one file:

```
-----BEGIN CERTIFICATE-----
Sample1/VQQKExNQU0EgQ29ycG9yYXRpb24gTHRkMRAwDgYDVQQLEwdOZXR3b3JseGVSZXZvY2F0aW9uTGlzd
D9iYXNlP29iamVjdENsYXNzPWNSTERpc3RyaWJ1dGlw
.....................................................................
.....................................................................
TZImiZPyLGQBGRYDaW50MRIwEAYKCZImiZPyLGQBGRYCc2cxEzARBgNVBAMTCmNbpSo6o/76yShtT7Vrlfz+m
XjWyEHaIy/QLCpPebYhejHEg4dZgzWWT/lQt==
-----END CERTIFICATE-----
-----BEGIN CERTIFICATE-----
Sample2/Gh0dHA6Ly9jb3JwMWRjc2cyLnNnLmludC5wc2FnbG9iYWwuY29tL0NlcRaOCApwwggKYMB0GA1UdD
gQWBBSqaWZzCRcpvJWOFPZ/Be9b+QSPyDAfBgNVHSMC
.....................................................................
.....................................................................
```

```
Wp5Lz1ZJAOu1VHbPVdQnXnlBkx7V65niLoaT90Eqd6laliVlJHj7GBriJ90uvVGuBQagggEChoG9bGRhcDovL
y9DTj1jb3JwMWRjc2cyL==
-----END CERTIFICATE-----
```

10.3.3 Delete a Certificate from the NNMi Keystore

The NNMi keystore can hold only one certificate at a time. Before replacing or renewing a certificate on the NNMi management server, you must delete the existing certificate from the NNMi keystore.

To delete a certificate from the NNMi keystore:

1. Change to the directory on the NNMi management server that contains the `nnm-key.p12` and `nnm-trust.p12` files:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`
2. Save a backup copy of the `nnm-key.p12` file.
3. Examine the contents of the keystore, and then note down the alias of the existing certificate:
   - Windows:
     ```
     %NnmInstallDir%bin\nnmkeytool.ovpl -list -keystore nnm-key.p12 -storetype PKCS12
      -storepass nnmkeypass
     ```
   - Linux:
     ```
     $NnmInstallDir/bin/nnmkeytool.ovpl -list -keystore nnm-key.p12 -storetype PKCS12
      -storepass nnmkeypass
     ```
4. Delete the existing certificate from keystore by running the following command:
   - Windows:
     ```
     %NnmInstallDir%bin\nnmkeytool.ovpl -delete -keystore nnm-key.p12 -storetype PKCS
     12 -storepass nnmkeypass -alias <alias>
     ```
   - Linux:
     ```
     $NnmInstallDir/bin/nnmkeytool.ovpl -delete -keystore nnm-key.p12 -storetype PKCS
     12 -storepass nnmkeypass -alias <alias>
     ```

   Note

   The alias, referred to as <alias> in this example, identifies the existing certificate.

5. Restart NNMi by running the following commands:

   Note

   Changes take effect only after restarting NNMi.

   - Windows:
     ```
     %NnmInstallDir%bin\ovstop -c
     %NnmInstallDir%bin\ovstart -c
     ```
   - Linux:

```
$NnmInstallDir/bin/ovstop -c
$NnmInstallDir/bin/ovstart -c
```

10.3.4 Replacing an Existing Certificate with a new Self-Signed or CA-Signed Certificate

A self-signed certificate is created and installed during NNMi installation. You would typically replace a certificate in any of the following scenarios:

- To use a new self-signed or CA-signed certificate instead of the default certificate.
- To renew an expired certificate.

To replace a certificate, do the following:

1. Generate a self-signed certificate. For details, see 10.3.1 Generating a Self-Signed Certificate.

   Or, if you organization requires the certificate to be signed by a CA, generate a CSR (Certificate Signing Request) file and obtain a CA signed certificate. For details, see 10.3.2 Generating a CA-Signed Certificate.
2. Test HTTPS access to the NNMi console using the following syntax:

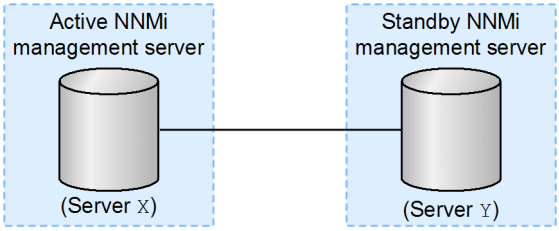
   `https://<fully_qualified_domain_name>:<port_number>/nnm/.`

   If you have used CA-signed certificate and if the browser trusts the CA, it will trust the HTTPS connection to the NNMi console.

   If you have used self-signed certificate, browser displays a warning message about the untrusted HTTPS connection to the NNMi Console.

10.3.5 Working with Certificates in Application Failover Environments

Figure 10-1: Using certificates with application failover



Caution

NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. Environments upgraded from an older version of NNMi continue to use a JKS repository to store certificates.

In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

When configuring the application failover feature, you must merge the content of the truststore file for both nodes into one `nnm-trust.p12` file.

Complete the following steps to configure the application failover feature to use self-signed or CA-signed certificates.

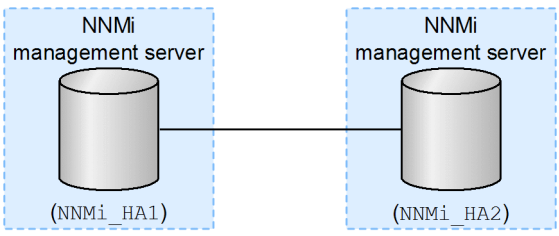
> **Caution**
>
> If you are using self-signed certificates with NNMi along with the application failover feature, and do not complete the following steps, NNMi processes will not start correctly on the standby NNMi management server (Server `Y` in this example).

1. Change to the following directory on Server `Y`:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`
2. Copy the `nnm-trust.p12` file from Server `Y` to some temporary location on Server `X`.
   The remaining steps refer to these file locations as `<truststore>`.
3. Run the following command on Server `X` to merge Server `Y`'s truststore into Server `X`'s `nnm-trust.p12` file:
   ```
   nnmcertmerge.ovpl -truststore <truststore>
   ```
4. Copy the merged `nnm-trust.p12` file from Server `X` to Server `Y`, so that both nodes have the merged files.
   The location of this file is as follows:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`
5. Run the following command on both Server `X` and Server `Y`.
   Verify that the displayed results from both servers, including the fully-qualified-domain names, match. If they do not match, do not continue; instead, redo beginning with step 1.
   Windows:
   ```
   %NnmInstallDir%bin\nnmkeytool.ovpl -list -keystore
   %NnmDataDir%shared\nnm\certificates\nnm-trust.p12 -storetype PKCS12 -storepass ovp
   ass
   ```
   Linux:
   ```
   $NnmInstallDir/bin/nnmkeytool.ovpl -list -keystore
   $NnmDataDir/shared/nnm/certificates/nnm-trust.p12 -storetype PKCS12 -storepass ovp
   ass
   ```
6. Continue configuring the application failover feature at 18. Configuring NNMi for Application Failover.

10.3.6 Working with Certificates in High-Availability Environments

This section describes how to configure NNMi to use Self-Signed or Certificate Authority Certificates in an HA environment.

Figure 10-2: Using certificates with HA



Caution

NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. If you have upgraded from an older version of NNMi, you must migrate to the PKCS #12 repository manually.

In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

(1) Configuring High-Availability Using Default Certificates

The process for configuring NNMi for HA correctly shares the default self-signed certificate among the primary and secondary cluster nodes. You do not need to take any extra steps to use the default certificate with NNMi running under HA.

(2) Configuring High-Availability Using New Certificates

This section creates a new self-signed or CA certificate, referred to as `newcert`. Complete the following steps to configure HA with this new CA or self-signed certificate.

Important

When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. If the change requires you to stop and restart the NNMi management server, you must put the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. See 19.6.1 Placing NNMi in maintenance mode for more information.

Tip

You can complete this procedure before or after configuring NNMi for HA, as described in 19.5 Shared NNMi Data.

1. Change to the following directory on `NNMi_HA1` before completing step 2:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`
2. On `NNMi_HA1`, run the following commands to import `newcert` into the `nnm-key.p12` file:

   Windows:

   ```
   %NnmInstallDir%bin\nnmkeytool.ovpl -import -alias <newcert_Alias> -storetype PKCS1
   2 -keystore nnm-key.p12 -file newcert -storepass nnmkeypass
   ```

   Linux:

   ```
   $NnmInstallDir/bin/nnmkeytool.ovpl -import -alias <newcert_Alias> -storetype PKCS1
   2 -keystore nnm-key.p12 -file newcert -storepass nnmkeypass
   ```

10.3.7 Working with Certificates in Global Network Management Environments

> **Caution**
>
> NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. Environments upgraded from an older version of NNMi continue to use a JKS repository to store certificates.
>
> In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

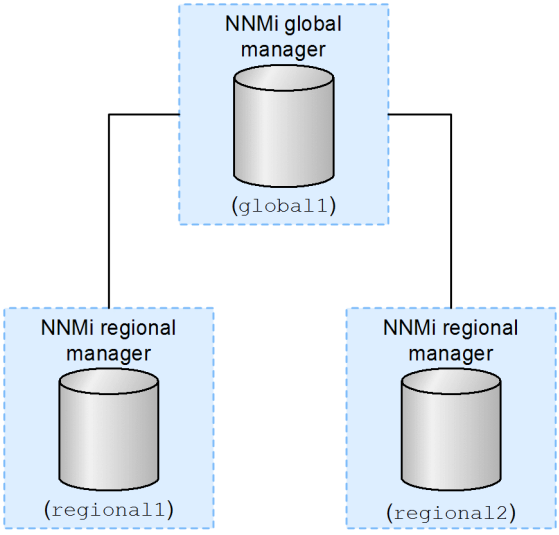
During NNMi installation, the installation script creates a self-signed certificate for the NNMi management server. This certificate contains an alias that includes the fully-qualified domain name of the node. The installation script adds this self-signed certificate to the NNMi management server's `nnm-key.p12` and `nnm-trust.p12` files.

Complete the following steps to configure the global network management feature to use self-signed/CA-signed certificates based on the following diagram.

Before you begin, make sure that the required certificates are created on the regional manager systems. For details, see 10.3.4 Replacing an Existing Certificate with a new Self-Signed or CA-Signed Certificate.

> **Note**
>
> If you are using a mix of newly installed NNMi 11-50 or later version instances and NNMi management servers upgraded to 11-50 or later version from an older version, follow the guideline in NNMi management servers upgraded to the version 11-50.

Figure 10-3: Global network management



1. Change to the following directory on `regional1` and `regional2`:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`

2. Copy the `nnm-trust.p12` files from the above locations on `regional1` and `regional2` to some temporary location on `global1`.
3. Run the following commands on `global1` to merge the `regional1` and `regional2` certificates into `global1`'s `nnm-trust.p12` file:

```
nnmcertmerge.ovpl -truststore <regional1_nnm-trust.p12_location>
nnmcertmerge.ovpl -truststore <regional2_nnm-trust.p12_location>
```

4. Run the following commands to restart NNMi on `global1`:

```
ovstop
ovstart
```

Important

When making file changes under High Availability (HA), you need to make the changes on both nodes in the cluster. For NNMi using HA configurations, if the change requires you to stop and restart the NNMi management server, you must put the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. See 19.6.1 Placing NNMi in maintenance mode for more information.

10.3.8 Configuring an SSL connection to the Directory service

Caution

NNMi 11-50 or later version introduce a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 or later version on a system. Environments upgraded from an older version of NNMi continue to use a JKS repository to store certificates.

In upgraded environments, you can migrate to the PKCS #12 repository by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

By default, when directory service communications are enabled, NNMi uses the LDAP protocol for retrieving data from a directory service. If your directory service requires an SSL connection, you must enable the SSL protocol to encrypt the data that flows between NNMi and the directory service.

SSL requires a trust relationship between the directory service host and the NNMi management server. To create this trust relationship, add a certificate to the NNMi truststore. The certificate confirms the identity of the directory service host to the NNMi management server.

To install a truststore certificate for SSL communications, follow these steps:

1. Obtain your company's truststore certificate from the directory server.
   The directory service administrator should be able to give you a copy of this text file.
   Note that the owner CN of the Truststore certificate must match the host name of the directory server.
2. Change to the directory that contains the NNMi truststore:
   - Windows: `%NnmDataDir%shared\nnm\certificates`
   - Linux: `$NnmDataDir/shared/nnm/certificates`

Run all commands in this procedure from the `certificates` directory.

3. Import your company's truststore certificate into the NNMi truststore.

> **Note**
>
> Import the root CA certificate of the LDAP directory server (without intermediate certificates) into the NNMi truststore.
>
> If you need to import root CA certificates for multiple LDAP directory servers, when you import the second and subsequent certificates, replace “nnmi_ldap” in the procedure with a name of your choice (example: nnmi_ldap2).

   a. Run the following command:

   Windows:

```
%NnmInstallDir%bin\nnmkeytool.ovpl -import -alias nnmi_ldap -storetype PKCS12 -k
eystore nnm-trust.p12 -storepass ovpass -file <Directory_Server_Certificate.txt>
```

   Linux:

```
$NnmInstallDir/bin/nnmkeytool.ovpl -import -alias nnmi_ldap -storetype PKCS12 -k
eystore nnm-trust.p12 -storepass ovpass -file <Directory_Server_Certificate.txt>
```

   Where `<Directory_Server_Certificate.txt>` is your company's truststore certificate.

   b. When prompted to trust the certificate, enter: `y`

   Example output for importing a certificate into the truststore

   The output from this command is of the form:

```
Owner:CN=NNMi_server.example.com
Issuer:CN=NNMi_server.example.com
Serial number:494440748e5
Valid from:Tue Oct 28 10:16:21 MST 2008 until:Thu Oct 04 11:16:21 MDT 2108
Certificate fingerprints:
MD5:29:02:D7:D7:D7:D7:29:02:29:02:29:02:29:02:29:02
SHA1:C4:03:7E:C4:03:7E:C4:03:7E:C4:03:7E:C4:03:7E:C4:03
Trust this certificate?[no]:y
Certificate was added to keystore
```

4. Examine the contents of the truststore:

   Windows:

```
%NnmInstallDir%bin\nnmkeytool.ovpl -list -storetype PKCS12 -keystore nnm-trust.p12
 -storepass ovpass
```

   Linux:

```
$NnmInstallDir/bin/nnmkeytool.ovpl -list -storetype PKCS12 -keystore nnm-trust.p12
 -storepass ovpass
```

   Example truststore output

   The truststore output is of the form:

```
Keystore type:PKCS12
Keystore provider:SunJSSE
Your keystore contains 1 entry
nnmi_ldap, Nov 14, 2008, trustedCertEntry,
Certificate fingerprint (MD5):29:02:D7:D7:D7:D7:29:02:29:02:29:02:29:02:29:02
```

Tip

The truststore can include multiple certificates.

5. Run the following commands to restart NNMi:

```
ovstop
ovstart
```

Important

When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. If the change requires you to stop and restart the NNMi management server, you must put the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. See 19.6.1 Placing NNMi in maintenance mode for more information.

11 Configuring the Telnet and SSH Protocols for Use by NNMi

Choosing the **Actions** > **Node Access** > **Telnet... (from client)** menu item invokes the `telnet` command to the selected node (from the Web browser in which the NNMi console is currently running). Choosing the **Actions** > **Node Access** > **Secure Shell... (from client)** menu item invokes the `secure shell` (`SSH`) command to the selected node. By default, neither Microsoft Edge nor Mozilla Firefox defines the `telnet` command or the `SSH` command, so using either of these menu items produces an error message. You can configure the telnet, SSH, or both protocols for each NNMi user (on a per-system basis), and you can change the NNMi console menu items. This chapter explains the configuration of the telnet and SSH protocols used in NNMi.

11.1 Disable the telnet or SSH menu item

If the NNMi users in your deployment environment do not require telnet or SSH connection from the NNMi console, you can disable the respective menu item to remove it from the NNMi console.

Disablement of a menu item on the NNMi console is applicable to all users who sign in to the NNMi console on this NNMi management server. To disable the **Telnet** or **Secure Shell** menu item, follow these steps:

1. In the **Configuration** workspace, expand **User Interface**, and then select **Menu Items**.
2. In the **Menu Items** view, double-click the **Telnet... (from client)** row or the **Secure Shell...(from client)** row.
3. On the **Menu Item** form, clear the **Enabled** check box, and then set the **Author** field to an appropriate value. Changing the author value ensures that this menu item remains disabled when you upgrade NNMi.
4. Save and close the form.

For details, see *Control the NNMi Console Menus* in NNMi Help.

11.2 Configure a telnet or SSH client for the browser on Windows

Configure the `telnet` command provided by the operating system for an NNMi user's Web browser. This procedure must be performed for each computer and Web browser from which an NNMi user needs to run the **Actions** > **Node Access** > **Telnet... (from client)** menu item.

Configure a third-party `SSH` command for an NNMi user's Web browser. This procedure must be performed for each computer and Web browser from which an NNMi user needs to run the **Actions** > **Node Access** > **Secure Shell... (from client)** menu item.

To complete any of the procedures in this section, you must have administrative privileges on the computer. The specific steps depend on the version (32-bit or 64-bit) of the browser and the operating system.

Only Microsoft Edge Chromium version is supported. To determine the version of Microsoft Edge, click the **Settings and more** button, click the **Help and Feedback**, and then click the **About Microsoft Edge**. If the version information includesthe following sentence, this Microsoft Edge is Chromium edition.“`This browser is made possible by the Chromium open source project and other open source software.`”

Firefox is available only in a 32-bit version.

The following table identifies the procedure to use for each browser and operating system combination.

Table 11-1: Matrix of telnet and SSH configuration procedures on Windows

Web browser	Windows operating system architecture	Applicable procedures
Microsoft Edge	64-bit	• 11.2.1 Windows operating system-provided telnet client • 11.2.2 Third-party telnet client (standard Windows) • 11.2.4 Third-party SSH client (standard Windows and Windows on Windows)
Firefox	32-bit	• 11.2.1 Windows operating system-provided telnet client • 11.2.2 Third-party telnet client (standard Windows) • 11.2.4 Third-party SSH client (standard Windows and Windows on Windows)
	64-bit Windows 10, Windows 11	• 11.2.2 Third-party telnet client (standard Windows) • 11.2.4 Third-party SSH client (standard Windows and Windows on Windows)
	64-bit other than Windows 10 or Windows 11	• 11.2.3 Third-party telnet client (Windows on Windows) • 11.2.4 Third-party SSH client (standard Windows and Windows on Windows)

Many of the tasks in this section involve editing the Windows registry. As an alternative to editing the registry directly, you can create a `.reg` file that can be run on each user's system. For example `.reg` files, see 11.3 Example files for changing the Windows registry.

For details about the tasks described in this section, see the following Microsoft articles:

- Installing the Microsoft-provided telnet client:
  `http://technet.microsoft.com/en-us/library/cc771275%28WS.10%29.aspx`
- Introduction to the Windows registry:
  `http://support.microsoft.com/kb/256986`
- Backing up and restoring the Windows registry:

http://support.microsoft.com/kb/322756

11.2.1 Windows operating system-provided telnet client

This procedure applies to the following cases:

- 32-bit Firefox on a 32-bit operating system
- 64-bit Microsoft Edge on a 64-bit operating system

To configure the telnet client provided by the operating system for use by a Web browser, follow these steps:

1. Windows 10, Windows 11, Windows Server 2016, Windows Server 2019, or Windows server 2022 only: Install the operating system's telnet client on the computer by following the steps appropriate to the operating system.

   Windows 10 or Windows 11:

   a. In the **Control Panel**, click **Programs**, and then click **Programs and Features**.

   b. Under **Tasks**, click **Turn Windows features on or off**.

   c. In the **Windows Features** dialog box, select the **Telnet Client** check box, and then click OK.

   Windows Server 2016, Windows Server 2019, or Windows Server 2022:

   a. In the **Server Manager**, under **Dashboard**, click **Add roles and features**.

   b. In the **Add Roles and Features Wizard**, select the **Telnet Client** check box, click **Next**, and then click **Install**.

2. Set file association for the URL:Telnet protocol file type.

   a. Back up the Windows registry.

   b. Use the Windows registry editor to modify the `[HKEY_CLASSES_ROOT\telnet\shell\open\command]` key with the following values:

Name	Type	Data
(default)	`REG_SZ`	`rundll32.exe url.dll,TelnetProtocolHandler %l`

   `%l` (with a lowercase *L*) is the argument passed to telnet, usually an IP address or the fully-qualified domain name of a node.

   For tighter control, you can encode the paths to the binaries in the key (as a single line). For example:

```
"C:\Windows\system32\rundll32.exe"
"C:\Windows\system32\url.dll",TelnetProtocolHandler %l
```

3. Restart the Web browser, and then, in the browser address bar, enter the `telnet` command:

```
telnet://node
```

   node is the IP address or fully-qualified domain name of a node that runs the telnet server. If you are prompted with a security warning, permit the action. In Firefox, select the **Remember my choice for telnet links** check box.

11.2.2 Third-party telnet client (standard Windows)

This procedure applies to the following cases:

- 32-bit Firefox on a 32-bit operating system
- 64-bit Microsoft Edge on a 64-bit operating system

To configure a third-party telnet client for use by a Web browser, follow these steps:

1. Obtain and install a third-party telnet client.
   This procedure gives examples for the PuTTY client installed to `C:\Program Files\PuTTY\putty.exe`. The PuTTY client is available from the following Website:

   ```
   http://www.putty.org
   ```

2. Set file association for the URL:Telnet protocol file type.
   a. Back up the Windows registry.
   b. Use the Windows registry editor to modify the `[HKEY_CLASSES_ROOT\telnet\shell\open\command]` key with the following values:

Name	Type	Data
(default)	`REG_SZ`	`"C:\Program Files\PuTTY\putty.exe" %l`

   `%l` (with a lowercase *L*) is the argument passed to telnet, usually an IP address or the fully-qualified domain name of a node.
   In a `.reg` file, escape each quotation mark (`"`) and backslash (`\`) character with a backslash (`\`) character.

3. Restart the Web browser, and then, in the browser address bar, enter the `telnet` command:

   ```
   telnet://node
   ```

   node is the IP address or fully-qualified domain name of a node that runs the telnet server.
   If you are prompted with a security warning, permit the action.
   In Firefox, select the **Remember my choice for telnet links** check box.

11.2.3 Third-party telnet client (Windows on Windows)

This procedure applies to the following cases:

- 32-bit Firefox on a 64-bit operating system

To configure a third-party telnet client for use by a Web browser, follow these steps:

1. Obtain and install a third-party telnet client.
   This procedure gives examples for the PuTTY client installed to `C:\Program Files\PuTTY\putty.exe`. The PuTTY client is available from the following Website:

   ```
   http://www.putty.org
   ```

2. Set file association for the URL:Telnet protocol file type.
   a. Back up the Windows registry.
   b. Use the Windows registry editor to modify the `[HKEY_CLASSES_ROOT\Wow6432Node\telnet\shell\open\command]` key with the following values:

Name	Type	Data
(default)	`REG_SZ`	`"C:\Program Files\PuTTY\putty.exe" %l`

   `%l` (with a lowercase *L*) is the argument passed to telnet, usually an IP address or the fully-qualified domain name of a node.

In a `.reg` file, escape each quotation mark (") and backslash (\) character with a backslash (\) character.

3. Restart the Web browser, and then, in the browser address bar, enter the `telnet` command:

```
telnet://node
```

node is the IP address or fully-qualified domain name of a node that runs the telnet server.

If you are prompted with a security warning, permit the action.

In Firefox, select the **Remember my choice for telnet links** check box.

11.2.4 Third-party SSH client (standard Windows and Windows on Windows)

This procedure applies to the following cases:

- 32-bit Firefox on a 32-bit or 64-bit operating system
- 64-bit Microsoft Edge on a 64-bit operating system

To configure a third-party SSH client for use by a Web browser, follow these steps:

1. Obtain and install a third-party SSH client.

   This procedure gives examples for the PuTTY client installed to `C:\Program Files\PuTTY\putty.exe`.

   Because PuTTY cannot correctly parse the `ssh://node` input, this example includes a script that strips the `ssh://` from the input argument. The script `C:\Program Files\PuTTY\ssh.js` contains the following commands:

```
host = WScript.Arguments(0).replace(/ssh:/,"").replace(/\//g,"");
shell = WScript.CreateObject("WScript.Shell");
shell.Run("\"c:\\Program Files\\PuTTY\\putty.exe\" -ssh " + host);
```

   This script was created for this example and is not included with PuTTY.

2. Define the SSH protocol.

   a. Back up the Windows registry.

   b. Use the Windows registry editor to add the `[HKEY_CLASSES_ROOT\ssh]` key with the following values:

Name	Type	Data
(default)	`REG_SZ`	URL:SSH protocol
`EditFlags`	`REG_DWORD`	`2`
`FriendlyTypeName`	`REG_SZ`	SSH
URL protocol	`REG_SZ`	No value

3. Set file association for the URL:SSH protocol file type.

   a. Back up the Windows registry.

   b. Use the Windows registry editor to modify the `[HKEY_CLASSES_ROOT\ssh\shell\open\command]` key with the following values:

Name	Type	Data
(default)	`REG_SZ`	`"C:\Windows\System32\WScript.exe" "C:\Program Files\PuTTY\ssh.js" %1`

`%l` (with a lowercase *L*) is the complete `ssh` argument, including the protocol specification. The `ssh.js` script passes the SSH target to PuTTY.

In a `.reg` file, escape each quotation mark (`"`) and backslash (`\`) character with a backslash (`\`) character.

4. Restart the Web browser, and then, in the browser address bar, enter the `ssh` command:

```
ssh://node
```

node is the IP address or fully-qualified domain name of a node that runs the telnet server.

If you are prompted with a security warning, permit the action.

In Firefox, select the **Remember my choice for ssh links** check box.

11.3 Example files for changing the Windows registry

If many NNMi users need to use the telnet or SSH protocol to access managed nodes from the NNMi console, you might be able to automate the Windows registry updates with one or more `.reg` files. This section contains example `.reg` files that you can use as a basis for creating your own `.reg` files. Note that the registry keys are located in a different path for running 32-bit applications on 64-bit versions of Windows than they are when the application and operating system match.

For details, see the Microsoft article at `http://support.microsoft.com/kb/310516`.

11.3.1 Example nnmtelnet.reg

This registry content example applies to 11.2.1 Windows operating system-provided telnet client.

```
Windows Registry Editor Version 5.00
[HKEY_CLASSES_ROOT\telnet\shell\open\command]
@="\"C:\\Windows\\system32\\rundll32.exe\"
\"C:\\Windows\\system32\\url.dll\",TelnetProtocolHandler %l"
```

11.3.2 Example nnmputtytelnet.reg

This registry content example applies to 11.2.2 Third-party telnet client (standard Windows).

```
Windows Registry Editor Version 5.00
[HKEY_CLASSES_ROOT\telnet\shell\open\command]
@="\"C:\\Program Files\\PuTTY\\putty.exe\" %l"
```

11.3.3 Example nnmtelnet32on64.reg

This registry content example applies to 11.2.3 Third-party telnet client (Windows on Windows).

```
Windows Registry Editor Version 5.00
[HKEY_CLASSES_ROOT\Wow6432Node\telnet\shell\open\command]
@="\"C:\\Program Files\\PuTTY\\putty.exe\" %l"
```

11.3.4 Example nnmssh.reg

This registry content example applies to 11.2.4 Third-party SSH client (standard Windows and Windows on Windows).

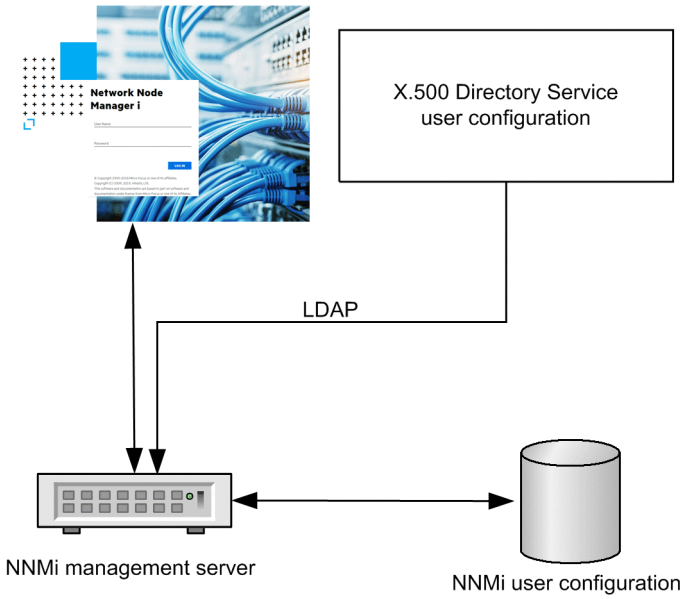
```
Windows Registry Editor Version 5.00
[HKEY_CLASSES_ROOT\ssh]
@="URL:ssh Protocol"
"EditFlags"=dword:00000002
"FriendlyTypeName"="Secure Shell"
"URL Protocol"=""
```

```
[HKEY_CLASSES_ROOT\ssh\shell\open\command] @="\"C:\\Windows\\System32\\WScript.exe\"
\"c:\\Program Files\\PuTTY\\ssh.js\" %l"
```

12 Integrating NNMi with a Directory Service Through LDAP

This chapter explains how to consolidate the storage of user names, passwords, and, optionally, NNMi user group assignments by integrating NNMi with a directory service.

12.1 NNMi user access information and configuration options



Together, the following items define an NNMi user:

- The *user name* uniquely identifies the NNMi user. The user name provides access to NNMi and receives incident assignments.
- The *password* is associated with the user name to control access to the NNMi console or NNMi commands.
- *NNMi user group* membership controls the information available and the type of actions that a user can take in the NNMi console. User group membership also controls the availability to the user of NNMi commands.

> **Important**
>
> If your device is SNMPv1 or SNMPv2c, note the following:
>
> SNMPv1 and SNMPv2c send their information packets in clear text.
>
> To secure your environment, use SNMPv3 or add protections, such as firewall controls, for the flow of SNMP traps and the collection of information from your devices.

NNMi provides several options for where the NNMi user access information is stored.

The following table shows the databases that store the NNMi user access information for each configuration mode.

Table 12-1: Options for storing user information

Mode	User account	User group	User group membership
Internal (option 1)	NNMi	NNMi	NNMi
Mixed (option 2)	Mixed (account name in NNMi, account password in LDAP)	NNMi	NNMi
External (option 3)	Directory service	Both	Directory service

NNMi uses the Lightweight Directory Access Protocol (LDAP) to communicate with the directory service. One of the following modes shown in the table above must be used in order to use LDAP with NNMi:

- Mixed Mode (referred to originally as Option 2): Some NNMi user information is in the NNMi database and some NNMi user information is in a directory service

  When you use the mixed mode, you configure NNMi to store user names, user groups, and user group mappings in the NNMi database, and you rely on a directory service for user names and passwords (user account definitions). This means that account name information must be stored in both NNMi and LDAP. Account passwords, on the other hand, are stored only in LDAP.
- External Mode (referred to originally as Option 3): All NNMi user information is in the directory service

  When you use the external mode, there is no need to add user account information to NNMi, because you use LDAP to store all user account information.

To add new user accounts or to modify existing accounts when you use the mixed mode, you must select the **Directory Service Account** check box. When you are configuring user accounts, you must not select the **Directory Service Account** check box for some users and not select it for others (in effect, combining the internal, mixed, and external modes); doing so will result in an unsupported configuration.

12.1.1 Internal mode: Storing all NNMi user information in the NNMi database

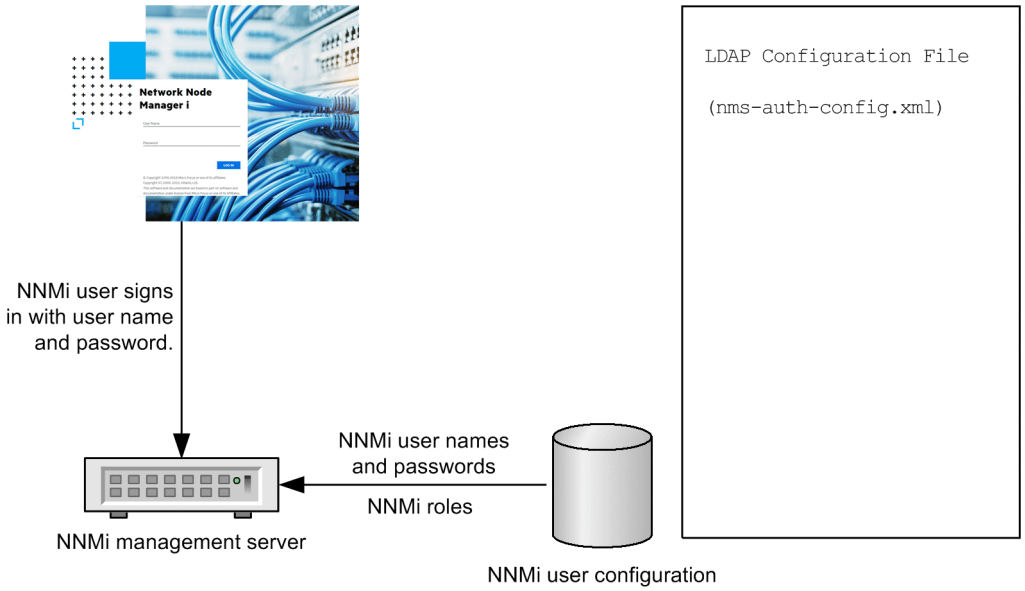
With configuration using the internal mode, NNMi accesses the NNMi database for all user access information, which the NNMi administrator defines and maintains in the NNMi console. The user access information is local to NNMi. NNMi does not access a directory service, and NNMi is not configured to retrieve information from the LDAP configuration file.

The figure below shows the information flow for this option, which is appropriate in the following situations:

- The number of NNMi users is small.
- No directory service is used.

For details about setting up all user information in the NNMi database, see *NNMi Configuration Settings to Control NNMi Access* in NNMi Help. You do not need to read the present chapter.

Figure 12-1: Flow of NNMi user sign-in information in the internal mode



12.1.2 Mixed mode: Storing some NNMi user information in the NNMi database and some NNMi user information in a directory service

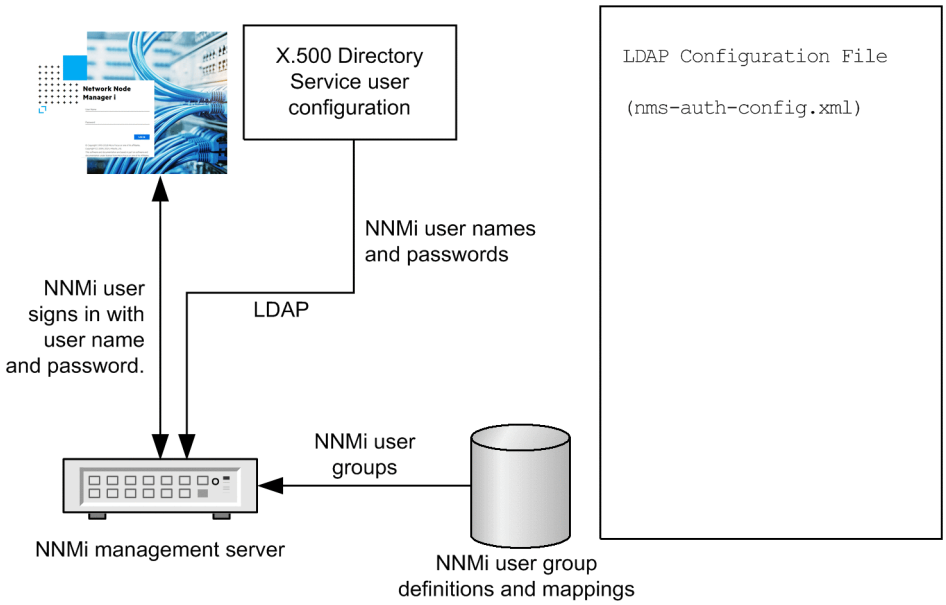
NNMi accesses a directory service for the user name and password, which are defined externally to NNMi and are also available to other applications. The mapping of users to NNMi user groups is maintained in the NNMi console. The configuration and maintenance of NNMi user access information is a joint effort, as described here:

- The directory service administrator maintains the user names and passwords in the directory service.
- The NNMi administrator enters the user names (as defined in the directory service), user group definitions, and the user group mappings in the NNMi console.
- The NNMi administrator configures NNMi's LDAP configuration file to describe to NNMi the directory service database schema for user names.

  In the figure below, making the last line a comment line prevents NNMi from acquiring NNMi user group information from the directory service.

Because user names must be entered in two places, user name maintenance must be performed in both places.

Figure 12-2: Flow of NNMi user sign-in information in the mixed mode



The figure above shows the information flow for this mode, which is appropriate in the following situations:

- The number of NNMi users is small, and a directory service is available.
- The NNMi administrator wants to manage the user groups instead of requiring a directory service change for each user group change.
- The directory service group definitions are available.

For details about integrating with a directory service for the user name and password, see the rest of this chapter and *Lightweight Directory Access Protocol (LDAP) to Control NNMi Access* in NNMi Help.

12.1.3 External mode: Storing all NNMi user information in a directory service

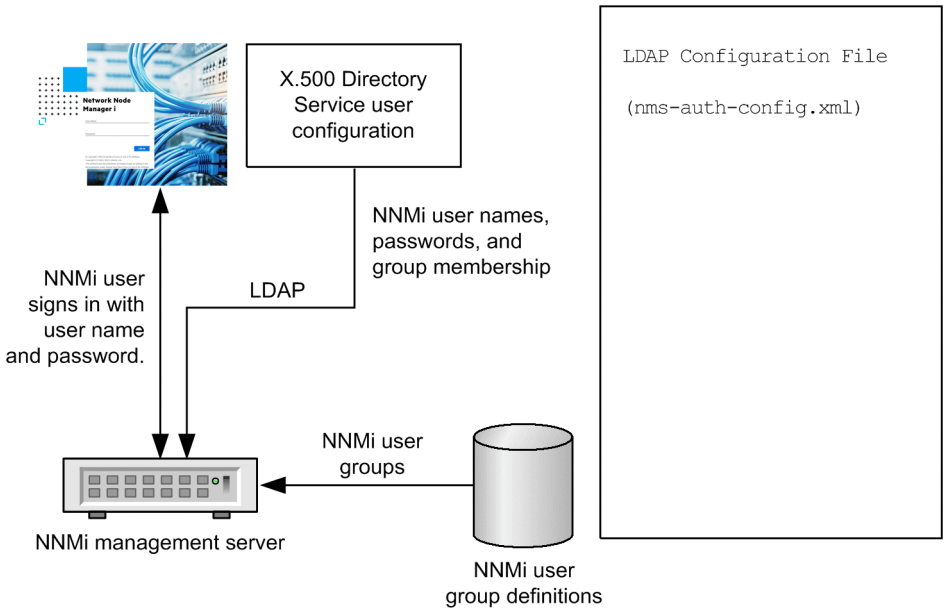
NNMi accesses a directory service for all user access information, which is defined externally to NNMi and is available to other applications. The NNMi user groups to which a user belongs is determined by the user's membership in one or more directory service groups.

The configuration and maintenance of NNMi user access information is a joint effort as described here:

- The directory service administrator maintains the user names, passwords, and group membership in the directory service.
- The NNMi administrator maps the directory service groups to NNMi user groups in the NNMi console.
- The NNMi administrator configures NNMi's LDAP configuration file to describe to NNMi the directory service database schema for user names and groups.

The figure below shows the information flow for this mode, which is appropriate for environments where the directory service can be modified to include user groups that align with the people who need access to NNMi.

Figure 12-3: Flow of NNMi user sign-in information in the external mode



Because this option is an expansion of the mixed mode scenario, we recommend the following configuration process:

1. Configure and verify NNMi user name and password retrieval from the directory service.
2. Configure NNMi user group retrieval from the directory service.

For details about integrating with a directory service that stores all user information, see the rest of this chapter and *Lightweight Directory Access Protocol (LDAP) to Control NNMi Access* in NNMi Help.

12.2 Configuring NNMi to access a directory service

You can configure directory service access in the `nms-auth-config.xml` file.

The file is located at:

- Windows: `%NnmDataDir%nmsas\NNM\conf`
- Linux: `$NnmDataDir/nmsas/NNM/conf`

By default, the `nms-auth-config.xml` file available in this location does not contain the XML elements required for LDAP configuration.

You can manually add all the necessary XML elements to this file by following the instructions in this section.

NNMi places a sample `nms-auth-config.xml` file in a different location, which can be used for reference.

The sample `nms-auth-config.xml` file is available in the following location:

- Windows: `%NnmInstallDir%newconfig\HPOvNnmAS\nmsas\conf`
- Linux: `$NnmInstallDir/newconfig/HPOvNnmAS/nmsas/conf`

> **Tip**
>
> You can also copy the entire <ldapLogin> element from the sample `nms-auth-config.xml` file,and then make necessary modifications.

For details about the `nms-auth-config.xml` file, see 12.6 LDAP configuration file reference.

For details about the general structure of a directory service, see 12.3 Directory service queries.

To configure access for the mixed mode, complete the following tasks:

- 12.2.1 Task 1: Back up the current NNMi user information
- 12.2.2 Task 2: (Optional) Configure secure communications to the directory service
- 12.2.3 Task 3: Configure user access from the directory service
- 12.2.4 Task 4: Test the user name and password configuration
- 12.2.9 Task 9: Clean up to prevent unexpected access to NNMi
- 12.2.10 Task 10: (Optional) Map the user groups to security groups

To configure access for the external mode, complete the following tasks:

- 12.2.1 Task 1: Back up the current NNMi user information
- 12.2.2 Task 2: (Optional) Configure secure communications to the directory service
- 12.2.3 Task 3: Configure user access from the directory service
- 12.2.4 Task 4: Test the user name and password configuration
- 12.2.5 Task 5: (Configuring for the external mode only) Configure group retrieval from the directory service

> **Note**
>
> If you plan to store NNMi user groups in the directory service, the directory service must be configured with the NNMi user groups. For details, see 12.4 Directory service configuration for storing NNMi user groups.

- 12.2.6 Task 6: (Configuring for the external mode only) Map the directory service groups to NNMi user groups
- 12.2.7 Task 7: (Configuring for the external mode only) Test the NNMi user group configuration
- 12.2.8 Task 8: (Configuring for the external mode only) Configure NNMi user groups for incident assignment
- 12.2.9 Task 9: Clean up to prevent unexpected access to NNMi
- 12.2.10 Task 10: (Optional) Map the user groups to security groups

12.2.1 Task 1: Back up the current NNMi user information

Back up the user information in the NNMi database:

```
nnmconfigexport.ovpl -c account -u user -p password -f NNMi_database_accounts.xml
```

12.2.2 Task 2: (Optional) Configure secure communications to the directory service

If the directory service requires the use of secure sockets layer (SSL), import your company's certificate into the NNMi truststore as described in 10.3.8 Configuring an SSL connection to the Directory service.

12.2.3 Task 3: Configure user access from the directory service

Complete this task for mixed mode and external mode only. Follow the appropriate procedure for your directory service.

1. Go to the following directory:
   - Windows: `%NnmDataDir%nmsas\NNM\conf`
   - Linux: `$NnmDataDir/nmsas/NNM/conf`
2. Back up the `nms-auth-config.xml` file that was shipped with NNMi, and then open the file in any text editor.
3. Specify values for the following elements:

> **Tip**
>
> NNMi places a sample `nms-auth-config.xml` file in a different location, which can be used for reference.
>
> The sample `nms-auth-config.xml` file is available in the following location:
>
> - Windows: `%NnmInstallDir%newconfig\HPOvNnmAS\nmsas\conf`
> - Linux: `$NnmInstallDir/newconfig/HPOvNnmAS/nmsas/conf`

You can also copy the entire <ldapLogin> element from the sample `nms-auth-config.xml` file, and then make necessary modifications.

Table 12-2: Elements of the ldapLogin Section of nms-auth-config.xml

<enabled> </enabled>		Specify `true` to use the `nms-auth-config.xml` file. By default, this element is set to `false`.

<userRoleFilterList>
</userRoleFilterList>
		Specify the NNMi roles to which NNMi users can assign incidents.
		To assign incidents to all operators, administrators, and guests, add this:
		`<userRoleFilterList>`
		`admin guest level2 level1`
		`</userRoleFilterList>`

<connectTimeLimit> </connectTimeLimit>		Specify the connection timeout value in milliseconds. The default value is `10000` (10 seconds). If you are encountering timeouts during NNMi user sign in, increase this value. For example: `<connectTimeLimit>10000</connectTimeLimit>`
<searchTimeLimit> </searchTimeLimit>		Specify the search timeout value in milliseconds. The default value is `30000` (30 seconds). If you are encountering timeouts during NNMi user sign in, increase this value. For example: `<searchTimeLimit>30000</searchTimeLimit>`
<server>		Container element to contain all LDAP configuration information.
	<host> </host>	URL of the LDAP server with port. For example: • To use HTTP: `ldap://hostname.domain.com:389` • To use HTTPS: `ldaps://hostname.domain.com:636` Note: To use HTTP, specify `ldap://`. To use HTTPS, specify `ldap://` or `ldaps://`.
	<secure> </secure>	Specify `true` if you want to use HTTPS. Otherwise, specify `false`.
</server>		
Note: The server element can be specified multiple times if the same information can be acquired from multiple servers in a redundant LDAP server configuration. In such cases, attempts to establish a connection will be made in order starting from the connection destination specified at the top.		
<bindCredential>		Container element to include bind credentials (mandatory for directory services that do not support anonymous logon).
	<bindDN> </bindDN>	Specify the bind DN.
	<bindCredential> </bindCredential>	Specify the bind DN password in the encrypted format. Run the "`nnmldap.ovpl -encrypt <mypassword>`" command to encrypt the password.
</bindCredential>		
<users>		Container element to include all user configuration details.
	<userSearch>	Container element to include the configuration information for searching users. Specify the `<userSearch></userSearch>` setting only once. Specifying this setting more than once is not supported.
	<base>	For example:

	</base>	• For Active Directory:
		`<base> CN={0} </base>`
		• For other LDAP technologies:
		`<base> SAMAccountName={0} </base>`

	<baseContextDN>
	</baseContextDN>
		For Active Directory, specify the portion of the directory service domain that stores user records.
		For example:
		• For Active Directory:
		`OU=Users,OU=Accounts,DC=mycompany,DC=com`
		• For other LDAP technologies:
		`ou=People,o=example.com`

	</userSearch>	
</users>		

Note: In mixed mode, specify the `<roleSearch></roleSearch>` setting only once, as follows, and then perform step 4 below.

```
<roleSearch>
   <roleBase></roleBase>
   <roleContextDN></roleContextDN>
</roleSearch>
```

4. After editing the `nms-auth-config.xml` file (`%NnmDataDir%nmsas\NNM\conf` (Windows) or `$NnmDataDir/nmsas/NNM/conf` (Linux)), run the following command:
   - Windows:
     ```
     %NnmInstallDir%bin\nnmldap.ovpl -reload
     ```
   - Linux:
     ```
     $NnmInstallDir/bin/nnmldap.ovpl -reload
     ```

12.2.4 Task 4: Test the user name and password configuration

1. In the LDAP configuration file, set `defaultRole` to `guest` for testing purposes.
   You can change this value at any time.
   In `nms-auth-config.xml` file add the following content before the `usersearch` element:
   `<defaultRoles>`
   `<role>guest</role>`
   `</defaultRoles>`
2. Save the LDAP configuration file.
3. Force NNMi to re-read the LDAP configuration file by executing the following command:
   `nnmldap.ovpl -reload`
4. Sign in to the NNMi console with a user name and password that are defined in the directory service.
   Run this test with a user name that is not already defined in the NNMi database.
5. Verify the user name and NNMi role (Guest) in the title bar of the NNMi console.
   - If user sign-in works correctly, go to step 8 of this task.
   - If user sign-in does not work correctly, continue on to step 6.

   After each test, sign out of the NNMi console to clear the session credentials.
6. Test the configuration for one user by running the following command:

```
nnmldap.ovpl -diagnose NNMi-user
```

Replace *NNMi-user* with the sign-in name of an NNMi user as defined in the directory service.

Examine the command output and respond appropriately. The following are suggestions:

- Verify that you completed correctly 12.2.3 Task 3: Configure user access from the directory service.
- Follow the detailed configuration process in 12.3.4 User identification.

Note

In mixed mode, the following message is output. However, this does not indicate a problem in operation, because the LDAP group is not referenced in mixed mode. Therefore, you can ignore the message.

```
!!!!!!!!!!!!!!!!!!!!!! NOTE !!!!!!!!!!!!!!!!!!!!!!
!  No LDAP groups found for this User Distinguished Name.
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!


!!!!!!!!!!!!!!!!!!!!!! NOTE !!!!!!!!!!!!!!!!!!!!!!
!  LDAP Appears to be Misconfigured. See above for more information.
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

7. Repeat steps 1 through 5 until you see the expected result when signing in to the NNMi console.
8. After you can sign in, choose your strategy:
   - If you plan to store NNMi user group membership in the NNMi database (configuring for the mixed mode), go to 12.2.9 Task 9: Clean up to prevent unexpected access to NNMi.
   - If you plan to store NNMi user group membership in the directory service (configuring for the external mode), continue on to Task 5.

12.2.5 Task 5: (Configuring for the external mode only) Configure group retrieval from the directory service

Complete this task to configure group retrieval for the external mode. Follow the appropriate procedure for your directory service.

1. Go to the following directory:
   - Windows: `%NnmDataDir%nmsas\NNM\conf`
   - Linux: `$NnmDataDir/nmsas/NNM/conf`
2. Take a backup of the `nms-auth-config.xml` file, and then open the file with a text editor.
3. Modify the following elements:

Tip

NNMi places a sample `nms-auth-config.xml` file in a different location, which can be used for reference.

The sample `nms-auth-config.xml` file is available in the following location:

- Windows: `%NnmInstallDir%newconfig\HPOvNnmAS\nmsas\conf`

- Linux: `$NnmInstallDir/newconfig/HPOvNnmAS/nmsas/conf`

You can also copy the entire <ldapLogin> element from the sample `nms-auth-config.xml` file, and then make necessary modifications.

Table 12-3: Elements of the ldapLogin Section of nms-auth-config.xml

<roleSearch>		Placeholder element to include the user role information. Specify the `<roleSearch></roleSearch>` setting only once. You cannot specify this setting more than once.
	<roleBase>member= {1} </roleBase>	Replace member with the name of the group attribute that stores the directory service user ID in the directory service domain.

	<roleContextDN>
	</roleContextDN>
		Specify the portion of the directory service domain that stores group records.
		The format is a comma-separated list of directory service attribute names and values.
		For example:
		• For Active Directory
		`CN=Users,DC=ldapserver,DC=mycompany,DC=com`
		• For other LDAP technologies
		`ou=Groups,o=example.com`

</roleSearch>		

4. Save the file.
5. Run the following command:

```
nnmldap.ovpl -reload
```

12.2.6 Task 6: (Configuring for the external mode only) Map the directory service groups to NNMi user groups

1. In the NNMi console, map the predefined NNMi user groups to their counterparts in the directory service:
   a. Open the **User Groups** view.
      In the **Configuration** workspace, expand **Security**, and then click **User Groups**.
   b. Double-click the **admin** row.
   c. In the **Directory Service Name** field, enter the full distinguished name of the directory service group for NNMi administrators.
   d. Click **Save and Close**.
   e. Repeat steps b through d for each of the `guest`, `level1`, and `level2` rows.

   These mappings provide NNMi console access. Every user who will access the NNMi console must be in a directory service group that is mapped to one of the predefined NNMi user groups named in this step.
2. For other groups containing one or more NNMi users in the directory service, create a new user group in the NNMi console.
   a. Open the **User Groups** view.
      In the **Configuration** workspace, expand **Security**, and then click **User Groups**.
   b. Click **New**, and then enter the information for the group:
      - Set **Name** to any unique value. Short names are recommended.
      - Set **Display Name** to the value users see.

- Set **Directory Service Name** to the full distinguished name of the directory service group.
- Set **Description** to text that describes the purpose of this NNMi user group.

c. Click **Save and Close**.

d. Repeat step b and step c for each additional directory service group of NNMi users.

These mappings provide topology object access in the NNMi console. Each directory service group can be mapped to multiple NNMi user groups.

12.2.7 Task 7: (Configuring for the external mode only) Test the NNMi user group configuration

1. Save NNMi's LDAP configuration file (`nms-auth-config.xml`).
2. Force NNMi to re-read the LDAP configuration file by executing the following command:

```
nnmldap.ovpl -reload
```

3. Sign in to the NNMi console with a user name and password that are defined in the directory service.

   Run this test with a user name that is not already defined in the NNMi database and is a member of a directory service group that is mapped to the `admin`, `level1`, or `level2` NNMi user group.
4. Verify the user name and NNMi role (as configured in the **Display Name** field in the **User Groups** view) in the title bar of the NNMi console.
   - If user sign-in works correctly, go to step 8.
   - If user sign-in does not work correctly, continue on to step 5.

   After each test, sign out of the NNMi console to clear the session credentials.
5. Test the configuration for one user by running the following command:

```
nnmldap.ovpl -diagnose NNMi-user
```

   Replace *NNMi-user* with the sign-in name of an NNMi user as defined in the directory service.

   Examine the command output and respond appropriately. The following are suggestions:
   - Verify that you completed correctly 12.2.5 Task 5: (Configuring for the external mode only) Configure group retrieval from the directory service.
   - Verify for each predefined NNMi user group that you completed correctly 12.2.6 Task 6: (Configuring for the external mode only) Map the directory service groups to NNMi user groups.
   - Follow the detailed configuration process in 12.3.5 User group identification.
6. Repeat steps 1 through 4 until you see the expected result when signing in to the NNMi console.

12.2.8 Task 8: (Configuring for the external mode only) Configure NNMi user groups for incident assignment

1. Sign in to the NNMi console with a user name and password that are defined in the directory service.
2. In any incident view, select an incident, and then click **Actions** > **Assign** > **Assign Incident**.

   Verify that you can assign the incident to a user in each of the NNMi roles specified by the `userRoleFilterList` parameter.

12.2.9 Task 9: Clean up to prevent unexpected access to NNMi

1. (Optional) Either change the value of or comment out the `defaultRole` parameter in the LDAP configuration file.

   If you change the value of, or comment out, the defaultRole element or parameter in the LDAP configuration file, force NNMi to re-read the LDAP configuration file by running the following command:

   ```
   nnmldap.ovpl -reload
   ```

2. (Configuring for the mixed mode only) To store user group membership in the NNMi database, reset the user access information in the NNMi database as follows:

   a. Remove any pre-existing user access information. (Delete all rows in the **User Accounts** view.)
   For details, see *Delete a User Account* in NNMi Help.

   b. For each NNMi user, create a new object in the **User Accounts** view for the user name.
   - For the **Name** field, enter the user name as defined in the directory service.
   - Select the **Directory Service Account** check box.
   - Do not specify a password.

   For details, see *User Account Tasks* in NNMi Help.

   c. For each NNMi user, map the user account to one or more NNMi user groups.
   For details, see *Map User Accounts to User Groups (User Account Mapping Form)* in NNMi Help.

   d. Update incident ownership so that each assigned incident is associated with a valid user name.
   For details, see *Manage Incident Assignments* in NNMi Help.

3. (Configuring for the external mode only) To rely on the directory service for user group membership, reset the user access information in the NNMi database as follows:

   a. Remove any pre-existing user access information. (Delete all rows in the **User Accounts** view.)
   For details, see *Delete a User Account* in NNMi Help.

   b. Update incident ownership so that each assigned incident is associated with a valid user name.
   For details, see *Manage Incident Assignments* in NNMi Help.

12.2.10 Task 10: (Optional) Map the user groups to security groups

For details, see *Security Group Mapping Tasks* in NNMi Help.

12.3 Directory service queries

NNMi uses LDAP to communicate with a directory service. NNMi sends a request, and the directory service returns stored information. NNMi cannot alter the information that is stored in the directory service.

12.3.1 Directory service access

LDAP queries to a directory service use the following format:

```
ldap://directory-service-host:port/search-string
```

- `ldap` is the protocol indicator. Use this indicator for both standard connections and SSL connections to the directory service.
- *directory-service-host* is the fully-qualified name of the computer that hosts the directory service.
- *port* is the port that the directory service uses for LDAP communication. The default port for non-SSL connections is `389`. The default port for SSL connections is `636`.
- *search-string* contains the information request. For details, see 12.3.2 Directory service content and RFC 1959, *An LDAP URL Format*, which is available at:
  `http://www.ietf.org/rfc/rfc1959.txt`

You can enter an LDAP query as a URL in a Web browser to verify that you have the correct access information and the correct structure for the search string.

If the directory service (for example, Active Directory) does not permit anonymous access, the directory service denies LDAP queries from a Web browser. In this case, you can use a third-party LDAP browser (for example, the LDAP browser included in Apache Directory Studio) to validate your configuration parameters.

12.3.2 Directory service content

A directory service stores information such as user names, passwords, and group membership. To access the information in a directory service, you must know the distinguished name that references the storage location of the information. For sign-in applications, the distinguished name is a combination of variable information (such as a user name) and fixed information (such as the storage location of user names). The elements that make up a distinguished name depend on the structure and content of the directory service.

The following examples show possible definitions for a group of users called `USERS-NNMi-Admin`. This group lists the directory service user IDs that have administrative access to NNMi. The following information pertains to these examples:

- The Active Directory example is for the Windows operating system.
- The other directory services example is for Linux operating systems.
- The file shown in each example is a portion of a lightweight directory interchange format (LDIF) file. LDIF files provide for sharing directory service information.
- The figure shown in each example is a graphical representation of the directory service domain that provides an expanded view of the information in the LDIF file excerpt.

Example content structure for Active Directory

In this example, the following items are of interest:

- The distinguished name of the user `John Doe` is:

```
CN=john.doe@example.com,OU=Users,OU=Accounts,DC=example,DC=com
```

- The distinguished name of the group `USERS-NNMi-Admin` is:

```
CN=USERS-NNMi-Admin,OU=Groups,OU=Accounts,DC=example,DC=com
```

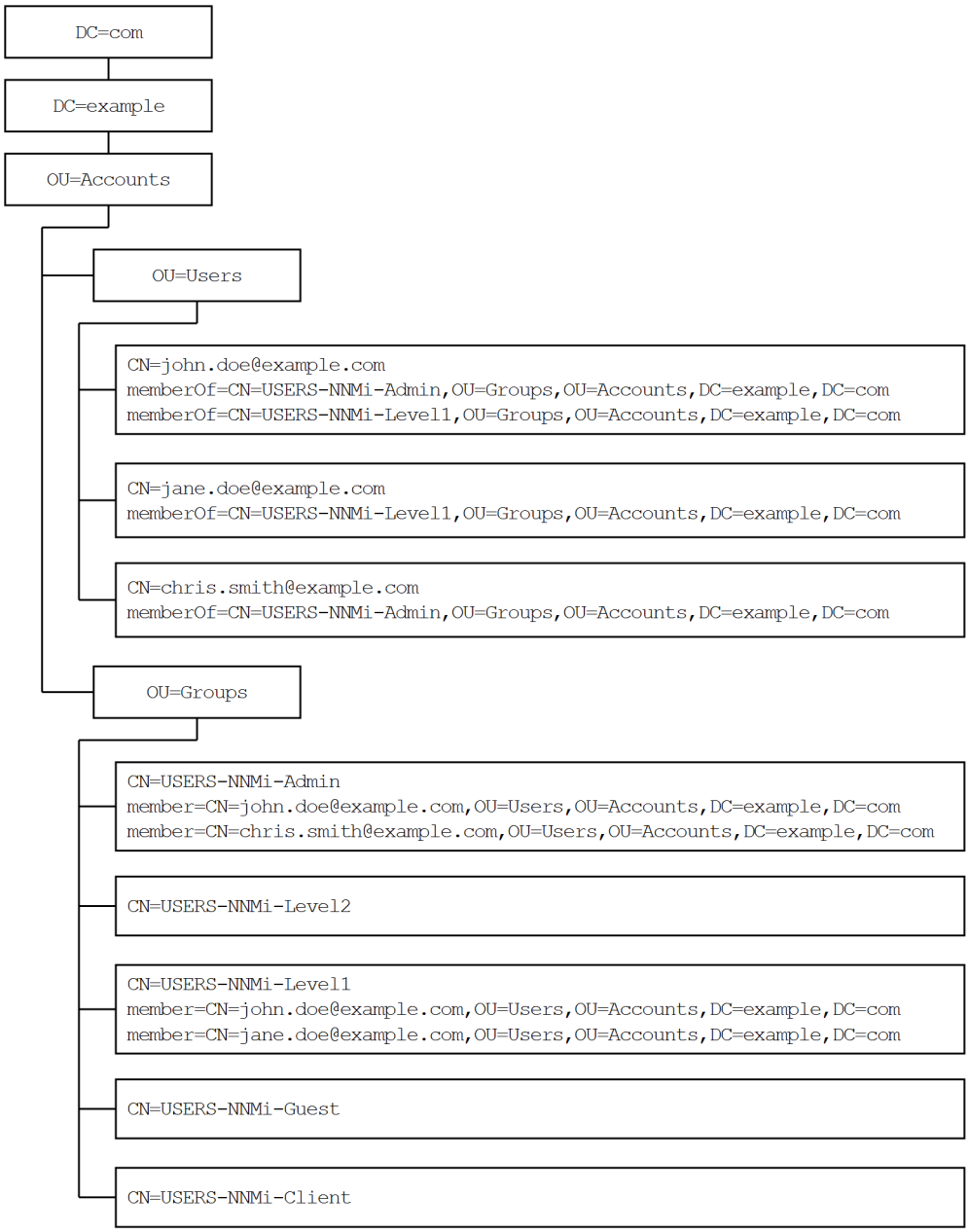
- The group attribute that stores the directory service user ID is: `member`

Example LDIF file excerpt:

```
groups |USERS-NNMi-Admin
dn: CN=USERS-NNMi-Admin,OU=Groups,OU=Accounts,DC=example,DC=com
cn: USERS-NNMi-Admin
description: Group of users for NNMi administration.
member: CN=john.doe@example.com,OU=Users,OU=Accounts,
- DC=example,DC=com
member: CN=chris.smith@example.com,OU=Users,OU=Accounts,
- DC=example,DC=com
```

The following figure illustrates this directory service domain.

Figure 12-4: Example domain for Active Directory



Example content structure for other directory services

In this example, the following items are of interest:

- The distinguished name of the user `John Doe` is:

```
uid=john.doe@example.com,ou=People,o=example.com
```

- The distinguished name of the group `USERS-NNMi-Admin` is:

```
cn=USERS-NNMi-Admin,ou=Groups,o=example.com
```

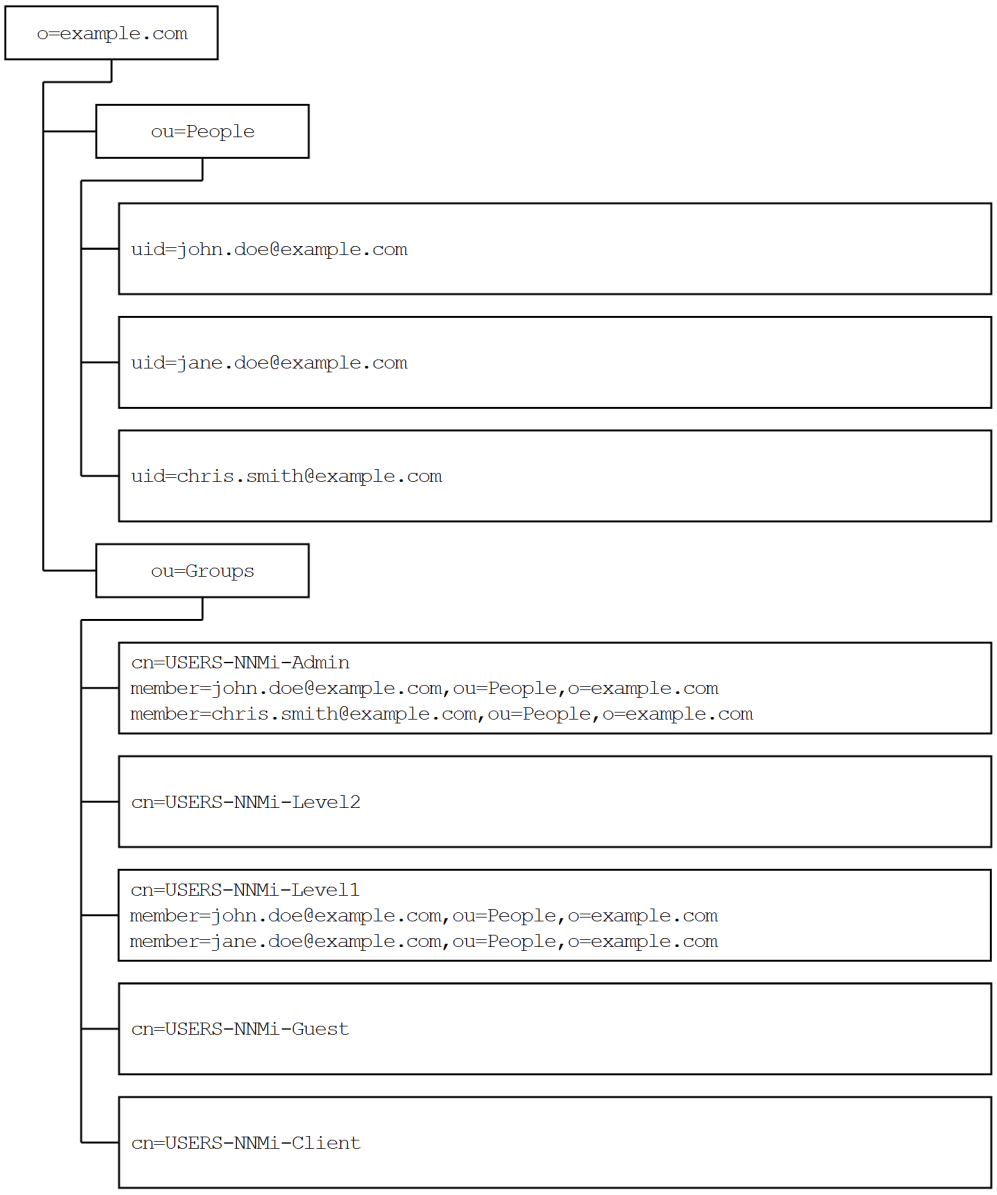
- The group attribute that stores the directory service user ID is: `member`

Example LDIF file excerpt:

```
groups |USERS-NNMi-Admin
dn: cn=USERS-NNMi-Admin,ou=Groups,o=example.com
cn: USERS-NNMi-Admin
```

```
description: Group of users for NNMi administration.
member: uid=john.doe@example.com,ou=People,o=example.com
member: uid=chris.smith@example.com,ou=People,o=example.com
```

Figure 12-5: Example domain for other directory services



12.3.3 Information owned by the directory service administrator

Table 12-4: Information for retrieving user names and passwords from a directory service and Table 12-5: Information for retrieving group membership from a directory service list the information to obtain from the directory service administrator before configuring NNMi for LDAP access to a directory service.

- If you plan to use the directory service for user names and passwords only (configuring for the mixed mode), gather the information shown in Table 12-4: Information for retrieving user names and passwords from a directory service.
- If you plan to use the directory service for all NNMi access information (configuring for the external mode), gather the information shown in both Table 12-4: Information for retrieving user names and passwords from a directory service and Table 12-5: Information for retrieving group membership from a directory service.

Table 12-4: Information for retrieving user names and passwords from a directory service

Information	Active Directory example	Other directory services example
The fully-qualified name of the computer that hosts the directory service	`directory_service_host.example.com`	
The port that the directory service uses for LDAP communication	• `389` for non-SSL connections • `636` for SSL connections	
Does the directory service require an SSL connection?	If yes, obtain a copy of your company's truststore certificate and see 10.3.8 Configuring an SSL connection to the Directory service.	
The distinguished name for one user name that is stored in the directory service (to demonstrate the directory service domain)	`CN=john.doe@example.com, OU=Users,OU=Accounts, DC=example,DC=com`	`uid=john.doe@example.com, ou=People,o=example.com`

Table 12-5: Information for retrieving group membership from a directory service

Information	Active Directory example	Other directory services example
The distinguished name for identifying the groups to which a user is assigned	The `memberOf` user attribute identifies the groups.	• `ou=Groups,o=example.com` • `cn=USERS-NNMi-*, ou=Groups,o=example.com`
The method of identifying a user within a group	• `CN=john.doe@example.com, OU=Users,OU=Accounts, DC=example,DC=com` • `CN=john.doe@example.com`	• `cn=john.doe@example.com, ou=People,o=example.com` • `cn=john.doe@example.com`
The group attribute that stores the directory service user ID	`member`	`member`
The names of the groups in the directory service that apply to NNMi access	• `CN=USERS-NNMi-Admin, OU=Groups,OU=Accounts, DC=example,DC=com` • `CN=USERS-NNMi-Level2, OU=Groups,OU=Accounts, DC=example,DC=com` • `CN=USERS-NNMi-Level1, OU=Groups,OU=Accounts, DC=example,DC=com` • `CN=USERS-NNMi-Client, OU=Groups,OU=Accounts, DC=example,DC=com` • `CN=USERS-NNMi-Guest, OU=Groups,OU=Accounts, DC=example,DC=com`	• `cn=USERS-NNMi-Admin, ou=Groups,o=example.com` • `cn=USERS-NNMi-Level2, ou=Groups,o=example.com` • `cn=USERS-NNMi-Level1, ou=Groups,o=example.com` • `cn=USERS-NNMi-Client, ou=Groups,o=example.com` • `cn=USERS-NNMi-Guest, ou=Groups,o=example.com`

12.3.4 User identification

User identification applies to the mixed mode and the external mode.

The distinguished name for user identification is the fully-qualified method of locating one user in the directory service. NNMi passes the user distinguished name in an LDAP request to the directory service.

In the LDAP configuration file, the user distinguished name is the concatenation of the <base> and <baseContextDN> elements in the `nms-auth-config.xml` file. If the password returned by the directory service matches the sign-in password the user entered into the NNMi console, user sign in continues.

When configuring user identification for the mixed mode, the following information applies:

- For NNMi console access, NNMi examines the following information and grants the user the highest possible privileges:
  - The value of the `defaultRole` parameter in the LDAP configuration file
  - This user's membership in the predefined NNMi user groups in the NNMi console
- For NNMi topology object access, NNMi grants access according to the security group mappings for the NNMi user groups in the NNMi console to which this user belongs.

When configuring user identification for the external mode, the following information applies:

- For NNMi console access, NNMi examines the following information and grants the user the highest possible privileges:
  - The value of the `defaultRole` parameter in the LDAP configuration file
  - This user's membership in the directory service groups that are mapped (with the **Directory Service Name** field) to the predefined NNMi user groups in the NNMi console
- For NNMi topology object access, NNMi grants access according to the security group mappings for the groups in the directory service to which this user belongs (as mapped to NNMi user groups in the NNMi console).

Active Directory user identification example

If the `nms-auth-config.xml` file contains `<base>CN={0}</base><baseContextDN>OU=Users,OU=Accounts,DC=example,DC=com</baseContextDN>`, and a user signs in to NNMi as john.doe, the string passed to the directory service is:

`CN=john.doe,OU=Users,OU=Accounts,DC=example,DC=com`

Other directory services user identification example

If the `nms-auth-config.xml` file contains `<base>uid={0}@example.com</base><baseContextDN>ou=People,o=example.com</baseContextDN>`, and a user signs in to NNMi as john.doe, the string passed to the directory service is:

`uid=john.doe@example.com,ou=People,o=example.com`

12.3.5 User group identification

User group identification applies to configuring for the external mode.

NNMi determines the user groups for an NNMi user as follows:

1. NNMi compares the values of the external names of all user groups configured in the NNMi console with the names of the directory service groups.
2. For any user group match, NNMi then determines whether the NNMi user is a member of that group in the directory service.

In the NNMi console, short text strings identify the unique names of the predefined NNMi user groups that grant NNMi console access. These text strings are also required by the `defaultRole` and `userRoleFilterList` parameters in the LDAP configuration file. The following table maps the unique names of these groups to their display names.

Table 12-6: NNMi user group name mapping

NNMi role name in the NNMi console	User group unique name and text string in NNMi configuration files
Administrator	`admin`
Global operators	`globalops`
Operator level 2	`level2`
Operator level 1	`level1`
Guest	`guest`
Web service client	`client`

The NNMi global operator user group (`globalops`) can access only all topology objects. A user is able to access the NNMi console only if that user is assigned to another user group (`admin`, `level2`, `level1`, or `guest`).

Because the `globalops` user group is mapped to all security groups by default, the administrator must not map this user group to security groups.

(1) Configuring user group retrieval from the directory service (detailed approach)

If the simple approach described in 12.2.5 Task 5: (Configuring for the external mode only) Configure group retrieval from the directory service in 12.2 Configuring NNMi to access a directory service did not work correctly, follow these steps:

1. Obtain the required user information from the directory service administrator.
2. Verify the format of group names and group members in the directory service by completing the appropriate procedure:
   - LDAP browser approach for Active Directory: See (2) Determining how the directory service identifies a group and group membership (LDAP browser approach for Active Directory), below.
   - LDAP browser approach for other directory services: See (3) Determining how the directory service identifies a group and group membership (LDAP browser approach for other directory services), below.
   - Web browser approach for other directory services: See (4) Determining how the directory service identifies a group (Web browser approach), below.
3. Configure the LDAP configuration file.
   a. Open the `nms-auth-config.xml` file in any text editor.
   b. Set the role element to correlate user names to the way user names are stored for groups in the directory service. Replace the actual user name with one of the following expressions:
      - Use {0} to denote the user name entered for sign-in (for example, john.doe).
      - Use {1} to denote the distinguished name of the authenticated user as returned by the directory service (for example, `uid=john.doe@example.com,ou=People,o=example.com`).
   c. Set the roleContextDN element to the portion of the directory service domain that stores group records. The format is a comma-separated list of directory service attribute names and values.

      For example:
      - For Active Directory:
        `CN=Users,DC=ldapserver,DC=mycompany,DC=com`

- For other LDAP technologies:
  `ou=Groups,o=example.com`

4. Test the configuration as described in 12.2 Configuring NNMi to access a directory service.

(2) Determining how the directory service identifies a group and group membership (LDAP browser approach for Active Directory)

In a third-party LDAP browser, do the following:

1. Navigate to the portion of the directory service domain that stores user information.
2. Identify a user who requires access to NNMi, and then examine the format of the distinguished names for the groups associated with that user.
3. Navigate to the portion of the directory service domain that stores group information.
4. Identify the groups that correspond to NNMi user groups, and then examine the format of the names for the users associated with a group.

(3) Determining how the directory service identifies a group and group membership (LDAP browser approach for other directory services)

In a third-party LDAP browser, do the following:

1. Navigate to the portion of the directory service domain that stores group information.
2. Identify the groups that correspond to NNMi user groups, and then examine the format of the distinguished names for those groups.
3. Also examine the format of the names for the users associated with a group.

(4) Determining how the directory service identifies a group (Web browser approach)

1. In a supported Web browser, enter the following URL:

   `ldap://`*`directory-service-host`*`:`*`port`*`/`*`group-search-string`*

   - *directory-service-host* is the fully-qualified name of the computer that hosts the directory service.
   - *port* is the port that the directory service uses for LDAP communication.
   - *group-search-string* is the distinguished name for a group name that is stored in the directory service (for example: `cn=USERS-NNMi-Admin,ou=Groups,o=example.com`).

2. Evaluate the results of the directory service access test.
   - If you see a message that the directory service does not contain the requested entry, verify the value of *group-search-string*, and then repeat step 1.
   - If you see the appropriate list of groups, the access information is correct.

3. Examine the group properties to determine the format of the names for the users associated with that group.

12.4 Directory service configuration for storing NNMi user groups

If you plan to store NNMi user groups in a directory service (configuring for the external mode), the directory service must be configured with NNMi user group information. Ideally, the directory service already contains appropriate user groups. If this is not the case, the directory service administrator can create new user groups specifically for NNMi user group assignment.

Because directory service configuration and maintenance procedures depend on the specific directory service software and your company's policies, those procedures are not documented here.

12.5 Troubleshooting the directory service integration

1. Verify the NNMi LDAP configuration by running the following command:

```
nnmldap.ovpl -info
```

   If the reported configuration is not as expected, verify the settings in the LDAP configuration file.

2. Force NNMi to re-read the LDAP configuration file by executing the following command:

```
nnmldap.ovpl -reload
```

3. Test the configuration for one user by running the following command:

```
nnmldap.ovpl -diagnose NNMi-user
```

   Replace *NNMi-user* with the sign-in name of an NNMi user as defined in the directory service.

   Examine the command output and respond appropriately.

> **Note**
>
> In mixed mode, the following message is output. However, this does not indicate a problem in operation, because the LDAP group is not referenced in mixed mode. Therefore, you can ignore the message.
>
> ```
> !!!!!!!!!!!!!!!!!!!!!! NOTE !!!!!!!!!!!!!!!!!!!!!!
> !  No LDAP groups found for this User Distinguished Name.
> !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
>
>
> !!!!!!!!!!!!!!!!!!!!!! NOTE !!!!!!!!!!!!!!!!!!!!!!
> !  LDAP Appears to be Misconfigured. See above for more information.
> !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
> ```

4. Verify that the directory service contains the expected records.

   Use a Web browser or a third-party LDAP browser (for example, the LDAP browser included in Apache Directory Studio) to examine the directory service information.

   Information about the format of a query to a directory service can be found in RFC 1959, *An LDAP URL Format*, which is available at:

```
http://www.ietf.org/rfc/rfc1959.txt
```

5. View the `%NnmDataDir%log\nnm\nnm.log` (Windows) or `/var/opt/OV/log/nnm/nnm.log` (Linux) log file to verify that the sign-in request is correct and to determine if any errors occurred:

   - A message similar to the line below indicates that the directory service requires HTTPS communication. In this case, enable SSL, as described in 10.3.8 Configuring an SSL connection to the Directory service.

```
javax.naming.AuthenticationNotSupportedException:[LDAP:error code 13 - confidentia
lity required]
```

   - A message similar to the line below indicates that a timeout occurred while communicating with the directory service. In this case, increase the value of `searchTimeLimit` in the LDAP configuration file.

```
javax.naming.TimeLimitExceededException:[LDAP: error code 3 - Timelimit Exceeded]
```

12.6 LDAP configuration file reference

12.6.1 nms-auth-config.xml

The `nms-auth-config.xml` file contains the settings for communicating with and building LDAP queries to the directory service in the XML format. This section prov ides a reference of only the elements that are relevant for LDAP configuration.

This file is located as follows:

- Windows: `%NnmDataDir%nmsas\NNM\conf`
- Linux: `$NnmDataDir/nmsas/NNM/conf`

By default, the `nms-auth-config.xml` file available in this location does not contain the XML elements required for LDAP configuration.

You can manually add all the necessary XML elements to this file by following the instructions in this section.

NNMi places a sample `nms-auth-config.xml` file in a different location, which can be used for reference.

The sample `nms-auth-config.xml` file is available in the following location:

- Windows: `%NnmInstallDir%newconfig\HPOvNnmAS\nmsas\conf`
- Linux: `$NnmInstallDir/newconfig/HPOvNnmAS/nmsas/conf`

> **Tip**
>
> You can also copy the entire <ldapLogin> element from the sample `nms-auth-config.xml` file, and then make necessary modifications.

After editing the `nms-auth-config.xml` file (`%NnmDataDir%nmsas\NNM\conf` (Windows) or `$NnmDataDir/nmsas/NNM/conf` (Linux)), force NNMi to read the LDAP configuration again by running the following command:

- Windows:

```
%NnmInstallDir%bin\nnmldap.ovpl -reload
```

- Linux:

```
$NnmInstallDir/bin/nnmldap.ovpl -reload
```

```
<ldapLogin>
<!-- This is the on/off switch for LDAP authentication. Set to true to use LDAP-based
 authentication-->
  <enabled>true</enabled>
<!-- This element enables you to specify which users can assign incidents.-->
  <userRoleFilterList>admin guest level2 level1</userRoleFilterList>
<!-- If <enabled> is set to true, define one or more <configuration> elements to spec
ify LDAP parameters -->
  <configuration>
<!-- The filter (optional) is matched against the user, that tries to log on, to dete
rmine if this is the right configuration to use. This is useful when multiple configu
```

```
rations are specified, to skip non-applicable LDAP servers to reduce log-on time. -->
    <filter>
      <usernamePattern>.*@hpe\.com</usernamePattern>
    </filter>
<!-- Time limit for performing searches against the LDAP server -->
    <searchTimeLimit>30000</searchTimeLimit>
    <connectTimeLimit>10000</connectTimeLimit>
<!-- Define at least one server URL -->
    <server>
      <hostname>ldaps://ldap.domain1.com</hostname>
      <secure>true</secure>
    </server>
<!---Optional. Bind credential and encrypted password for connecting to LDAP servers
that do not support anonymous access. Use "nnmldap.ovpl -encrypt" to create the encry
pted password.--->
    <bindCredential>
      <bindDN>someUser@some.com</bindDN>
      <bindCredential>someEncryptedPassword</bindCredential>
    </bindCredential>
<!-- This element defines the rules to search for users in this LDAP configuration --
>
    <users>
<!-- Optional. Filter that is matched against the user that attempts to log on. The i
ntention is to skip nonapplicable LDAP configurations to reduce the log-on time. Note
 that this is a Java regular expression.-->
      <filter>
        <usernamePattern>.*some\.com</usernamePattern>
      </filter>
<!-- Optional. The display name expression to show in the NNMi console.-->
      <displayName>${sn},${givenName} (HPE)</displayName>
<!-- Optional. Default roles that are given to all users that are authenticated again
st this configuration -->
      <defaultRoles>
        <role>guest</role>
      </defaultRoles>
<!-- One or more search configuration for locating user accounts. The pattern "{0}" i
n the string will be replaced with the log-on name entered by the user in the log-on
screen. -->
      <userSearch>
        <base>uid={0}</base>
        <baseContextDN>ou=People,o=domain.com</baseContextDN>
      </userSearch>
    </users>
<!-- Defines the rules to search for user roles or groups in this LDAP configuration
-->
    <roles>
<!-- Optional. Filter that defines which users should be attempted for role lookup ag
ainst this configuration. Note that this is a Java regular expression. -->
      <filter><usernamePattern>x</usernamePattern></filter>
<!-- One or more search configuration for locating LDAP groups that contain the authe
nticated user DN. Use the string "{1}" where the user's DN would appear. -->
      <roleSearch>
        <roleBase>member={1}</roleBase>
        <roleContextDN>ou=Groups,o=some.com</roleContextDN>
      </roleSearch>
      <roleSearch>
        <roleBase>GroupMember={1}</roleBase>
        <roleContextDN>CN=Groups,DC=mycompany,DC=com</roleContextDN>
      </roleSearch>
    </roles>
  </configuration>
</ldapLogin>
```

12.7 Switching to the nms-auth-config.xml File

When the product is upgraded from 11-10 to 11-50 or later, the settings of the file `ldap.properties` are automatically migrated to the file `nms-auth-config.xml`.

Important

If the product is upgraded to 11-50 or later with `defaultRole` commented out in the file `ldap.properties` (as shown below), the file `nms-auth-config.xml` generated during the upgrade cannot be used as is.

```
#defaultRole=guest
```

Comment out or delete the following part, and then run the command `nnmldap.ovpl -reload` to reload the LDAP settings file.

```
<defaultRoles>
 <role/>
</defaultRoles>
```

13 Managing Overlapping IP Addresses in a NAT Environment

NAT (network address translation) helps you save IP addresses by allowing many local networks to be connected to the global Internet using a single dynamic external (public) IP address. NAT can also enhance the security of private networks by hiding internal addresses from external networks. This chapter explains the configurations of NAT and overlapping IP addresses used by NNMi.

13.1 About NAT

Normally, network address translation is used to interconnect local networks with external networks. This technology has been developed as a solution to the need for more IPv4 addresses. Also, the demand for technologies such as NAT had been increasing because a specific range of IP addresses (see RFC 1918) had been designated for internal use only (routing on the Internet is not supported).

NAT translates IP header information. It translates the internal addresses of IP packets that need to pass through public networks into external addresses. NAT uses static and dynamic external addresses to translate internal addresses to external addresses.

13.2 Benefits of NAT

NAT provides the following benefits:

- IP address spaces can be saved because many hosts connect to the global Internet by using a single dynamic external IP address.
- Private IP addresses can be reused.
- The security of private networks can be enhanced by hiding the internal addresses from external networks.

13.3 Supported NAT types

NNMi supports the following NAT protocols:

- Static NAT

  With static NAT, each internal IP address is always mapped to the same external IP address (each node has a pair of an internal address and an external address). This type of NAT allows accesses on the Internet while an unregistered (private) IP address is assigned to the internal host (such as a Web server).

- Dynamic NAT

  Dynamic NAT is a scheme that enables the binding of external and internal addresses to be changed at each session. An internal IP address is mapped to a public IP address that is obtained from a pool of available registered (public) IP addresses. Normally, a table of registered IP addresses is maintained within the NAT router in the network. When an access from an internal IP address to the Internet is requested, the router selects from the table another internal IP address that is available.

- Dynamic port address translation (dynamic PAT) (also called a network address and port translation (NAPT))

  Dynamic PAT is a type of NAT that translates not only IP addresses but also port numbers. If both addresses and port numbers are translated, multiple internal addresses can be used to communicate on the Internet concurrently using a single external address.

13.4 How to implement NAT in NNMi

NNMi manages a NAT environment by identifying each node that uses a tenant/IP address pair. NNMi administrators create a tenant definition for each NAT address domain. The tenant identifies a logical grouping of nodes. For example, an Internet provider's network might have multiple customers who implemented private IP addresses. Within NNMi, the Internet provider can assign each customer's nodes to a specific tenant name that identifies the customer. Within such a logical tenant grouping:

- NNMi administrators use discovery seeds to identify the tenant's member nodes on the basis of tenant/IP address pairs.
- Subnet connection rules apply independently within each tenant's group of nodes.
- Router redundancy groups are monitored within each tenant, independently from any other tenant's group of nodes.
- NNMi discovers L2 Connections only within each tenant's group of nodes, and between that defined tenant's nodes and nodes assigned to a tenant named default tenant.
- Assign any infrastructure device that interconnects multiple NAT domains (such as the NAT gateway router) to the default tenant. This ensures that NNMi displays the layer 2 connections your work group (and customers) needs to see.
- Security groups determine how many tenants an NNMi user can see. An assigned security group can include nodes from more than one tenant. For details, see 14. NNMi Security and Multi-Tenancy.

> **Note**
>
> A best practice is to have no duplicate domain name system (DNS) names across all NAT domains in your network management environment.

The NNMi implementation method and requirements vary depending on the NAT protocol you are using. For example, use of dynamic NAT or PAT requires additional hardware and licenses. See the appropriate section listed in the following based on your NAT protocol:

- 13.5 Considerations on static NAT
- 13.6 Dynamic NAT and dynamic PAT considerations

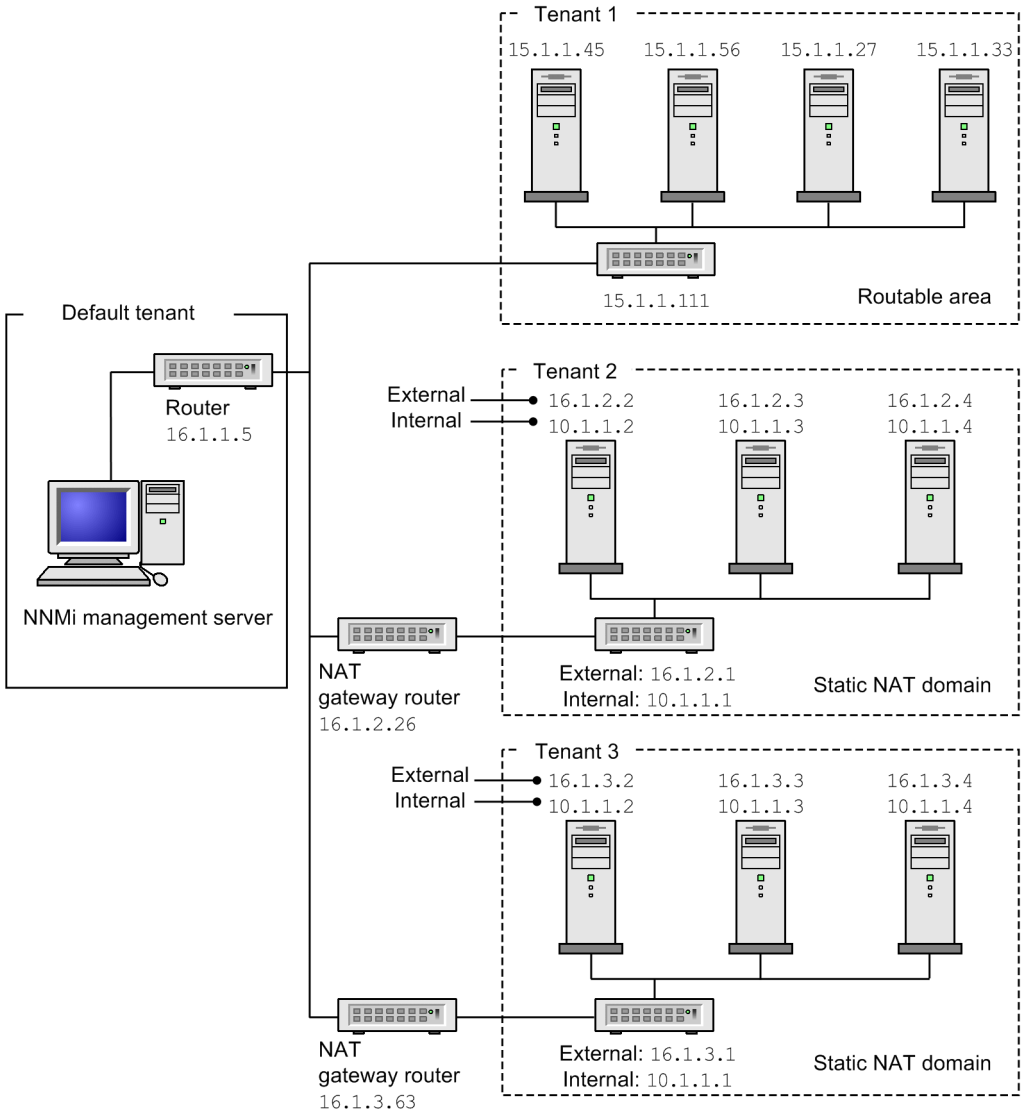
For details, see 13.6.6 Deploying NNMi in a network address translation (NAT) environment and 13.6.7 NNMi calculations for state and status.

13.5 Considerations on static NAT

If each instance is configured as a unique tenant, one NNMi management server can monitor any number of static NAT instances. For details about tenants, see 14. NNMi Security and Multi-Tenancy and *Configure Tenants* in NNMi Help.

The following figure shows an example of a static NAT configuration.

Figure 13-1: Example of a static NAT configuration



Legend:

External: External address

Internal: Internal address

The node belonging to the default tenant can establish a Layer-2 connection with any of the nodes in any of the tenants. A node in a non-default tenant can establish a Layer 2 connection only with the devices in the same tenant or the default tenant.

Subnets are specific to tenants (a subnet does not span multiple tenants). The benefit of subnets is that the same subnet can be used by different tenants.

A router redundancy group (RRG) cannot span multiple tenants.

Allocate all infrastructure devices that interconnect to multiple NAT domains (such as NAT gateways) in the default tenant. This ensures that the Layer 2 connections that work groups (and clients) must check are displayed in NNMi.

The devices in the default security group are displayed in all views. To control access to a device, assign that device to a security group that is not the default security group.

13.5.1 Hardware and software requirements for static NAT

There are no special hardware or software requirements for static NAT. One NNMi management server can manage any number of static NAT domains with either NNMi or NNMi Advanced.

13.5.2 Communication using static NAT

NNMi communicates successfully through a static NAT firewall by automatically applying any available overlapping address mappings to determine the tenant/external IP address pairs for static NAT communications. For details about the benefits, see 13.7 Mapping overlapping IP addresses.

(1) Administering ICMP polling of the management addresses in a static NAT environment

In a NAT environment, a firewall blocks NNMi from communicating with NAT nodes using the IP addresses on the nodes (the private IP addresses). To remedy this, the NAT address (the public IP address) is used for communication with NNMi.

In a NAT environment, a node's management address might be different from the IP addresses hosted on the node. For NNMi to discover a node in a NAT environment, you must add the NAT address to NNMi as a discovery seed. NNMi uses this NAT address for communication, even though it is not in the node's `ipAddressTable`.

By providing this feature, NNMi avoids false node down incidents and offers a better root cause analysis.

(2) Overview of ICMP polling of the management addresses in a NAT environment

(a) ICMP polling of the management addresses in a NAT environment

If you have a NAT environment, we recommend that you do not disable this setting.

To enable ICMP management address polling (if it has been disabled):

1. From the workspace navigation panel, select the **Configuration** workspace, expand the `Monitoring` folder, select **Monitoring Configuration**, and locate the **Default Settings** tab.
2. In the **ICMP Fault Monitoring** section, select **Enable Management Address Polling**.
   See *Set Default Monitoring* in NNMi Help.
   View the information NNMi displays after performing **Actions** -> **Monitoring Settings** for SNMP agents. The displayed information indicates whether management address polling is enabled for NNMi.

When ICMP management address polling is enabled, NNMi changes as follows:

- The **Management Address ICMP State** field appears in the following forms and table views:

- **Node** form
- **SNMP Agent** form
- **SNMP Agent** table views

- NNMi changes the display location of the management address ICMP state, as well as the way it determines the SNMP agent status.

The following table shows the management address ICMP and IP address state polling actions that NNMi takes for ICMP management address polling and ICMP fault polling settings.

Table 13-1: ICMP configurations and resulting state polling

ICMP management address polling	ICMP fault polling	Management ICMP address state	IP address state
Enabled#	Disabled#	Polled#	Not polled#
Enabled	Enabled	Polled	Polled
Disabled	Disabled	Not polled	Not polled
Disabled	Enabled	Not polled	Polled

#: Default setting

The table below shows the SNMP agent statuses and the variation in generated incidents, which are determined by APA based on the responses from the SNMP agent and the management address ICMP. With ICMP polling of management addresses enabled, APA considers the management address ICMP response and the SNMP agent response when generating conclusions and incidents.

Table 13-2: Determining SNMP agent status and generated incidents

SNMP agent response	Management address ICMP response	SNMP agent status	Generated incident
Responding	Responding	Normal	None
Responding	Not responding	Minor	The following incidents might be generated by other network problems: • None • `AddressNotResponding`
Not responding	Responding	Critical	`SNMPAgentNotResponding`
Not responding	Not responding	Critical	The following incidents might be generated by other network problems: • None • `NodeDown`

13.5.3 Discovery and static NAT

The NNMi administrator must create a tenant definition to identify each static NAT domain within your network management environment. Spiral discovery requires discovery seeds (tenant and address pairs) to identify each node before NNMi can discover and monitor each node.

The NNMi administrator must create a discovery seed for each node in the static NAT domain. A discovery seed must provide the following information for each node:

- External IP address (public address from the external/internal IP address pair)
- Tenant name

For details, see NNMi Help.

When you add discovery seeds to a static NAT environment (by using the `nnmloadseeds.ovpl` command or the NNMi console), make sure that you use a node's external (public) IP address. For details, see the *nnmloadseeds.ovpl Reference Page*.

We recommend that you use a domain name system (DNS) name that is not duplicated.

13.5.4 Monitoring configuration for static NAT

Depending on your network environment, the NNMi administrator can select the ICMP fault monitoring settings to be used. See also 13.6.7 NNMi calculations for state and status.

- **Monitoring Configuration** > **Node Settings** tab
  Configure monitoring for a node group. In this case, make your choices in the **ICMP Fault Monitoring** section. For details, see NNMi online Help.
  - Management address polling (enabled by default and highly recommended)
  - IP address fault polling (optional)
- **Monitoring Configuration** > **Default Settings** tab
  In this case, make your choices in the **ICMP Fault Monitoring** section. For details, see NNMi online Help.

> **Important**
>
> If your network environment also includes any dynamic NAT domains, default settings might not be appropriate because you might want different settings for the static NAT domains from those for the dynamic NAT domains.

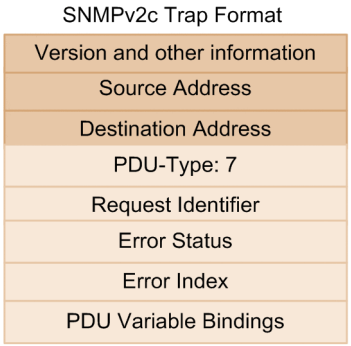
13.5.5 Traps and static NAT

For an NNMi management server to be able to receive SNMP traps from the nodes located behind a NAT gateway, you must change the managed nodes. This subsection explains two types of SNMP traps, `SNMPv2c` and `SNMPv1`.

NNMi must unambiguously resolve the source address of each trap that it receives.

(1) SNMPv2c traps

The figure below shows the format of an `SNMPv2c` trap. In this figure, the top section forms the IP header and the lower section forms the SNMP Trap Protocol Data Unit (PDU).

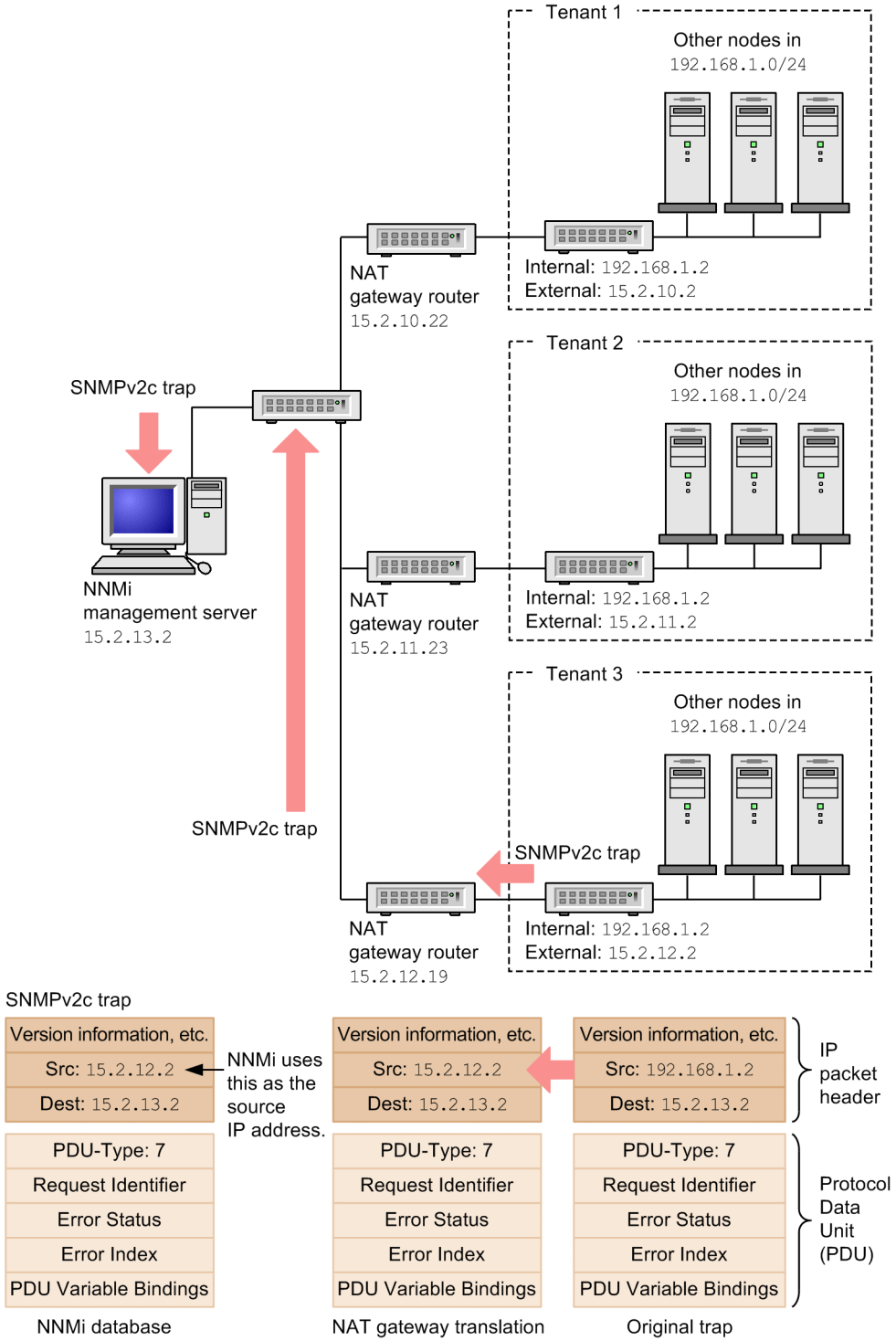


`SNMPv2c` traps do not include an `Agent Address` field in the PDU section. Therefore, the trap's only source field is located in the IP packet header. The source field is translated by the NAT router appropriately.

Make sure that the sources of all traps of devices located behind the NAT router are recognized by the interface associated with the source node's private internal IP address. This ensures that the NAT gateway can translate a trap to the appropriate public address.

The figure below shows an example of correct translation from a NAT gateway. The NAT gateway properly translates a trap that begins with the source address of `192.168.1.2` to address `15.2.12.2`. Then the NNMi management server correctly resolves this address.

Figure 13-2: SNMPv2c example



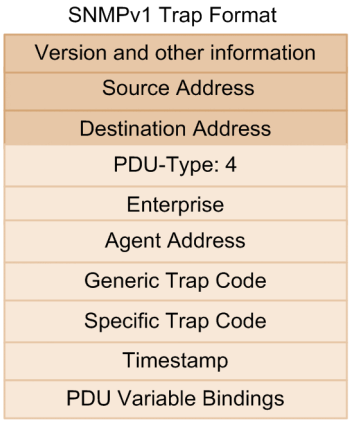
Legend:

External: External address

Internal: Internal address

(2) SNMPv1 traps

An `SNMPv1` trap includes an `Agent Address` field in the PDU. The figure below shows the format of `SNMPv1` traps. In this figure, the IP header forms the top section and the SNMP trap PDU forms the lower section.



Because the `Agent Address` field is embedded in the PDU and not in the header, the NAT router does not normally translate this value. To configure NNMi to recognize the header address and ignore the payload's agent address:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Locate the following line:

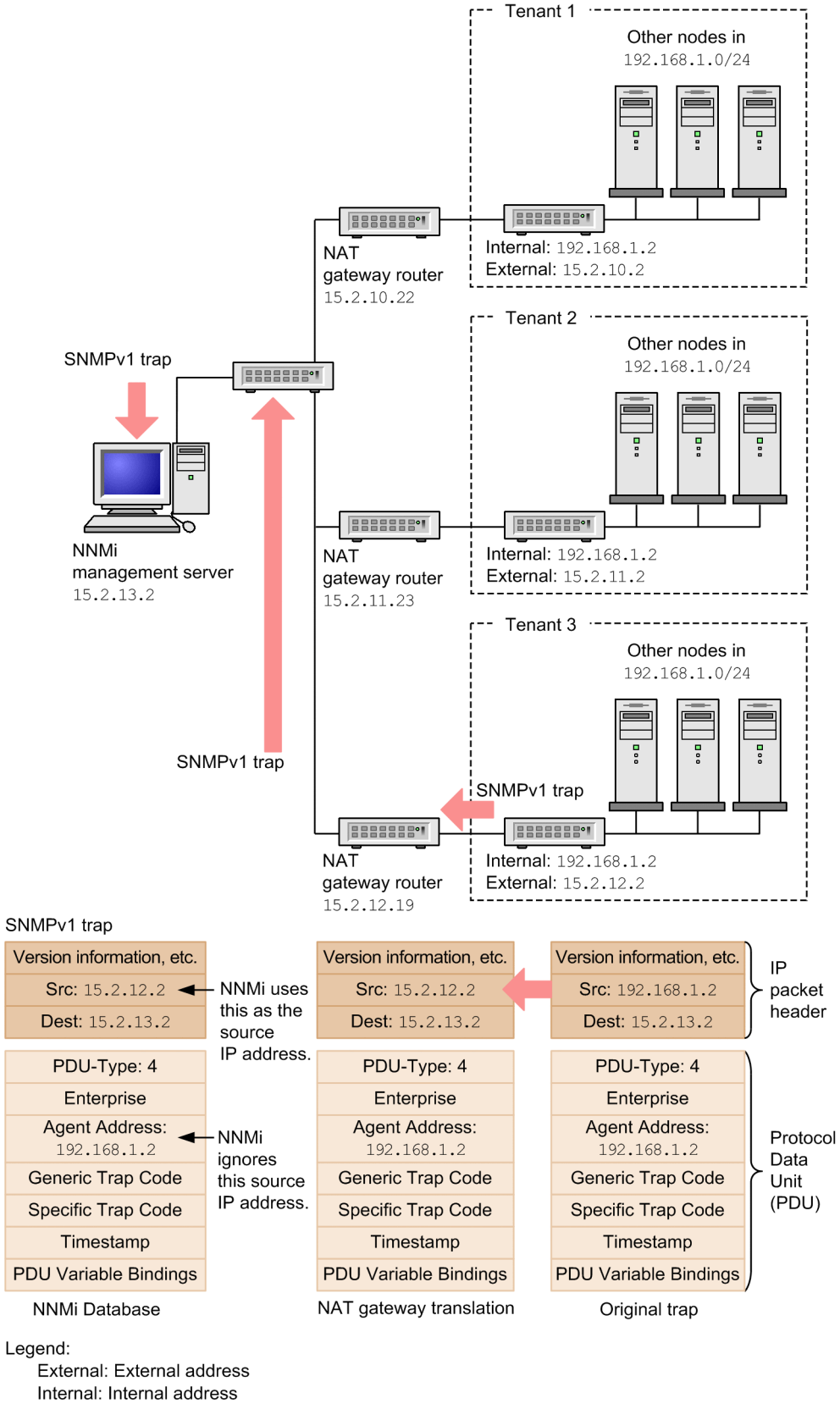
   ```
   #!com.hp.nnm.trapd.useUdpHeaderIpAddress=false
   ```
3. Change the value to `true` and remove the characters `#!`, as shown below:

   ```
   com.hp.nnm.trapd.useUdpHeaderIpAddress=true
   ```
4. Save the changes.
5. Execute the following commands to restart NNMi:

   ```
   ovstop
   ovstart
   ```

The following figure shows an example of an `SNMPv1` trap where NNMi ignores the conflicting `Agent Address` fields.

Figure 13-3: SNMPv1 example



NNMi provides the following Custom Incident Attributes (CIAs):

- `cia.agentAddress`: This is the IP address stored in the `SNMPv1` trap data of the SNMP agent that generated the trap.
- `cia.internalAddress`: If the network management domain supports static NAT, the NNMi administrator can configure this attribute to display the internal IP address that is mapped to the external management address of the selected incident's source node.

You must use the **Overlapping IP Address Mapping** form to map the external management IP address (public address) to this internal address (private address). For details, see NNMi Help.

13.5.6 Subnets and static NAT

Note the following subnet and NAT considerations:

- Subnets are unique to tenants (a subnet does not span multiple tenants). The benefit of subnets is that the same subnet can be used by different tenants.
- Subnet filters use tenant and address pairs.
- If subnet connection rules are configured, they apply to all tenants. The subnet members must be unique in all tenants (a node is assigned to only one tenant). You can use subnet connection rules to establish a link between a tenant and the default tenant. This feature is supported only when one of the two linked tenants is the default tenant.

13.5.7 Global network management and static NAT

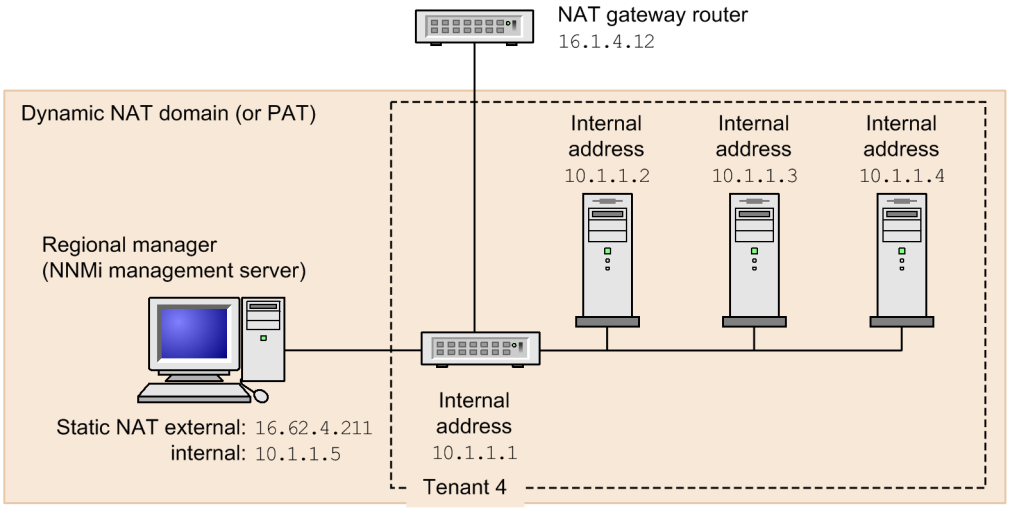
At least one static or routable (non-translated) address must exist per regional manager. This enables NNMi management servers to communicate with each other, keeping communications internal and secure. For details about global network management, see 15. Global Network Management.

13.6 Dynamic NAT and dynamic PAT considerations

One NNMi management server can manage one dynamic NAT or dynamic PAT domain. All nodes in such a domain must belong to the same unique tenant. The NNMi management server must participate in a global network management environment as a regional manager. For details, see the example of a dynamic NAT configuration shown below.

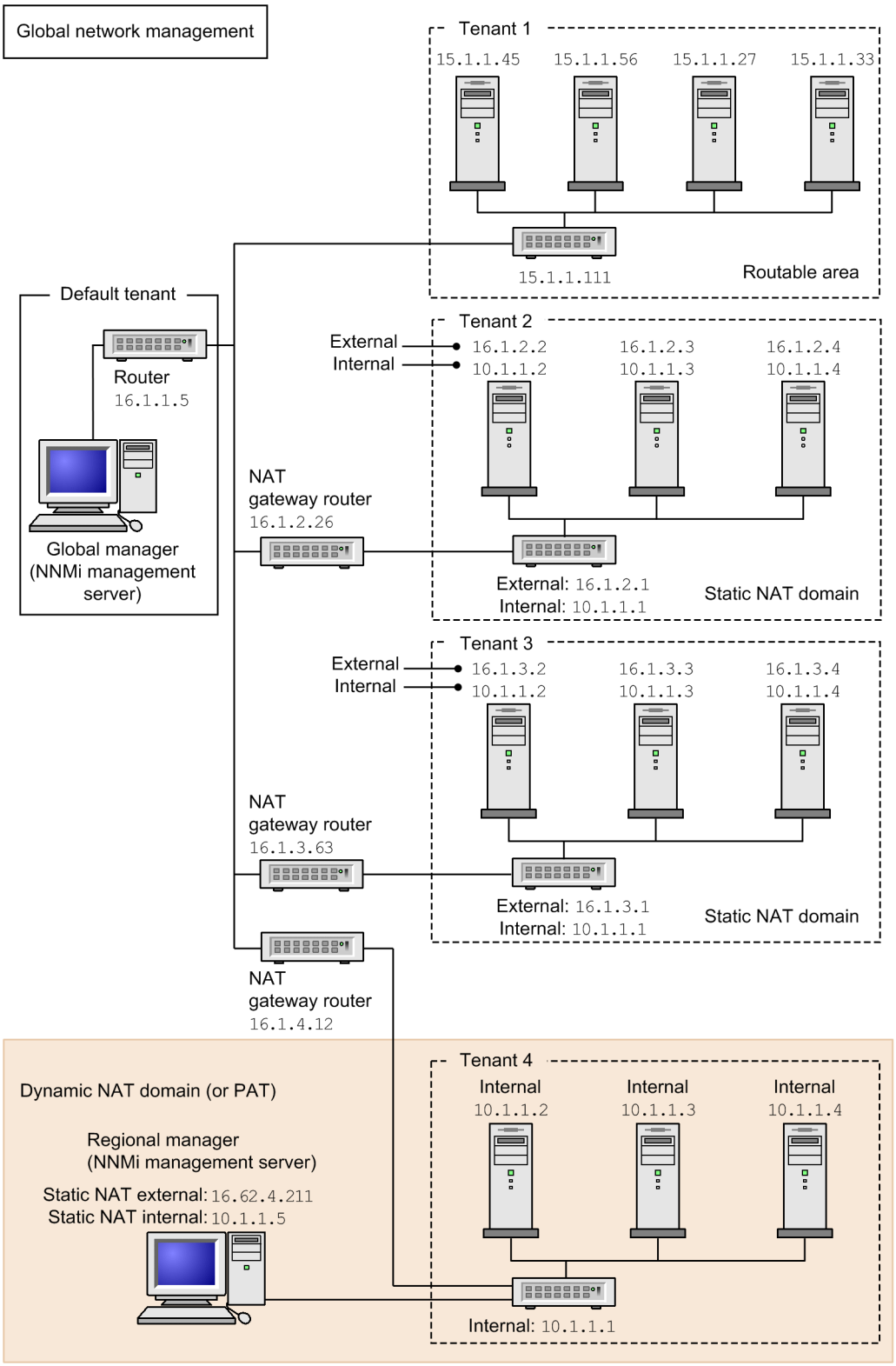
If a regional manager is located behind a NAT firewall, its external (public) address must be static.

Figure 13-4: Example dynamic NAT configurations



To monitor multiple dynamic NAT and dynamic PAT domains, use NNMi's global network management feature. Tenants must be unique within the entire NNMi global network management configuration. For details, see the following figure for an example of a global network management configuration within a NAT environment.

Figure 13-5: Example global network management configuration within a NAT environment



Legend:

External: External address

Internal: Internal address

Devices that belong to the default tenant can have a Layer 2 connection to any device in any tenant. Devices within any tenant other than the default tenant can have a Layer 2 connection only to devices within the same tenant or the default tenant.

Assign all infrastructure devices that interconnect multiple NAT domains (such as the NAT gateway) to the default tenant. This ensures that NNMi displays the Layer 2 connections your workgroup (and customers) needs to see.

The devices in the default security group are displayed in all views. To control access to a device, assign that device to a security group that is not the default security group.

For details about global network management, see 15. Global Network Management. For details about configuring tenants, see *Configure Tenants* in NNMi Help.

13.6.1 Hardware and software requirements for dynamic NAT and dynamic PAT

NNMi Advanced software is required for dynamic NAT and dynamic PAT environments. Each dynamic NAT or dynamic PAT domain requires its own NNMi regional manager.

13.6.2 Discovery and dynamic NAT or dynamic PAT

NNMi uses tenants to support networks containing overlapping address domains. Overlapping address domains might exist in the dynamic NAT or dynamic PAT area in the network management domain. To handle such a network, NNMi places overlapping address domains in different tenants (by using seeded discovery). For details, see NNMi Help.

When adding discovery seeds (with the `nnmloadseeds.ovpl` command or from the NNMi console) in a dynamic NAT or PAT environment, make sure that you use the internal IP addresses of the nodes.

For details, see the *nnmloadseeds.ovpl Reference Page* or NNMi Help.

13.6.3 Monitoring configuration for dynamic NAT

Depending on your network environment, the NNMi administrator can choose to use the ICMP fault monitoring settings. See also 13.6.7 NNMi calculations for state and status.

- **Monitoring Configuration** > **Node Settings** tab
  Configure monitoring for a node group. In this case, make your choices in the **ICMP Fault Monitoring** section. For details, see NNMi online Help.
  - Management address polling (enabled by default and highly recommended)
  - IP address fault polling (optional)
- **Monitoring Configuration** > **Default Settings** tab
  In this case, make your choices in the **ICMP Fault Monitoring** section. For details, see NNMi online Help.

> **Important**
>
> If your network environment also includes any static NAT domains, default settings might not be appropriate because you might want different settings for static NAT domains from those for dynamic NAT domains.

13.6.4 Subnets and dynamic NAT or dynamic PAT

Note the following subnet and dynamic NAT and dynamic PAT considerations:

- Subnets are unique to tenants (a subnet does not span multiple tenants). The benefit of subnets is that the same subnet can be used by different tenants.
- Subnet filters use tenant and address pairs.
- If subnet connection rules are configured, they apply to all tenants. The subnet members must be unique in all tenants (a node is assigned to only one tenant). You can use subnet connection rules to establish a link between a tenant and the default tenant. This feature is supported only when one of the two linked tenants is the default tenant.

13.6.5 Global network management and dynamic NAT or dynamic PAT

At least one static or routable (non-translated) address must exist per regional manager. This enables NNMi management servers to communicate with each other, keeping communications internal and secure.

If a regional manager is located behind a NAT firewall, its external address must be static.

For details about global network management, see 15. Global Network Management. See also *Tenant Best Practices for Global Network Management* in NNMi Help.

13.6.6 Deploying NNMi in a network address translation (NAT) environment

To deploy NNMi in a NAT environment:

1. Identify and compile a list of the NAT domains in your network management environment.
2. Determine the type of supported NAT that is used within each NAT domain.
3. Deploy each NNMi management server as required in relation to each NAT domain (inside or outside the NAT domain's internal IP address space).

   See the following special considerations:

   - 13.5 Considerations on static NAT
   - 13.6 Dynamic NAT and dynamic PAT considerations
4. Use the NNMi **Configuration** > **Discovery** > **Tenants** workspace to define a unique tenant name for each NAT domain.

   > **Important**
   >
   > If you are using global network management in your deployment, this name must be unique among all NNMi management servers (regional managers and the global manager).
5. Determine the nodes within each NAT domain that NNMi needs to monitor.
6. Only for static NAT domains: Create any overlapping address mappings to identify each node's assigned NAT external/internal IP address pair.

   For the benefits of creating overlapping address mappings, see 13.7 Mapping overlapping IP addresses.

   Provide the following information:

- Tenant name
- External IP address
- Internal IP address

Use either the NNMi **Configuration** > **Discovery** > **Overlapping Address Mappings** workspace or the `nnmloadipmappings.ovpl` command line tool.

For details, see NNMi online Help.

7. Depending on where the NNMi management server is deployed in your network environment, a firewall might block NNMi from communicating with nodes in a NAT domain when NNMi uses the node's internal addresses. Therefore, for the **Configuration** > **Communication Configuration** setting, use the appropriate **Preferred Management Address** setting (NAT's external or internal IP address).
8. Verify the **Monitoring Configuration** settings for NAT in your network environment:
   - 13.5.4 Monitoring configuration for static NAT
   - 13.6.3 Monitoring configuration for dynamic NAT

   For details about **Monitoring Configuration**, see NNMi online Help.
9. Configure a discovery seed for each node.

   Important

   Assign any infrastructure device that interconnects multiple NAT domains (such as a NAT gateway router) to the default tenant.

   Use either the NNMi **Configuration** > **Discovery** > **Seeds** workspace or the `loadseeds.ovpl` command line tool:
   - If the NNMi management server is inside the internal IP address space, configure discovery seeds using the internal IP address:
     - Host name/IP (use the internal IP address)
     - Tenant name
   - If the NNMi management server is outside the internal IP address space, configure discovery seeds using the external IP address:.
     - Host name/IP (use the external IP address)
     - Tenant name

   For details, see NNMi online Help.
10. Verify that NNMi discovery found the nodes you expected.

    If not, double-check your configurations (above).
11. Verify that the NNMi settings meet your team's needs:
    - Fine-tune the security group assignment of each node to manage which team members/customers can see each node at the NNMi console. Use NNMi **Configuration** > **Security** > **Security Groups** workspace.
    - Review the monitoring configuration settings that apply to these nodes and fine-tune as necessary. Use the NNMi **Configuration** > **Monitoring** > **Monitoring Configuration** workspace.
12. Verify that the connections between nodes appear on the NNMi maps as expected.

    If not, do the following:
    - Verify that both nodes involved in a connection have proper tenant assignments (default tenant or other tenant).
    - Verify that the **Subnet Connection Rules** tab settings in **Configuration** > **Discovery** > **Discovery Configuration** are correct.

- To force NNMi to add connections that are not found automatically, use the `nnmconnedit.ovpl` command line tool. For details, see the reference page for the `nnmconnedit.ovpl` command.

13. Review the SNMP trap forwarding rules configured in each node's SNMP agent to include the appropriate NNMi management server's IP address.
14. Only for static NAT domains: Configure the SNMP agent on each static NAT node to ensure that the interface associated with **Internal Address** in NNMi's **Overlapping Address Mappings** sources all traps that are sent to the NNMi management server.
15. If your network environment includes SNMPv1, make the appropriate required changes to the NNMi configuration.
    See 13.5.5 Traps and static NAT.

13.6.7 NNMi calculations for state and status

By default, NNMi automatically enables ICMP polling of each node's management address, including nodes residing in a NAT environment (**Configuration** > **Monitoring** > **Monitoring Configuration**, the **Default Settings** tab, **ICMP Fault Monitoring** section's **Enable Management Address Polling** setting). If you have a NAT environment, we recommend that you do not disable this setting.

> **Important**
>
> In the **Inventory** > **Node** view, select a node and use the **Actions** > **Configuration Details** > **Monitoring Settings** command. The displayed information indicates whether NNMi has this management address polling enabled

When management address polling is enabled, the **Agent ICMP State** field appears in the following locations:

- **Node** form
- **SNMP Agent** form
- **SNMP Agent** table views

The following table shows how NNMi behavior changes based on the **ICMP Fault Monitoring** settings.

Table 13-3: Monitoring configuration settings and the resulting State Poller behavior

ICMP fault monitoring settings		Management ICMP address state IP address state	
Enable management address polling	**Enable IP address fault polling**	**Agent ICMP state**	**IP address state**
Enabled#	Disabled#	Polled	Not polled
Enabled	Enabled	Polled	Polled
Disabled	Disabled	Not polled	Not polled
Disabled	Enabled	Not polled	Polled

#: Default settings

When management address polling is enabled, NNMi considers both the management address's ICMP response and the SNMP agent's response when calculating conclusions and generating incidents.

The following table shows the SNMP agent status calculations determined by the combined ICMP and SNMP responses.

Table 13-4: Determining SNMP agent status

SNMP agent's response	Management address's ICMP response	Resulting SNMP agent status
Responding	Responding	Normal
Responding	Not responding	Minor
Not responding	Responding	Critical
Not responding	Not responding	Critical

13.7 Mapping overlapping IP addresses

If a network management environment contains overlapping address domains, each such domain must be configured as a unique tenant. For details, see *Configure Tenants* in NNMi Help and 14. NNMi Security and Multi-Tenancy.

If your network management domain supports static NAT but the NNMi management server is not within the scope of static NAT, you can configure NNMi to display the NAT external IP address (public address) in the **Mapped Address** attribute in the **IP Address** form for the identified tenant/NAT internal IP address (such as a private IPv4 address) pairs.

If you are configuring NNMi for areas of your network management domain that use dynamic NAT or dynamic PAT, do not use the **Overlapping IP Address Mapping** form. For details, see 13.6 Dynamic NAT and dynamic PAT considerations.

A static NAT configuration for a network domain might be applied to public IP addresses or private IP addresses, or both.

To configure NNMi to display the static NAT external IP address in the **Mapped Address** attribute in the **IP Address** form for the identified tenant/NAT internal IP address pairs, do one of the following:

- On the NNMi console, use the **Overlapping IP Address Mapping** form.
- Use the `nnmloadipmappings.ovpl` command.

For details, see NNMi Help or the *nnmloadipmappings.ovpl Reference Page*.

13.7.1 Ranges of private IP addresses

The Internet Engineering Task Force (IETF) and Internet Assigned Numbers Authority (IANA) reserved the following IP address ranges for private networks, such as enterprise local area networks (LANs), corporate offices, and residential networks:

IPv4 private address ranges (RFC 1918):

- `10.0.0.0` to `10.255.255.255` (24-bit block)
- `172.16.0.0` to `172.31.255.255` (20-bit block)
- `192.168.0.0` to `192.168.255.255` (16-bit block)

IPv6 private address ranges:

- `fc00::/7` address block = RFC 4193 unique local addresses (ULA)
- `fec0::/10` address block = deprecated (RFC 3879)

14 NNMi Security and Multi-Tenancy

In NNMi, security and multi-tenancy provide for restricting user access to information about the objects in the NNMi database. This restriction is useful for customizing the views of network operators to their areas of responsibility. It also supports service providers with per-organization configuration of NNMi. This chapter describes the NNMi security and tenant models and gives suggestions for configuration. By default, all NNMi console users can see information for all objects in the NNMi database. If this default configuration is acceptable for your environment, you do not need to read this chapter.

14.1 Effects of limiting object access

Configuring NNMi security has the following impacts:

Topology inventory objects:

- Each NNMi console user sees only those nodes that match the configuration for that user's NNMi user account.
- Sub-node objects, such as interfaces, inherit the access control from the node.
- Inter-node objects, such as connections, are visible only if the NNMi console user can see at least one of the nodes involved.
- An NNMi console user sees only those node groups for which that user can access at least one node in the group.

Maps and path views:

- Maps show connections for which the NNMi console user has permission to view both of the participating nodes.
- Path views omit or show as clouds any intermediate nodes to which the NNMi console user does not have access.

Incidents:

- For incidents whose source node is in the NNMi topology, an NNMi console user sees only the incidents for which the user has access to the source node.
- Incidents that do not have a source node, such as NNMi health and licensing management event incidents, are handled as a group. The NNMi administrator determines which NNMi console users see them (by associating the users with the **Unresolved Incidents** security group).
- Incidents that result from traps for which the source node is not in the NNMi topology are handled in the same way as incidents with no source node. If NNMi is configured to generate these incidents, the NNMi administrator determines which NNMi console users see them (by associating the users with the **Unresolved Incidents** security group).

The incident assignment action does not check user access. It is possible for an NNMi administrator to assign an incident to an NNMi console user who does not have permission to view that incident.

NNMi console actions:

- For actions that run without any selections, an NNMi console user sees only those actions the user has permission to run.
- For actions that run against one or more selected objects, an NNMi console user must have the correct access level to the selected objects. Depending on the security configuration, the NNMi console might present actions that are not valid on some of the objects visible in the NNMi console views. Invoking one of these actions results in an error message regarding this limitation.
- For map views, NNMi cannot distinguish between unknown nodes and nodes that exist in the NNMi topology but are not accessible by the current user.

MIB browser and Line Grapher:

- An NNMi console user can view MIB data and graphs for nodes to which the user has access.
- An NNMi console user can view MIB data for nodes for which the user knows the SNMP community string.

NNMi console URLs:

Users must sign in to NNMi before accessing an NNMi console view from a direct URL. NNMi enforces that user's access according to the NNMi security configuration and limits the available topology accordingly.

14.2 The NNMi security model

The NNMi security model provides user access control to the objects in the NNMi database. This model is appropriate for use by any network management organization that wants to limit NNMi user access to specific objects and incidents. The NNMi security model has the following benefits:

- Provides a way to limit an NNMi console operator's view of the network. Operators can focus on specific device types or network areas.
- Provides for customizing operator access to the NNMi topology. The level of operator access can be configured per node.
- Provides for filtering the **Nodes (All Attributes)** view by security group.
- Simplifies the configuration and maintenance of node groups that align with the security configuration.
- Can be used independently of the NNMi tenant model.

Possible use cases for NNMi security include the following:

- Provide NNMi operator focus on equipment type within a site (custom maps).
- Provide NNMi operators at different sites views that show only the nodes at a given site (custom maps).
- Stage nodes during deployment. NNMi administrators see all nodes, while NNMi operators see only the deployed nodes.
- Provide full access to all NOC operators, and limit access to NOC customers.
- Provide full network views to the central NOC operators, and limit the views of the regional NOC operators.

14.2.1 Security groups

In the NNMi security model, user access to nodes is controlled indirectly though user groups and security groups. Each node in the NNMi topology is associated with only one security group. A security group can be associated with multiple user groups.

Each user account is mapped to the following user groups:

One or more of the following preconfigured NNMi user groups:

- NNMi Administrators
- NNMi Global Operators
- NNMi Operator Level 1
- NNMi Operator Level 2
- NNMi Guest Users

This mapping is required for NNMi console access and determines the actions that are available within the NNMi console. If a user account is mapped to more than one of these NNMi user groups, the user receives the superset of the permitted actions.

The **NNMi Web Services Clients** user group does not grant access to the NNMi console; however, it does grant administrator-level access to all NNMi objects.

The NNMi Global Operators user group (`globalops`) grants access to topology objects only. A user must be assigned to one of the other user groups (`level2`, `level1`, or `guest`) to access the NNMi console.

The administrator must not map the `globalops` user group to any security group because this user group is, by default, mapped to all security groups.

Custom user groups that are mapped to security groups.

These mappings provide access to objects in the NNMi database. Each mapping includes an object access privilege level that applies to the nodes for a security group. The object access privilege level also applies to the related database objects, such as interfaces and incidents. For example, a user with Object Operator Level 1 access to node `A` containing interfaces `X` and `Y` has Object Operator Level 1 access to all of the following database objects:

- Node `A`
- Interfaces `X` and `Y`
- Incidents whose source object is node `A`, interface `X`, or interface `Y`

NNMi provides the following security groups:

Default Security Group

In a new NNMi installation, the initial security group assignment for all nodes is the **Default Security Group**. This means that the default is that all users can see all objects in the **Default Security Group**. The NNMi administrator can configure the nodes that are to be associated with the **Default Security Group** and the users who can access the objects in the **Default Security Group**.

Unresolved Incidents

The **Unresolved Incidents** security group provides access to incidents that NNMi creates from received traps whose source node is not in the NNMi topology. By default, all users can see all incidents associated with the **Unresolved Incidents** security group. The NNMi administrator can configure the users who are permitted to access the incidents associated with the **Unresolved Incidents** security group.

All sensors inherit the node's security group assignment.

Best practices

The following are best practices for configuring NNMi security:

- Map each user account to only one preconfigured NNMi user group.
- Do not map the preconfigured NNMi user groups to security groups.
- Because any user account mapped to the **NNMi Administrators** user group receives administrator-level access to all objects in the NNMi database, do not map this user account to any other user groups.
- Create a separate user account for the Web Services Client role. Because this user account has access to the entire NNMi topology, map this user account to only the **NNMi Web Service Clients** user group.

14.2.2 Example security group structure

The three user frames in the figure below indicate for this example NNMi topology the primary groupings for which users need to view the nodes. For complete user access control, each of the four unique subgroups corresponds to a unique security group. Each unique security group can be mapped to one or more user groups to represent the available levels of user access to the objects in that security group.

Table 14-1 lists the mappings between the security groups and the possible custom user groups for this topology. An actual implementation of this security model might not require all of these custom user groups.

Table 14-2 lists the mappings for several user accounts and the user groups for this topology.

Figure 14-1: Example topology for user access requirements

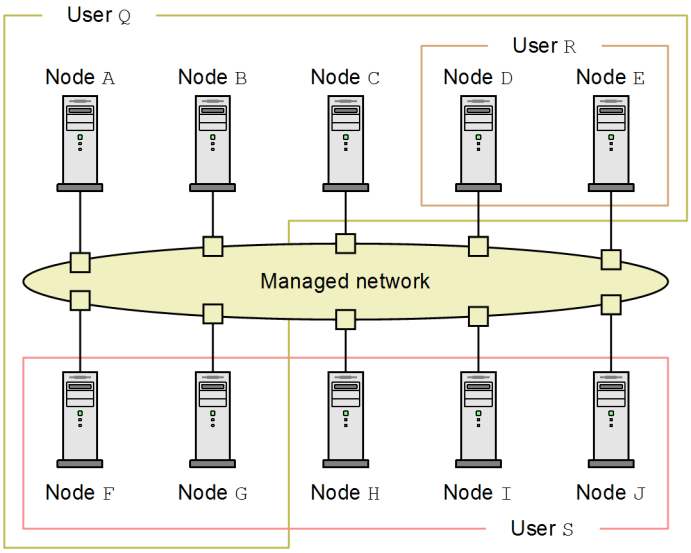


Table 14-1: Example security group mappings

Security group	Security group's nodes	User groups	Object access privileges
SG1	A, B, C	UG1 Administrator	Object Administrator
		UG1 Level 2	Object Operator Level 2
		UG1 Level 1	Object Operator Level 1
		UG1 Guest	Object Guest
SG2	D, E	UG2 Administrator	Object Administrator
		UG2 Level 2	Object Operator Level 2
		UG2 Level 1	Object Operator Level 1
		UG2 Guest	Object Guest
SG3	F, G	UG3 Administrator	Object Administrator
		UG3 Level 2	Object Operator Level 2
		UG3 Level 1	Object Operator Level 1
		UG3 Guest	Object Guest
SG4	H, I, J	UG4 Administrator	Object Administrator
		UG4 Level 2	Object Operator Level 2
		UG4 Level 1	Object Operator Level 1
		UG4 Guest	Object Guest

Table 14-2: Example user account mappings

User account	User groups	Node access	Notes
User Q	NNMi Level 2 Operators	None	This user has operator level 2 access to the nodes in the user Q frame.
	UG1 Level 2	A, B, C	
	UG2 Level 2	D, E	

User account	User groups	Node access	Notes
User Q	UG3 Level 2	F, G	This user has operator level 2 access to the nodes in the user Q frame.
User R	NNMi Level 1 Operators	None	This user has operator level 1 access to the nodes in the user R frame.
	UG2 Level 1	D, E	
User S	NNMi Level 2 Operators	None	This user has operator level 2 access to the nodes in the user S frame.
	UG3 Level 2	F, G	
	UG4 Level 2	H, I, J	
User T	NNMi Level 2 Operators	None	User T has access (with varying privilege levels) to all nodes in the example topology. This user has administrative access to nodes D and E but cannot see the menu items for tools that require administrative access. If granted access to the NNMi management server, this user can run command-line tools that require administrative access against nodes D and E only.
	UG1 Guest	A, B, C	
	UG2 Administrator	D, E	
	UG3 Level 2	F, G	
	UG4 Level 1	H, I, J	

14.3 The NNMi tenant model

The NNMi tenant model provides strict segregation of topology discovery and data into tenants, also called organizations or customers. This model is appropriate for use by service providers, especially managed service providers, and large enterprises. The NNMi tenant model has the following benefits:

- Marks the organization to which each node belongs.
- Provides for filtering the **Nodes (All Attributes)** inventory view by tenant and security group.
- Meets regulatory requirements for separating operator access to customer data.
- Simplifies the configuration and maintenance of node groups that align with the tenant configuration.
- Simplifies configuration of NNMi security.

Use NNMi multi-tenancy to provide different customer views for a service provider that has multiple customers (tenants) managed from the same NNMi management server.

14.3.1 Tenants

The NNMi tenant model adds the idea of an organization to the security configuration. Each node in the NNMi topology belongs to only one tenant. The tenant provides logical separation in the NNMi database. Object access is managed through security groups.

For each node, the initial discovery tenant assignment occurs when the node is first discovered and added to the NNMi database. For seeded nodes, you can specify the tenant to assign to each node. NNMi assigns to the Default Tenant all other discovered nodes (those included in an auto-discovery rule but not seeded directly). An NNMi administrator can change the tenant for a node at any time after discovery.

Each tenant definition includes an initial discovery security group. NNMi assigns this initial discovery security group to the node along with the initial discovery tenant. An NNMi administrator can change the security group for a node at any time after discovery.

Changing the tenant assignment of a node does not automatically change the security group assignment.

NNMi provides the Default Tenant. This means that the default is that all NNMi users have access (through the **Default Security Group**) to all objects associated with this tenant.

All sensors inherit the tenant and security group assignments of the node.

Best practices

The following best practices apply to NNMi tenant configuration:

- For a small organization, a single security group per tenant is probably sufficient.
- You might want to subdivide a large organization into multiple security groups.
- To prevent users from accessing nodes across organizations, ensure that each security group includes nodes for only one tenant.

14.3.2 Example tenant structure

The figure below shows an example NNMi topology consisting of two tenants. The three frames for users L, M, and N indicate the primary groupings for which users need to view the nodes. The topology for Tenant 1 is managed as a single group, so it needs only one security group. The topology for Tenant 2 is managed in overlapping sets, so it is separated into three security groups.

Table 14-3 lists the mappings between the security groups and the possible custom user groups for this topology. (An actual implementation of this security model might not require all of these custom user groups.)

Table 14-4 lists the mappings for several user accounts and the user groups for this topology.

Figure 14-2: Example topology for multiple tenants

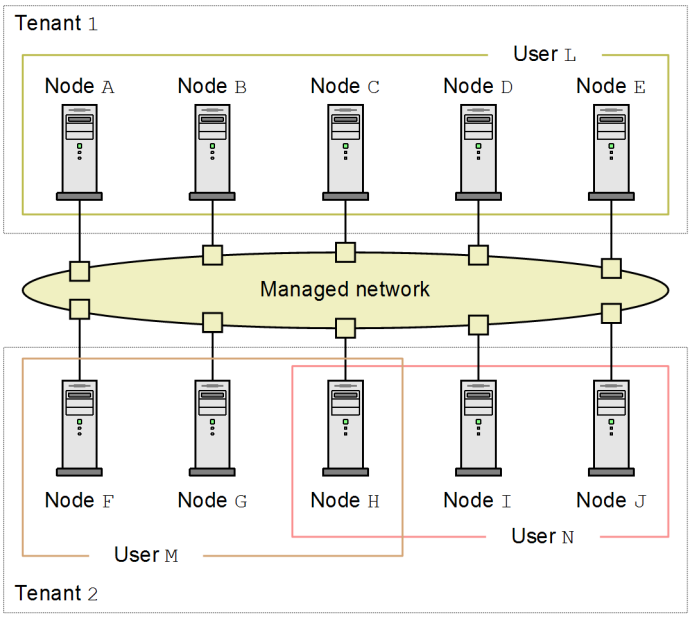


Table 14-3: Example security group mappings for multiple tenants

Security group	Security group's nodes	User groups	Object access privileges
T1 SG	A, B, C, D, E	T1 Administrator	Object Administrator
		T1 Level 2	Object Operator Level 2
		T1 Level 1	Object Operator Level 1
		T1 Guest	Object Guest
T2 SGa	F, G	T2_a Administrator	Object Administrator
		T2_a Level 2	Object Operator Level 2
		T2_a Level 1	Object Operator Level 1
		T2_a Guest	Object Guest
T2 SGb	H	T2_b Administrator	Object Administrator
		T2_b Level 2	Object Operator Level 2
		T2_b Level 1	Object Operator Level 1
		T2_b Guest	Object Guest

Security group	Security group's nodes	User groups	Object access privileges
T2 SGc	I, J	T2_c Administrator	Object Administrator
		T2_c Level 2	Object Operator Level 2
		T2_c Level 1	Object Operator Level 1
		T2_c Guest	Object Guest

Table 14-4: Example user account mappings for multiple tenants

User account	User groups	Node access	Notes
User L	NNMi Level 2 Operators	None	This user has operator level 2 access to the nodes in the user L frame, which groups all nodes in Tenant 1.
	T1 Level 2	A, B, C, D, E	
User M	NNMi Level 1 Operators	None	This user has operator level 1 access to the nodes in the user M frame, which groups a subset of the nodes in Tenant 2.
	T2_a Level 1	F, G	
	T2_b Level 1	H	
User N	NNMi Level 2 Operators	None	This user has operator level 2 access to the nodes in the user N frame, which groups a subset of the nodes in Tenant 2.
	T2_b Level 2	H	
	T2_c Level 2	I, J	

14.4 NNMi security and multi-tenancy configuration

NNMi security and multi-tenancy configuration applies to the entire NNMi database. Any NNMi administrator can view and configure operator access to all objects for all tenants.

After an NNMi administrator has defined at least one custom security group, the **Security Groups** field is visible on all **Node** forms and as a column in the **Nodes** and **Nodes (All Attributes)** inventory views.

After an NNMi administrator has defined at least one custom tenant, the **Tenant** field is visible on all **Node** forms and as a column in the **Nodes** and **Nodes (All Attributes)** inventory views.

Node groups

To create a node group that aligns with part of the security or multi-tenancy configuration, specify a node group additional filter based on security group UUID, security group name, tenant UUID, or tenant name. Use these node groups to configure per-security group or per-tenant polling cycles for monitoring and incident lifecycle transition actions.

> **Tip**
>
> Because security group and tenant names can change, specify the security group or tenant UUID in additional filters. This information is available on the configuration forms and in the `nnmsecurity.ovpl` command output.

User groups: NNMi console access

User account mapping to one of the predefined NNMi user groups sets the NNMi role and the visibility of menu items in the NNMi console. We recommend that each user account be granted the NNMi role that matches the highest object access privilege for that user's topology objects.

The exception to this recommendation is at the administration level because NNMi administrators can access all topology objects. To configure an NNMi console user as an administrator of only some nodes in the NNMi topology, assign that user to the NNMi Level 2 Operators or NNMi Level 1 Operators user group. Also assign that user to a custom user group mapped with the Object Administrator object access privilege to a security group containing a subset of the nodes in the topology.

User groups: directory service

If you are storing user group membership in the NNMi database, all object access configuration occurs in the NNMi configuration areas through user groups, user account mappings, security groups, and security group mappings.

If you are storing user group membership in a directory service, object access configuration is shared between NNMi configuration (security groups and security group mappings) and the directory service content (user group membership). Do not create user accounts or user account mappings in the NNMi database. For each applicable group in the directory service, create one or more user groups in the NNMi database. In NNMi, set the **Directory Service Name** field of each user group definition to the distinguished name of that group in the directory service.

For details, see 12. Integrating NNMi with a Directory Service Through LDAP.

14.4.1 Security and multi-tenancy configuration tools

NNMi provides several tools for configuring multi-tenancy and security.

Security Wizard

The **Security Wizard** in the NNMi console is useful for visualizing the security configuration. It is the easiest way to assign nodes to security groups within the NNMi console. The **View Summary of Changes** tab presents a list of unsaved changes from the current wizard session. It also identifies potential problems with the security configuration.

For details about using the **Security Wizard**, click NNMi Help links within the wizard.

> **Note**
>
> The **Security Wizard** is for NNMi security configuration only. It does not include tenant information.

NNMi console forms

The forms for individual security and multi-tenancy objects in the NNMi console are useful for concentrating on one aspect of the configuration at a time. For details about using these forms, see NNMi Help for each form.

The **Tenants** view contains NNMi multi-tenancy configuration information. This view is available under **Discovery** in the **Configuration** workspace. Each **Tenant** form describes one NNMi tenant and shows the nodes currently assigned to that tenant. The node assignment information is read-only.

To change the tenant or security group assignment for a node, use the **Node** form or the `nnmsecurity.ovpl` command.

The NNMi console views described below are available under **Security** in the **Configuration** workspace. These views contain NNMi security configuration information.

User Accounts

- Each **User Accounts** form describes one NNMi user and shows the user groups to which that user belongs. The membership information is read-only.
- If you are storing user group membership in a directory service, user accounts are not visible in the NNMi console.

User Groups

Each **User Groups** form describes one NNMi user group and shows the user accounts and security groups mapped to that user group. The mapping information is read-only.

User Account Mapping

- Each **User Account Mapping** form shows one user account-to-user group association.
- Changes to user account mappings do not affect the current NNMi console users. These users receive any changes the next time they sign in to the NNMi console.
- If you are storing user group membership in a directory service, user account mappings are not visible in the NNMi console.

Security Groups

Each **Security Groups** form describes one NNMi security group and shows the nodes currently assigned to that security group. The node assignment information is read-only.

Security Group Mapping

- Each **Security Group Mapping** form shows one user group-to-security group association.
- After initial configuration, the object access privilege associated with a security group mapping is read-only. To change the object access privilege for a security group mapping, delete that mapping and re-create it.

Command line

The `nnmsecurity.ovpl` command-line interface is useful for automation and bulk operations. The tool also provides reports of potential problems with the security configuration.

Many of the `nnmsecurity.ovpl` options support loading input data from comma-separated values (CSV) files. You can maintain configuration data in a file or system that can generate CSV output for consumption by the `nnmsecurity.ovpl` command. The command can also accept UUIDs generated outside of NNMi.

> **Tip**
>
> Because security group and tenant names do not need to be unique, specify the security group or tenant UUID as input to the `nnmsecurity.ovpl` command.

The following example script uses the `nnmsecurity.ovpl` command to create the security configuration for two user accounts and five nodes:

```
#!/bin/sh
# create two users
nnmsecurity.ovpl -createUserAccount user1 -password -role level1
nnmsecurity.ovpl -createUserAccount user2 -password -role level2
# create two user groups
nnmsecurity.ovpl -createUserGroup local1
nnmsecurity.ovpl -createUserGroup local2
# assign the user accounts to the new user groups
nnmsecurity.ovpl -assignUserToGroup -user user1 -userGroup local1
nnmsecurity.ovpl -assignUserToGroup -user user2 -userGroup local2
# create two security groups
nnmsecurity.ovpl -createSecurityGroup secgroup1
nnmsecurity.ovpl -createSecurityGroup secgroup2
# assign the new user groups to the new security groups
nnmsecurity.ovpl -assignUserGroupToSecurityGroup -userGroup local1 -securityGroup
secgroup1 -role level1
nnmsecurity.ovpl -assignUserGroupToSecurityGroup -userGroup local2 -securityGroup
secgroup2 -role level2
# assign nodes to security groups
nnmsecurity.ovpl -assignNodeToSecurityGroup -node mplspe01 -securityGroup secgroup
1
nnmsecurity.ovpl -assignNodeToSecurityGroup -node vwan_router-1 -securityGroup sec
group1
nnmsecurity.ovpl -assignNodeToSecurityGroup -node vwan_router-2 -securityGroup sec
group1
nnmsecurity.ovpl -assignNodeToSecurityGroup -node data_center_1 -securityGroup sec
group2
nnmsecurity.ovpl -assignNodeToSecurityGroup -node mplspe03 -securityGroup secgroup
2
```

14.4.2 Configuring multi-tenancy

NNMi provides the following ways to configure multi-tenancy:

- The **Tenant** form in the NNMi console

  This is useful for working with individual tenants.
- `nnmsecurity.ovpl` command-line interface

  This is useful for automation and bulk operations. The tool also provides reports of potential problems with the tenant configuration.

The process of defining and configuring NNMi multi-tenancy to assign each NNMi topology object to a tenant (organization) is a cyclical process.

Note the following about configuring NNMi multi-tenancy:

- The security group that NNMi assigns to a discovered node is set by the value of the **Initial Discovery Security Group** for the tenant associated with that node.

- When you use the NNMi security model without also configuring NNMi tenants, all nodes are assigned to the Default Tenant.
- When you seed a node for NNMi discovery, you can specify the tenant to which that node belongs. When NNMi discovers a node through an auto-discovery rule, NNMi assigns that node to the Default Tenant. After discovery, you can change the tenant assignment for the node.

One high-level approach to planning and configuring NNMi multi-tenancy is as follows:

1. Analyze your customer requirements to determine how many tenants are required in the NNMi environment.

   We recommend that tenants be used only when managing multiple separate networks with a single NNMi management server.
2. Analyze the managed network topology to determine which nodes belong to each tenant.
3. Analyze the topology of each tenant to determine the groups of nodes to which NNMi users need access.
4. Remove the default associations between the predefined NNMi user groups and the **Default Security Group** and **Unresolved Incidents** security group.

   This step ensures that users do not inadvertently obtain access to nodes they are not supposed to be managing. At this point, only NNMi administrators can access objects in the NNMi topology.
5. Configure the identified tenants.

   a. Create the identified security groups.

   b. Create the identified tenants.

   For each tenant, set the **Initial Discovery Security Group** to either the **Default Security Group** or a tenant-specific security group with restricted access. This approach ensures that new nodes for the tenant are not generally visible until the NNMi administrator configures access.
6. Prepare for discovery by assigning tenants to seeds.

   After discovering a group of nodes, you can change the value of the **Initial Discovery Security Group**. Using this approach limits the manual re-assignment of nodes to security groups.
7. After discovery completes, do the following:
   - Verify the tenant for each node and make changes as necessary.
   - Verify the security group for each node and make changes as necessary.
8. Configure custom user groups.

   For details about configuring custom user groups, see 14.4.4 Verifying the configuration.

14.4.3 Configuring security groups

If you plan to integrate NNMi with a directory service for consolidating the storage of user names, passwords, and, optionally, NNMi user group assignments, complete that configuration before configuring NNMi security.

NNMi provides the following ways to configure security:

- The **Security Wizard** in the NNMi console

  This wizard is useful for visualizing the security configuration. The **View Summary of Changes** tab presents a list of unsaved changes from the current wizard session. It also identifies potential problems with the security configuration.
- Forms in the NNMi console for individual security objects

  These forms are useful for concentrating on one aspect of the security configuration at a time.

- `nnmsecurity.ovpl` command-line interface

  This tool is useful for automation and bulk operations. The tool also provides reports of potential problems with the security configuration.

The process of defining and configuring NNMi security to limit users' access to objects in the NNMi topology is a cyclical process.

> **Note**
>
> This example moves from security groups to user accounts. For examples of configuring NNMi security from user accounts to security groups, search for *Configure Security Example* in NNMi Help.

Note the following about configuring NNMi security:

- The security group that NNMi assigns to a discovered node is set by the value of the **Initial Discovery Security Group** for the tenant associated with that node.
- When you use the NNMi security model without also configuring NNMi tenants, all nodes are assigned to the Default Tenant.

One high-level approach to planning and configuring NNMi security is as follows:

1. Analyze the managed network topology to determine the groups of nodes to which NNMi users need access.
2. Remove the default associations between the predefined NNMi user groups and the **Default Security Group** and **Unresolved Incidents** security group.

   This step ensures that users do not inadvertently obtain access to nodes they are not supposed to be managing. At this point, only NNMi administrators can access objects in the NNMi topology.
3. Configure a security group for each subset of nodes. Remember that a given node can belong to only one security group.

   a. Create the security groups.

   b. Assign the appropriate nodes to each security group.
4. Configure custom user groups.

   a. For each security group, configure a user group for each level of NNMi user access.

   - If you are storing user group membership in the NNMi database, no users are mapped to these user groups yet.
   - If you are storing user group membership in a directory service, set the **Directory Service Name** field for each user group to the distinguished name of that group in the directory service.

   b. Map each custom user group to the correct security group. Set the appropriate object access privilege for each mapping.
5. Configure user accounts.

   If you are storing user group membership in the NNMi database, do the following:

   - Create a user account object for each user who is permitted to access the NNMi console. The process of configuring user accounts depends on whether you are using a directory service for NNMi console sign-in.
   - Map each user account to one of the predefined NNMi user groups (for access to the NNMi console).
   - Map each user account to one or more custom NNMi user groups (for access to topology objects).

   If you are storing user group membership in a directory service, verify that each user belongs to one of the predefined NNMi user groups and one or more custom user groups.
6. Verify the configuration as described in 14.4.4 Verifying the configuration.

7. Maintain the security configuration.
   - Watch for nodes added to the **Default Security Group**, and move these nodes to the correct security groups.
   - Add new NNMi console users to the correct user groups.

14.4.4 Verifying the configuration

To verify that the security configuration is correct, verify each aspect of the configuration separately. This subsection describes some approaches to verifying the configuration. Other approaches are possible.

> **Note**
>
> NNMi provides reports of possible security configuration errors. Access these reports by choosing **Security Reports** from the **Tools** menu in the NNMi console. Alternatively, you can access the reports by using the `nnmsecurity.ovpl` command with the `-displayConfigReport` option specified.

Verifying security group-to-node assignments

Verify that each node is assigned to the correct security group by using one of the following methods:

- Sort the **Nodes** or **Nodes (All Attributes)** inventory view by security group, and then examine the groupings.
- Use the `nnmsecurity.ovpl` command with the `-listNodesInSecurityGroup` option specified.

Verifying user group-to-security group assignments

Verify which user groups are mapped to each security group by using one of the following methods:

- Sort the **Security Group Mapping** view by user group or security group, and then examine the groupings. Also verify the object access privilege for each mapping.
- On the **Map User Groups and Security Groups** tab of the **Security Wizard**, select one user group or security group at a time to see the current mappings for that object.
- Use the `nnmsecurity.ovpl` command with the `-listUserGroupsForSecurityGroup` option specified.

Verifying that each user has NNMi console access

For NNMi console access, ensure that each user is assigned to one of the predefined NNMi user groups:

- NNMi Administrators
- NNMi Level 1 Operators
- NNMi Level 2 Operators
- NNMi Guest Users

All other user group assignments provide access to objects in the NNMi database.

Users without NNMi console access are listed on the **View Summary of Changes** tab of the **Security Wizard**. The **Security Reports** menu item under the **Tools** menu and the `-displayConfigReport usersWithoutRoles` option to the `nnmsecurity.ovpl` command also provide this information.

Verifying user-to-user group assignments

Verify user group membership by using one of the following methods:

- Sort the **User Account Mapping** view by user account or user group, and then examine the groupings.
- On the **Map User Accounts and User Groups** tab of the **Security Wizard**, select one user account or user group at a time to see the current mappings for that object.

- Use the `nnmsecurity.ovpl` command with the `-listUserGroups` and `-listUserGroupMembers` options specified.

Verifying tenant-to-node assignments

One approach to verifying that each node is assigned to the correct tenant is to sort the **Nodes** or **Nodes (All Attributes)** inventory view by tenant, and then examine the groupings.

Verifying current user settings

To verify the NNMi console access for the currently logged-on user, click **Help**, and then click **System Information**. The **User Information** section on the **Product** tab lists the following information for the current NNMi session:

- User name as defined for the user account in the NNMi database or the accessed directory service.
- NNMi role, which corresponds to the most privileged of the predefined NNMi user groups to which the user is mapped (NNMi Administrators, NNMi Level 2 Operators, NNMi Level 1 Operators, or NNMi Guest Users). This mapping determines which actions are available within the NNMi console.
- User groups mapped to this user name. This list includes the predefined NNMi user group that sets the NNMi role and any other user groups that provide access to objects in the NNMi database.

14.4.5 Exporting the NNMi security and multi-tenancy configuration

The table below describes the configuration areas (available with the `nnmconfigexport.ovpl -c` command) for exporting the NNMi security and multi-tenancy configuration. These export areas are beneficial for maintaining the configuration across multiple NNMi management servers, especially in a Global Network Management environment.

Table 14-5: NNMi security and multi-tenancy configuration export areas

Configuration area	Description
`account`	Exports user accounts, user groups, and user account-to-user group mappings. Useful for sharing user definitions across multiple NNMi databases.
`security`	Exports tenants and security groups. Useful for sharing security definitions across multiple NNMi databases. Importing this information creates new objects and updates existing objects but does not delete objects not included in the current export. Therefore, this option is safe to use with an NNMi database containing locally-defined objects.
`securitymappings`	Exports user group-to-security group mappings. For a complete export of the security and multi-tenancy configuration, perform a concurrent export of the `account`, `security`, and `securitymappings` configuration areas.

14.5 Defining NNMi security and multi-tenancy in global network management

In a global network management (GNM) environment, a node's tenant is set on the NNMi management server that manages that node. The tenant UUID for a given node is the same on each global and regional manager in the GNM environment.

A node's security group is set on each NNMi management server whose topology contains that node. Thus, user access to objects in the topology is configured separately on each NNMi management server in the GNM environment. The global and regional managers might use the same or different security group definitions.

If you want user access to be similar on the global manager and regional managers, you can employ some configuration tricks, but you probably cannot completely avoid custom configuration on each NNMi management server.

Tip

- Define all tenants and security groups on the global manager. Use `nnmconfigexport.ovpl -c security` to export the tenant and security group definitions. On each regional manager, use `nnmconfigimport.ovpl` to import the tenant and security group definitions. Alternatively, you can use the `nnmsecurity.ovpl` command to create tenants and security groups with the same UUIDs as on another NNMi management server. Following this recommendation ensures that each tenant and security group has the same UUID within the GNM environment.

  This best practice becomes a required part of the configuration if users will be launching NPS reports from the global manager.

  Tenant UUIDs must be unique, but tenant names can be reused. NNMi considers two tenants with the same name and different UUIDs to be two distinct tenants with no shared configuration.
- If you are setting up one regional manager per organization, all nodes on a regional manager can be in a single tenant. However, configure a unique tenant on each regional manager to ensure separation of the topology data on the global manager.

  Incidents forwarded from a regional manager to a global manager might include some additional custom incident attributes (CIAs) to convey security and tenant information.

  If the incident's source object belongs to a tenant other than the Default Tenant, the forwarded incident contains the following CIAs:

  `cia.tenant.name`

  `cia.tenant.uuid`

  If the incident's source object belongs to a security group other than the **Default Security Group**, the forwarded incident contains the following CIAs:

  `cia.securityGroup.name`

  `cia.securityGroup.uuid`

14.5.1 Initial configuration of security and multi-tenancy in global network management

After a global network management (GNM) is first configured, the regional manager updates the global manager with information about the nodes in the regional topology (according to the GNM configuration).

Topology synchronization with the Default Tenant only

For GNM environments with custom security groups and the Default Tenant, on the global manager all nodes managed remotely are added to the global manager topology with the following configuration:

- Default Tenant
- The security group that is set as the **Initial Discovery Security Group** for the Default Tenant

Topology synchronization with custom tenants

For GNM environments with custom security groups and custom tenants, on the global manager all nodes managed remotely are added to the global manager topology with the UUID of the tenant assigned to the node. If that tenant UUID does not exist on the global manager, the GNM processes create that tenant in the NNMi configuration of the global manager as follows:

- The tenant UUID is the same value as on the regional manager.
- The tenant name is the same value as on the regional manager.
- The value of the **Initial Discovery Security Group** is set to the security group with the same name as the tenant. (NNMi creates this security group if it does not already exist on the global manager.)

As the node is added to the topology on the global manager, it is assigned to the **Initial Discovery Security Group** for the tenant UUID as configured on the global manager. That is, the security group association on the global manager is independent of the security group association on the regional manager.

Tip

The following are suggestions for simplifying security configuration on the global manager:

- Maintain a spreadsheet or other record of the nodes managed by each regional manager. For each node, note the expected security group on the regional manager and that on the global manager. After GNM configuration completes, use the `nnmsecurity.ovpl` command to verify and update the security group assignments.
- If the GNM environment will include multiple regional managers updating a single global manager, enable the GNM configuration from one regional manager at a time to the global manager.
- If appropriate, you can change the value of the **Initial Discovery Security Group** of the Default Tenant (or a custom tenant) before adding each regional manager to the GNM configuration. Note that this approach can have mixed results if new nodes are being added to the topology on the previously configured regional managers.
- Before enabling GNM, on the global manager set the **Initial Discovery Security Group** of each tenant used on the regional manager to be a private security group that operators cannot access. An administrator on the global manager then needs to explicitly move the nodes to the appropriate security groups for other NNMi console operators.

14.5.2 Effects of security and multi-tenancy assignment on a global network management

The following table describes how changes to a node's tenant or security group assignment on a regional manager affect the global manager.

Table 14-6: Global manager impact of configuration changes on a regional manage

Action	Effect
On the regional manager, assign a node to a different tenant.	The node on the global manager is changed to be assigned to the different tenant. If this tenant UUID does not exist on the global manager, it is created.
On the regional manager, assign a node to a different security group.	No change on the global manager. The NNMi administrator can choose to replicate the change manually.
On the regional manager, change the configuration (name, description, or initial discovery security group) of a tenant.	No change on the global manager. The NNMi administrator can choose to replicate the change manually.
On the regional manager, change the configuration (name or description) of a security group.	No change on the global manager. The NNMi administrator can choose to replicate the change manually.

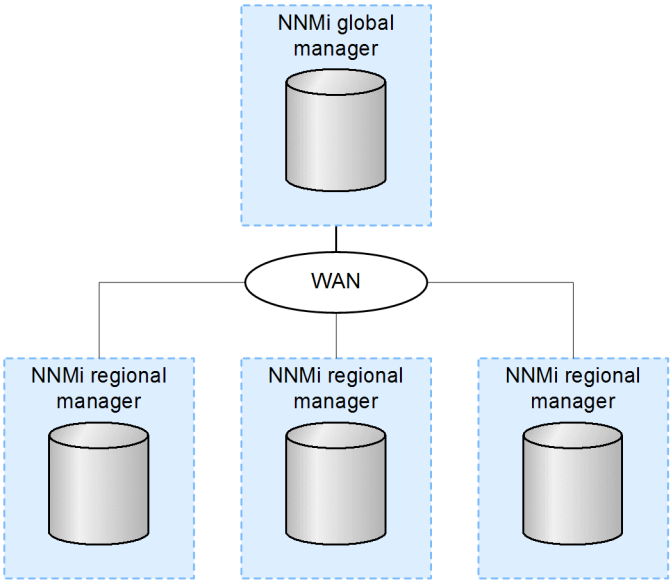
15 Global Network Management

This chapter describes how to manage a global network.

15.1 Prerequisites for global network management

To use the global network management feature, you must ensure that the versions and revisions of all NNMi management servers composing the global network management are the same. Their update versions can be different.

15.2 Global network management benefits



Suppose you have NNMi deployed on multiple NNMi management servers in several geographic locations. You have these NNMi management servers discovering and monitoring the network to meet your discovery and monitoring needs. Using these existing NNMi management servers and configurations, you can designate specific NNMi management servers as global managers to display combined node object data without additional discovery or monitoring configuration changes.

The NNMi global network management feature enables multiple NNMi management servers to work together while managing different geographic areas of the network. You designate specific NNMi management servers as global managers to display combined node object data from two or more regional managers.

The NNMi global network management feature offers the following benefits:

- Provides a central big-picture view of your corporate-wide network from the global manager
- Easy to set up:
  - Each regional manager administrator specifies node object data from all nodes or from a specific group of nodes for inclusion at the global manager level.
  - Each global manager administrator specifies which regional managers are allowed to contribute information.
- Generates and manages incidents independently on each server (generated within the context of the topology available on each server)

For details, see *NNMi's Global Network Management Feature (NNMi Advanced)* in NNMi Help.

Each group of dynamic network address translation (NAT) or dynamic port address translation (PAT) or dynamic network address and port translation (NAPT) requires an NNMi regional manager, in addition to a tenant that is unique within the entire NNMi global network management configuration. For details, see 13. Managing Overlapping IP Addresses in a NAT Environment and NNMi Help.

15.3 Evaluating the use of global network management

15.3.1 Monitoring networks at multiple sites continuously

If your information technology group manages network equipment located at multiple sites on a 24/7 basis, your group can use NNMi's global network management feature to observe combined topology and incident views.

15.3.2 Monitoring selected critical devices

To view device status and incidents for critical devices located at multiple locations from one NNMi management server, you must configure forwarding filters on the regional managers. Doing so enables you to select the node object data you want the regional managers to send to the global manager. For example, you can set up forwarding filters on the regional managers so that only information about critical devices is forwarded to the global manager.

15.3.3 Considering licensing

You must purchase and install NNMi Advanced licenses on the NNMi management server you plan to use as the global manager. NNMi management servers do not need NNMi Advanced licenses to function as regional managers.

You can use the global network management feature to limit the new licenses you need on the global manager. For example, if your information technology group needs to monitor critical equipment located at multiple sites, you can configure a forwarding filter on the regional managers to make sure you only forward information about critical devices to the global manager. This enables you to make wise use of your NNMi investment and maintain control over your use of the license capacity you have on the global manager.

If you have increased the NNMi licenses for the regional managers such that the total number of licensed nodes is larger than the NNMi Advanced licenses on the global manager, the global manager will not have been able to maintain a complete inventory of all nodes in all regions. To synchronize the global manager with all of the regional managers so that the global manager can find and create the nodes it skipped due to insufficient licenses, you must purchase and install enough NNMi Advanced licenses on the global manager to meet or exceed the total number of licenses you have installed on the regional managers.

After you have enough licenses installed, do one of the following:

- Wait for all the configured rediscovery intervals on all the regional managers to elapse so that all nodes in all regions become rediscovered. Once the regional managers have rediscovered all nodes in all regions, they send this rediscovered node information to the global manager.

  The global manager receives this node information and creates global nodes for all nodes in each region.
- Run the `nnmnoderediscover.ovpl -all` script on each regional manager.

  Note

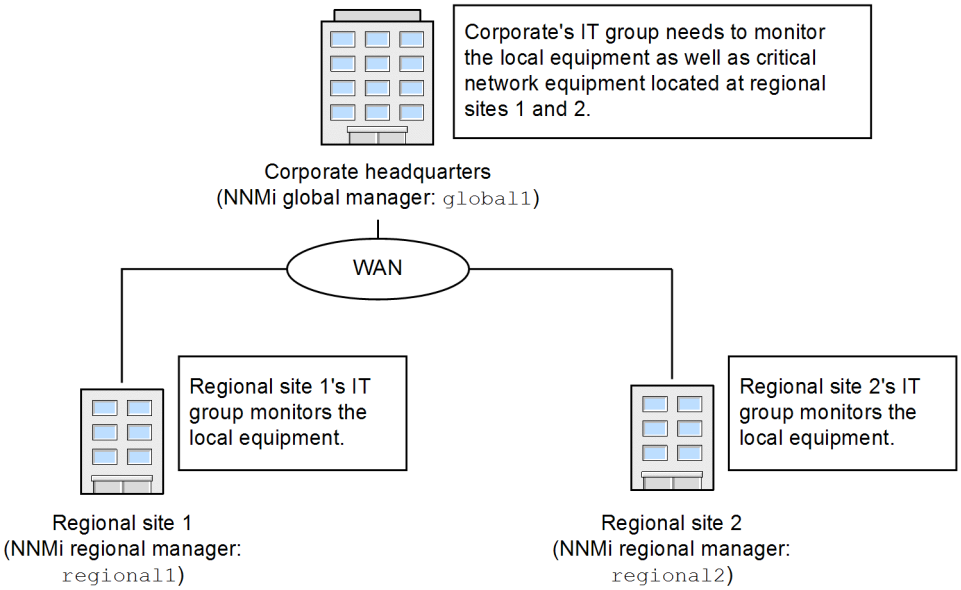
  The second option results in both a lot of traffic on your network and consumption of a lot of NNMi resources from the entire set of NNMi managers. This option is not as resource intensive as the initial NNMi discovery, but it is similar to doing an initial discovery. The best approach is to space the running of the script for each region by some amount of time or by waiting for the current regional manager's workload to drop to normal before starting the next regional manager's rediscovery.

15.4 Practical global network management examples

The example in the figure below shows a company that has two operating sites in different geographic locations. The company headquarters is located in a third geographic area. NNMi management servers are functioning at all three locations.

From a network perspective, the IT group at corporate headquarters needs to monitor the local network equipment at the headquarters as well as critical network equipment located at regional sites 1 and 2. The IT groups at regional sites 1 and 2 need to monitor the local critical network equipment located at their respective sites.

Figure 15-1: Example network



15.4.1 Reviewing the requirements

Suppose the NNMi management servers at corporate headquarters, regional site 1, and regional site 2 manage several routers and switches located at their individual sites. For this example, refer to the NNMi management servers as `global1`, `regional1`, and `regional2`, respectively. Suppose you configured these NNMi management servers to discover and monitor critical switches and routers located at their own locations. In such a case, there is no need to reconfigure discovery for the NNMi management servers at any of these sites to use the global network management feature.

Note

During global network management configuration, you might be tempted to use the `nnmbackup.ovpl` script to back up one NNMi management server, then use the `nnmrestore.ovpl` script to restore this backup to a second NNMi management server, then connect both of these NNMi management servers to a regional NNMi management server. Do not do this. Placing the backup data from one NNMi management server onto a second NNMi management server means that both servers have the same database UUID. After you restore NNMi on the second NNMi management server, you would need to uninstall NNMi from the original NNMi management server.

The IT group at the corporate site wants to monitor critical equipment located at regional sites 1 and 2, but they do not want to manage all devices. The following table summarizes the monitoring needs.

Table 15-1: Network requirements for global network management

Site	NNMi management server	Critical switches	Regional equipment to manage
Corporate headquarters	`global1`	15 HP ProCurve 2620 Switches	All HP ProCurve 2620 Switches at all regional sites
Regional site 1	`regional1`	15 HP ProCurve 2620 Switches	Not applicable
Regional site 2	`regional2`	15 HP ProCurve 2620 Switches	Not applicable

To summarize, the NNMi management server, `global1`, monitors the corporate headquarters. Two NNMi management servers, `regional1` and `regional2`, monitor each of the regional sites. It is essential to be able to view from corporate headquarters the incidents and device information for the HP ProCurve 2620 Switches located at regional sites 1 and 2. Suppose that, for this example, `regional1` and `regional2` both manage several common switches located at regional site 1.

(1) Regional manager and global manager connections

When you configure global network management connections, consider the following information:

- NNMi enables you to configure more than one global manager to communicate with a regional manager. For example, if you need a second global manager, `global2`, to communicate with `regional1`, NNMi enables you to configure both `global1` and `global2` to communicate with `regional1`. For details, see the *Release Notes*.
- Global network management works with one connection layer. For example, the examples in this chapter discuss one connection layer, `global1` communicating with `regional1` and `global1` communicating with `regional2`. Do not configure NNMi for multiple connection levels. For example, do not configure `global1` to communicate with `regional1`, then configure `regional1` to communicate with `regional2`. The global network management feature is not designed for this type of three-layer configuration.
- Do not configure two NNMi management servers to communicate both ways with each other. For example, do not configure `global1` to communicate with `regional1`, then configure `regional1` to communicate with `global1`.

15.4.2 Initial preparation

(1) Port availability: Configuring the firewall

For the global network management feature to function properly, verify that certain well-known ports are open for TCP access from `global1` to `regional1` and `regional2`. The NNMi installation script sets http port `20480` and https port `20481` by default, but you can change this value during installation.

> **Note**
>
> In the example discussed in this subsection, `global1` establishes TCP access to `regional1` and `regional2`. Firewalls are usually configured based on the server initiating the connection. After `global1` establishes the connection to `regional1` and `regional2`, traffic flows in both directions.

Edit the following file to see the current values or to make changes to the port configuration:

- Windows: `%NNM_CONF%\nnm\props\nms-local.properties`

- Linux: `$NNM_CONF/nnm/props/nms-local.properties`

The following table shows the well-known ports that need to be accessible.

Table 15-2: Required accessible sockets

Security	Parameter	TCP port
Non-SSL	`nmsas.server.port.web.http`	`20480`
	`nmsas.server.port.hq`	`4457`
SSL	`nmsas.server.port.web.https`	`20481`
	`nmsas.server.port.hq.ssl`	`4459`

(2) Configuring Certificates

If you plan to use the global network management feature with a secure communication protocol between `global1` and the two regional NNMi management servers (`regional1` and `regional2`), you must configure the certificates. During NNMi installation, the NNMi installation script creates a self-signed certificate on the NNMi management server so it can identify itself to other entities. Configure the NNMi management servers you plan to use with the global network management feature with the correct certificates. Complete the steps shown in 10.3.7 Working with Certificates in Global Network Management Environments.

NNMi management servers upgraded to the version 11-50

If you are working with a set of NNMi management servers where some management servers were upgraded to NNMi 11-50 from an older version of NNMi and some management servers have newly installed instances of NNMi 11-50 you must perform some additional configuration tasks before configuring GNM.

Prior to the version 11-50, NNMi used to provide a Java KeyStore (JKS) repository to store certificates. NNMi 11-50 introduces a Public Key Cryptography Standards (PKCS) #12 repository to store certificates. The new PKCS #12 file-based certificate management technique is available for use as soon as you install a new instance of NNMi 11-50 on a system.

However, when you upgrade an older version of NNMi to the version 11-50, the PKCS #12 file-based certificate management does not immediately come into effect and NNMi continues to use the JKS repository for certificate management.

Before configuring GNM in this kind of environment, make sure that all upgraded NNMi management servers are configured to use the PKCS #12 file-based certificate management technique by following the instructions in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

(3) NNMi management server sizing considerations

This example assumes you plan to use existing NNMi management servers in a global network management configuration.

For specific information about the size of server you need for NNMi, see the *Release Notes*.

(4) Synchronizing system clocks

It is important that you synchronize the NNMi management server clocks for `global1`, `regional1`, and `regional2` before you connect these servers in a global network management configuration. All NNMi management servers in your network environment that participate in global network management (global managers and regional

managers) or single sign-on (SSO) must have their internal time clocks synchronized in universal time. Use a time synchronization program, such as the Linux Network Time Protocol Daemon (NTPD) tool or one of the available Windows operating system tools. For details, see *Clock Synchronization Issues (SSO/Global Network Management)* or *Troubleshoot Global Network Management* in NNMi Help and 15.11.2 Clock synchronization.

> **Note**
>
> NNMi opens a warning message at the bottom of the NNMi console if there is a connection problem with a regional manager, such as a server clock synchronization issue.

(5) Using the application failover feature with self-signed certificates in global network management

If you plan to use the global network management feature using self-signed certificates in an application failover configuration, you must complete some additional steps.

(6) Using self-signed certificates in global network management

If you plan to use the global network management feature using self-signed certificates, you must complete some additional steps. For details, see 10.3.7 Working with Certificates in Global Network Management Environments.

(7) Using a Certificate Authority in global network management

If you plan to use the global network management feature using a Certificate Authority, you must complete some additional steps. For details, see 10.3.7 Working with Certificates in Global Network Management Environments.

(8) Listing the critical equipment you want to monitor

Compile a list of the equipment managed by each regional manager and monitored from the global manager. For example, compile a list of the equipment managed by `regional1` and `regional2` that you want to monitor from `global1`. You use this information in a forwarding filter. For details, see 15.5 Configuring forwarding filters on the regional managers.

Carefully consider the possible outcomes of limiting the information forwarded to `global1` from `regional1` and `regional2`. Below are some points to consider during your planning:

- Be careful not to exclude too many devices, as `global1` needs a complete topology from `regional1` and `regional2` to do a complete analysis to generate accurate incidents.
- Excluding non-critical devices helps reduce system performance costs on `global1`.
- Excluding non-critical devices helps improve the solution's overall scalability and reduce the network traffic required by NNMi.

(9) Reviewing the global and regional managers' management domains

Review the global and regional managers' management domains to help determine the information you want to forward from the regional managers to the global manager.

In our example, NNMi management servers `global1`, `regional1`, and `regional2` manage their own sets of nodes. Later in this example, you configure `regional1` and `regional2` to forward to `global1` information about equipment they manage.

Use the procedure below to understand the equipment that `global1`, `regional1`, and `regional2` currently monitor. This will assist you in selecting the critical equipment you want `regional1` and `regional2` to forward to `global1`.

For this example, complete the following steps to review this information:

1. Point your browser to `global1`'s NNMi console.
2. Sign in.
3. Click **Inventory** workspace.
4. From here you can review the discovered inventory `global1` currently monitors.
5. Point your browser to `regional1`'s NNMi console.
6. Sign in.
7. Click **Inventory** workspace.
8. Review the nodes that `regional1` monitors and compile a list of the devices you want to monitor from `global1`.
9. Point your browser to `regional2`'s NNMi console.
10. Sign in.
11. Click **Inventory** workspace.
12. Review the nodes that `regional2` monitors and compile a list of the devices you want to monitor from `global1`.

(10) Reviewing NNMi Help topics

To review all the Help topics related to global network management, complete the following steps:

1. From NNMi Help, click **Search**.
2. In the **Search** field, type `Global Network Management`.
3. Click **Search**.

This search will result in more than 50 topics related to global network management.

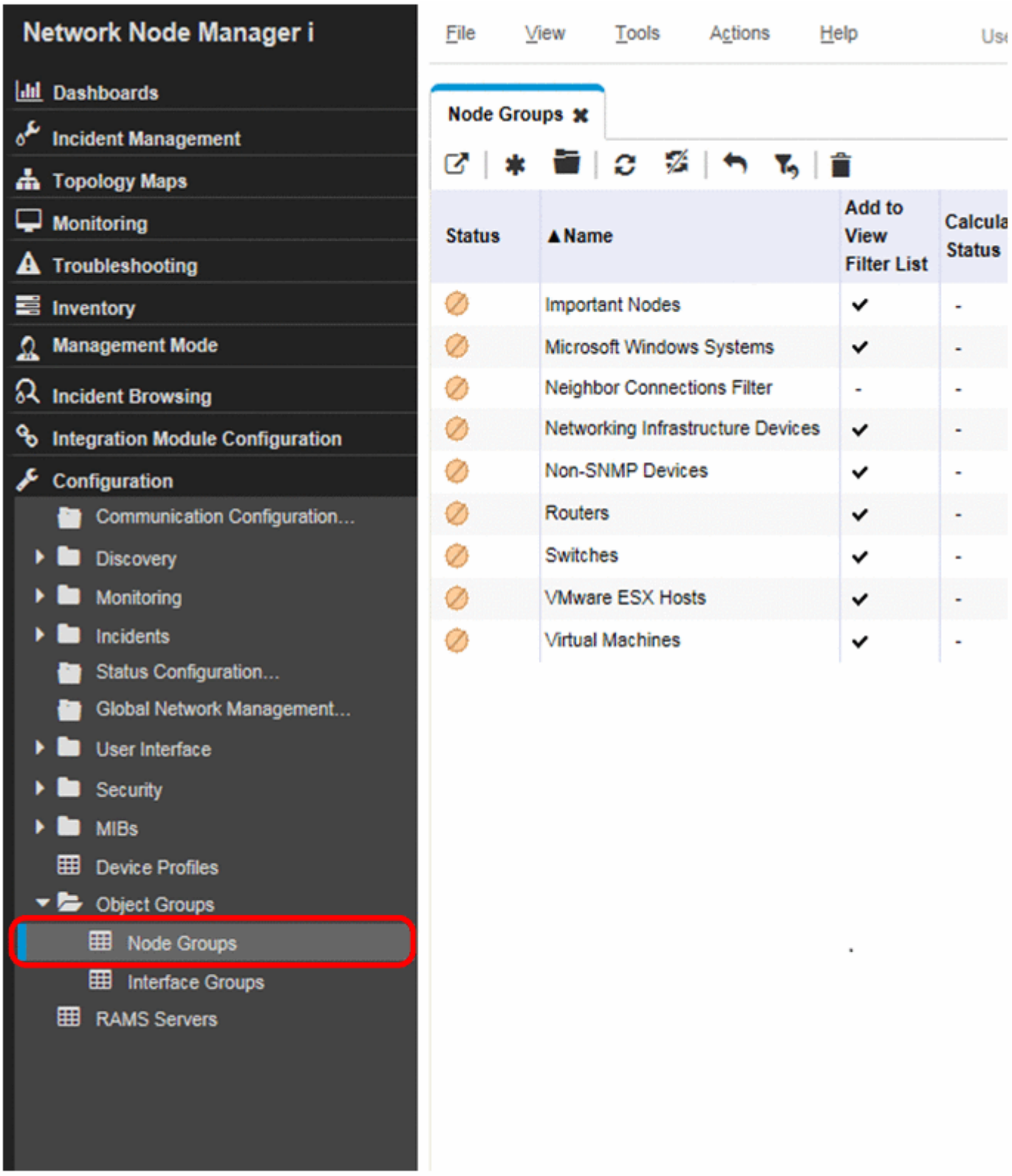
15.5 Configuring forwarding filters on the regional managers

In this example, `global1` communicates with both `regional1` and `regional2`. To control the node object data you want global manager `global1` to receive from regional managers `regional1` and `regional2`, configure forwarding filters on `regional1` and `regional2`.

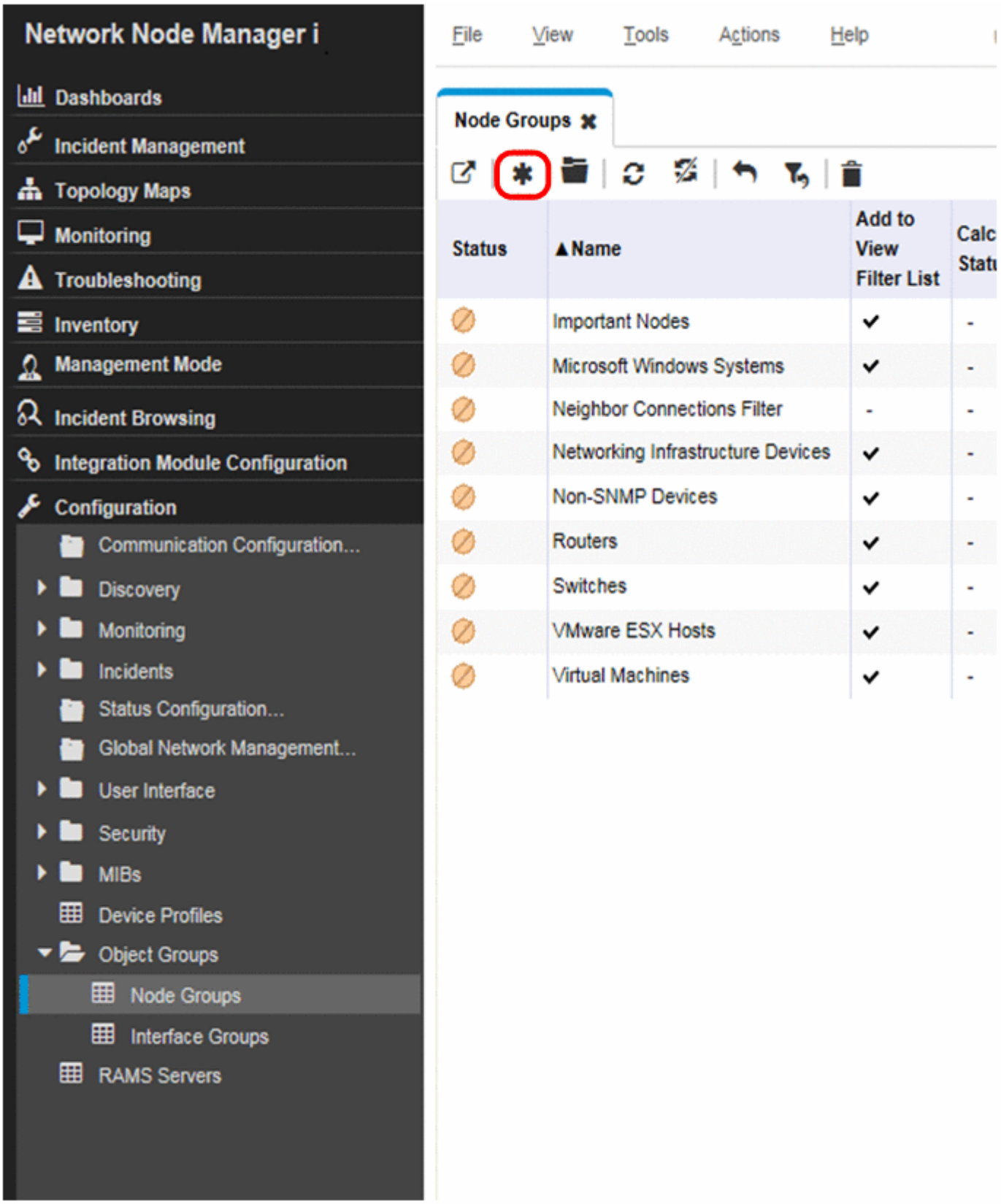
15.5.1 Configuring a forwarding filter to limit forwarded nodes

The example creates a node group to enable `regional1` to forward to `global1` only node information for HP ProCurve 2620 Switches. To create a new node group and set this limitation, complete the following steps:

1. From **Configuration** > **Object Groups** for `regional1` on the NNMi console, click **Node Groups**.


Network Node Manager i
Dashboards
Incident Management
Topology Maps
Monitoring
Troubleshooting
Inventory
Management Mode
Incident Browsing
Integration Module Configuration
Configuration
Communication Configuration...
Discovery
Monitoring
Incidents
Status Configuration...
Global Network Management...
User Interface
Security
MIBs
Device Profiles
Object Groups
Node Groups
Interface Groups
RAMS Servers
File
View
Tools
Actions
Help
Node Groups
Status
Name
Add to View Filter List
Calcula Status
Important Nodes
Microsoft Windows Systems
Neighbor Connections Filter
Networking Infrastructure Devices
Non-SNMP Devices
Routers
Switches
VMware ESX Hosts
Virtual Machines

2. Click **New**.



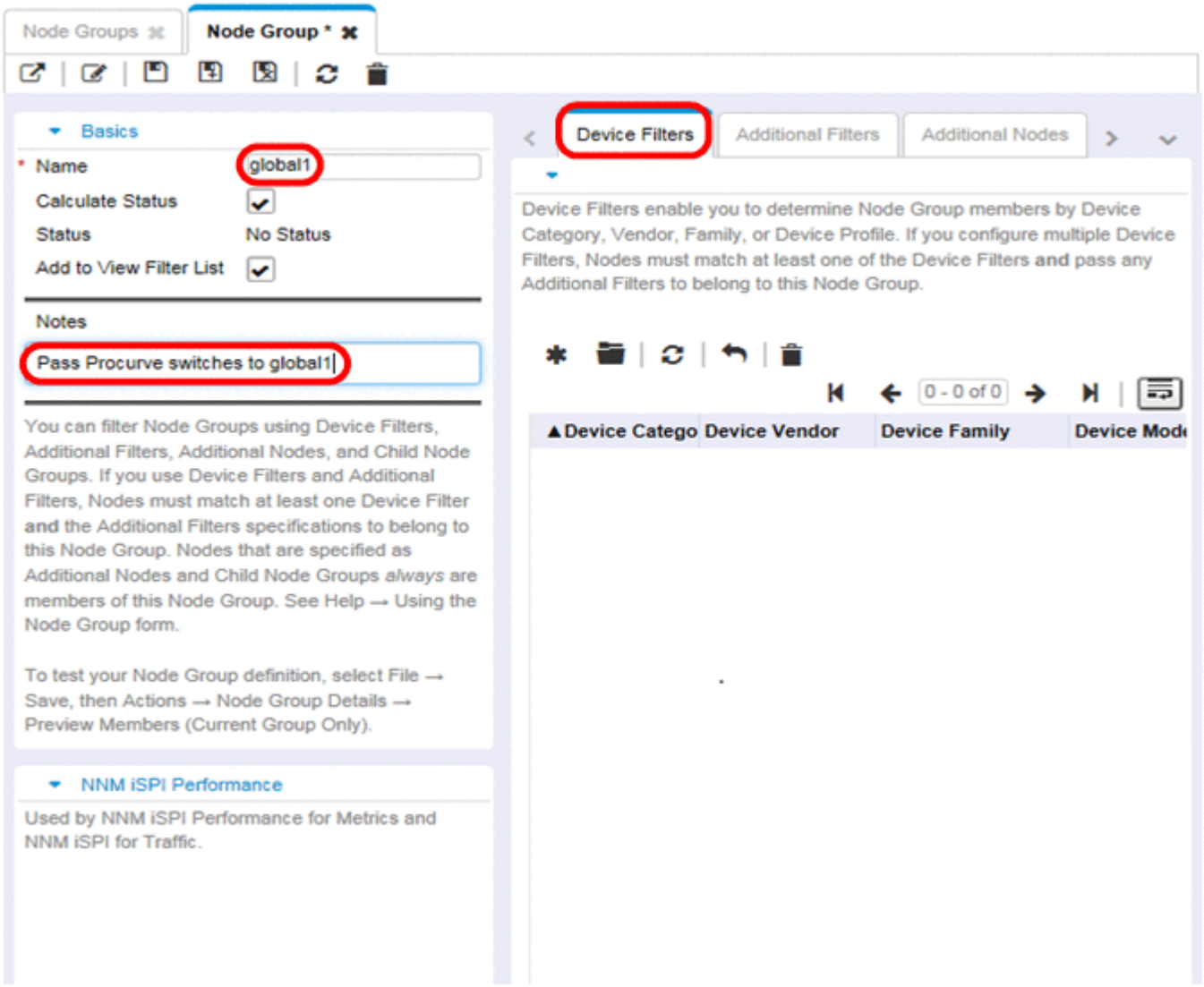
Note

Although this example explains how to create a new node filter, and then use it to create forwarding filters from `regional1` and `regional2`, you can use any existing filter as a model to be modified

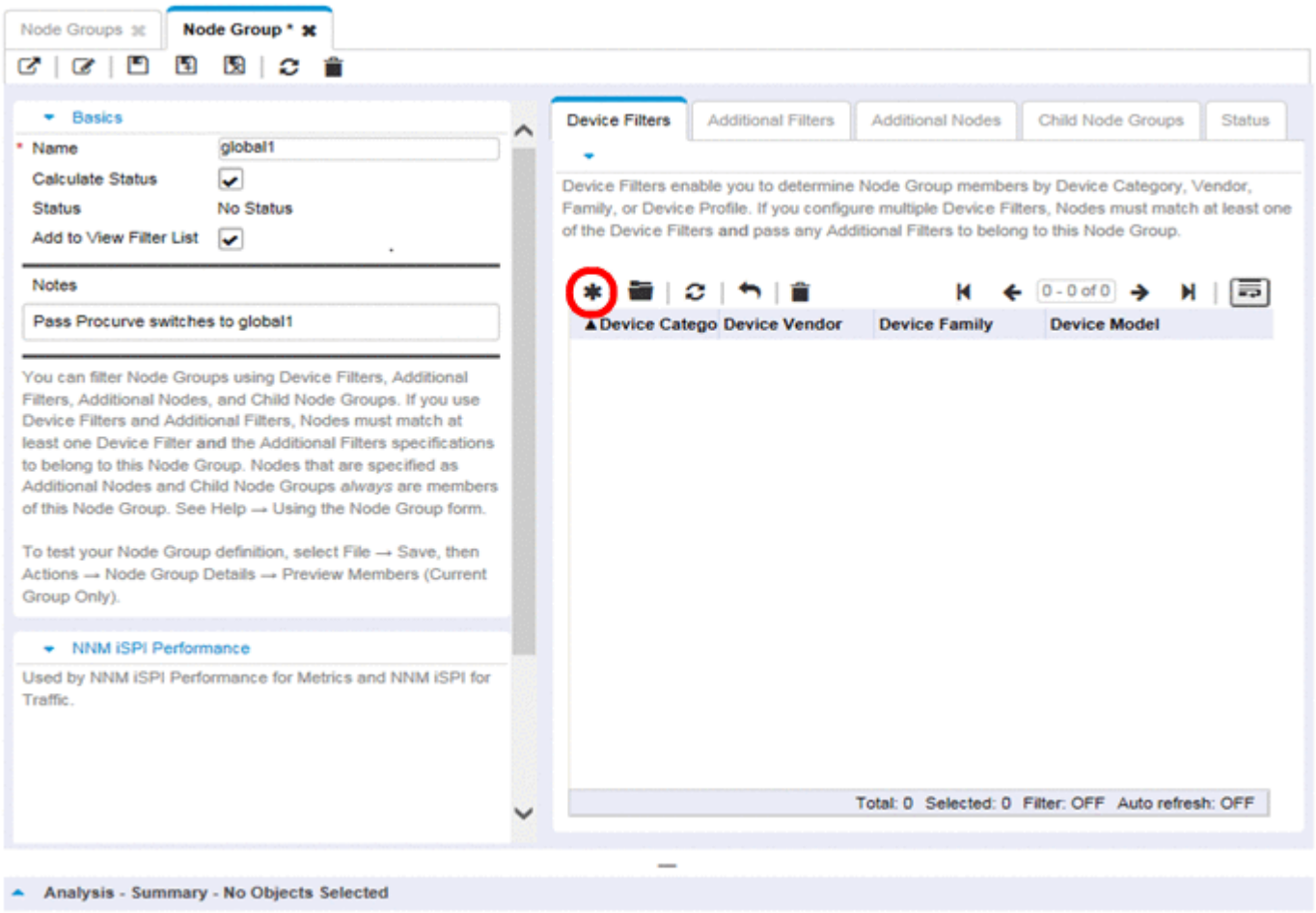
to serve as a forwarding filter from a regional NNMi management servers to the global NNMi management server.

You can create a container node group that contains no devices or filters of its own, then use this node group to specify child node groups. Using this approach, you can forward node object data to global NNMi management servers using one container node group.

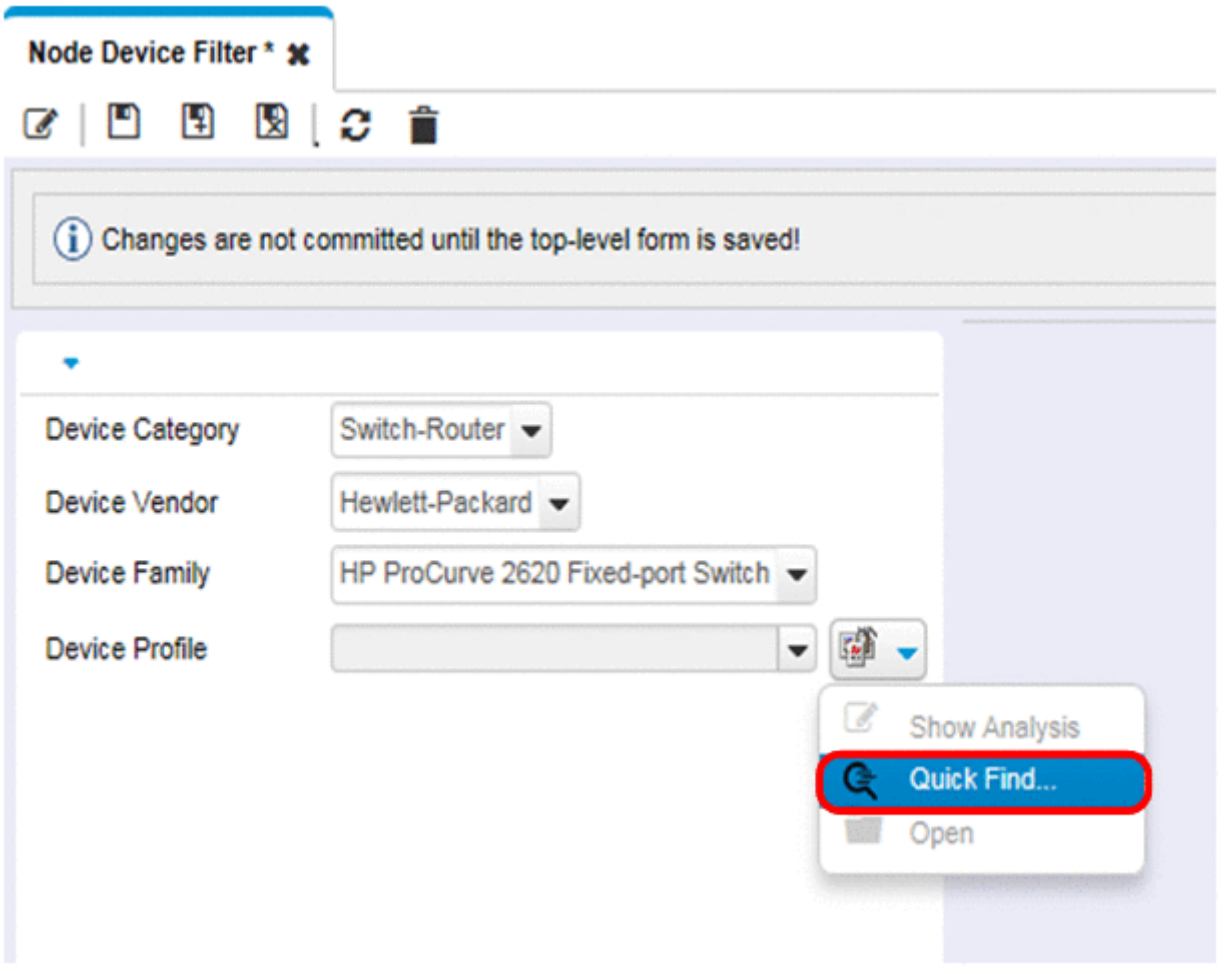
3. Type `global1` in the **Name** field as the filter name and enter in the **Notes** field any notes you need about the filter you are creating.



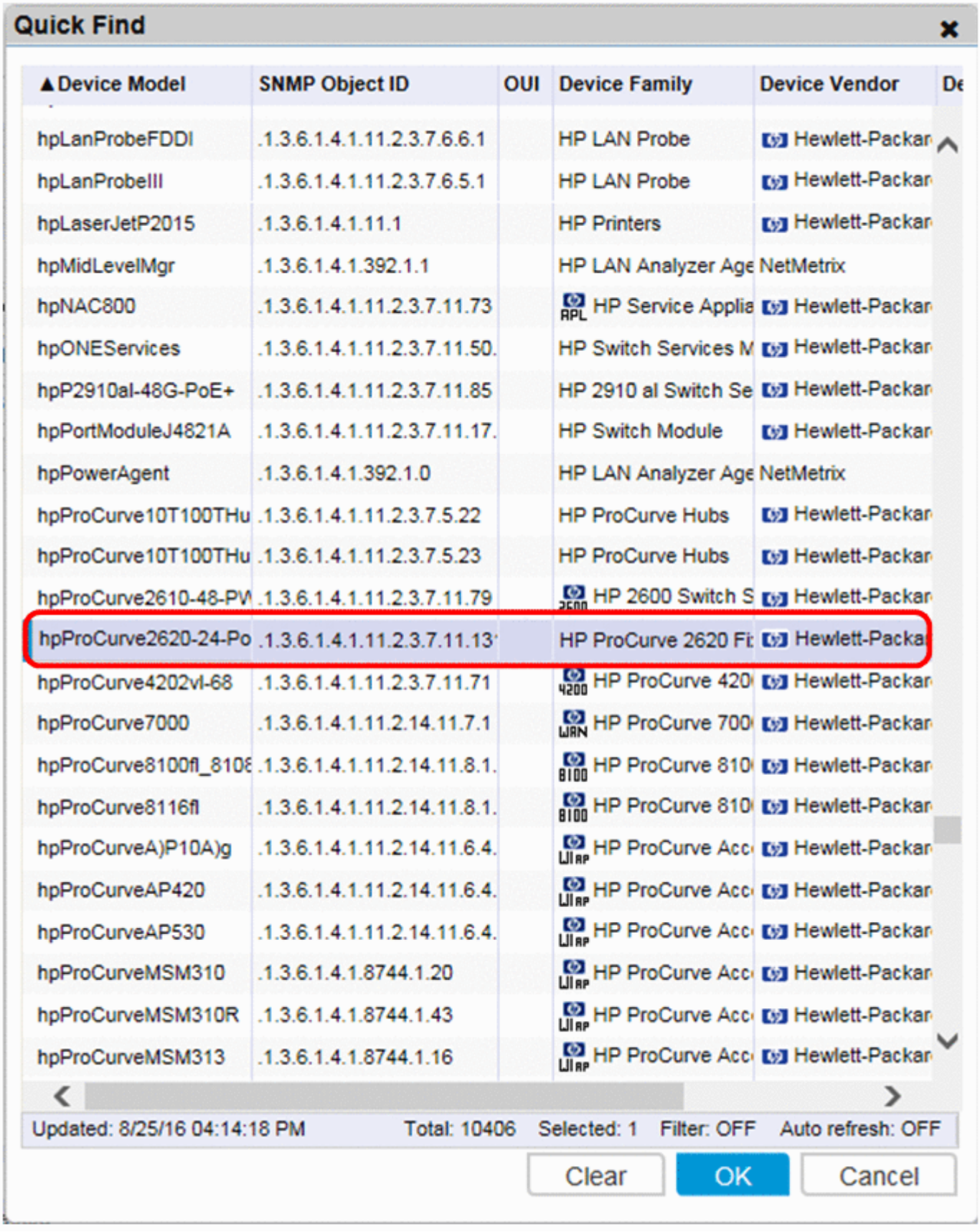
4. Click the **New** icon on the **Device Filters** tab to open a **Node Device Filter** form.



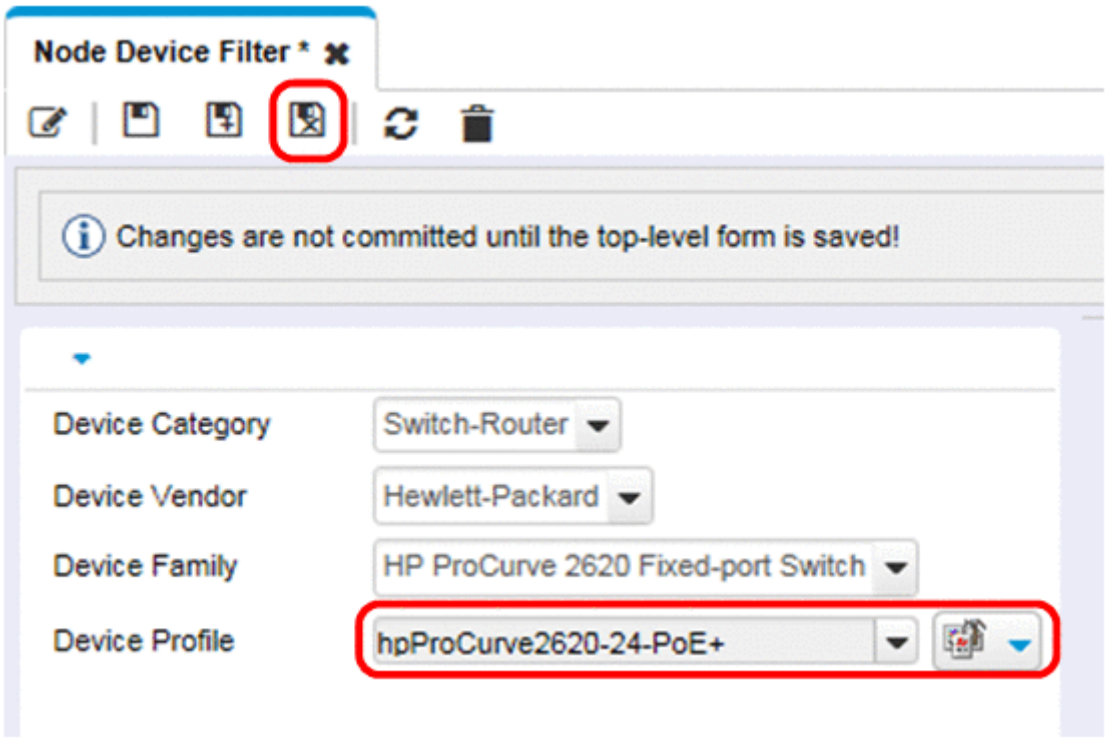
5. Using the pull-down, select **Switch-Router** for **Device Category**, **Hewlett-Packard** for **Device Vendor**, and **HP ProCurve 2620 Fixed-port Switch** for **Device Family**.
6. Using the pull-down, click **Quick Find** to open a **Device Profile** form.



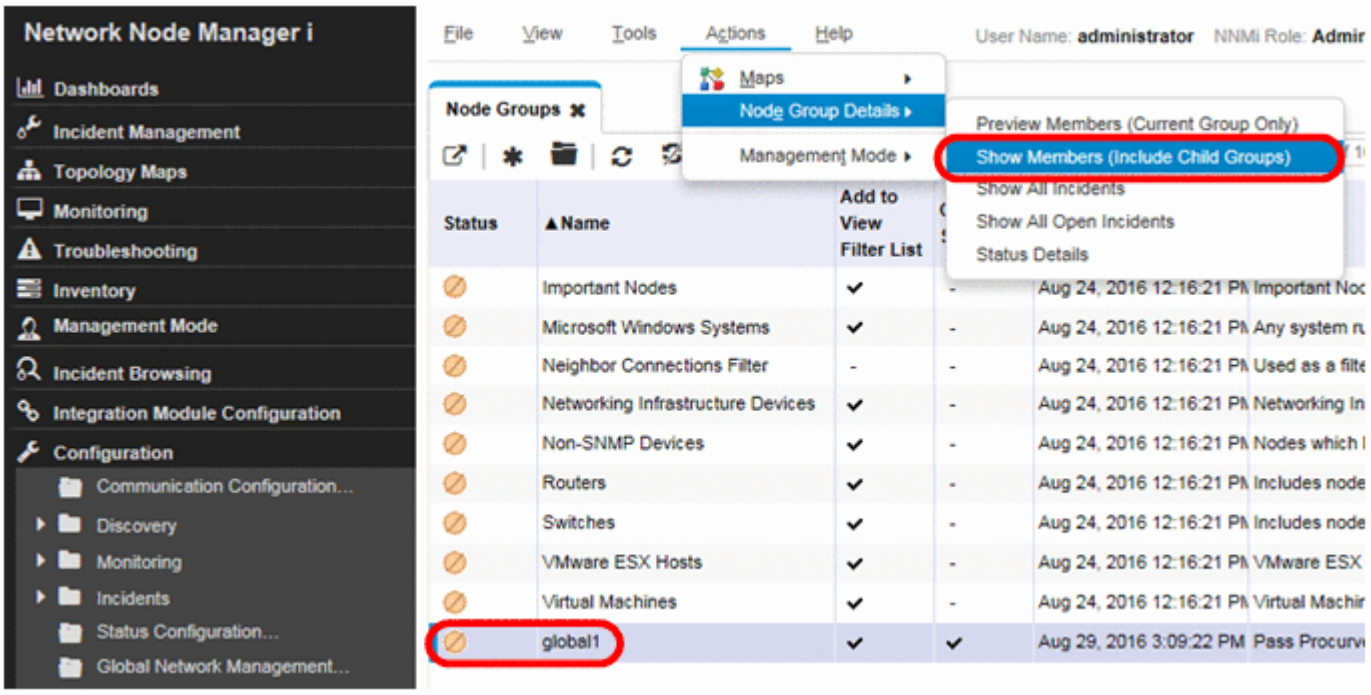
7. Find and select the profile for the HP ProCurve 2620 switch, then click **OK**.



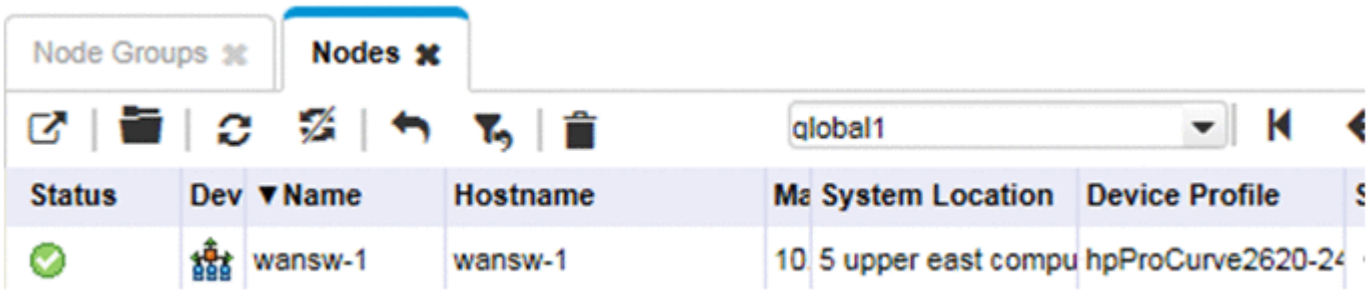
8. Click **Save and Close** for each configuration form.



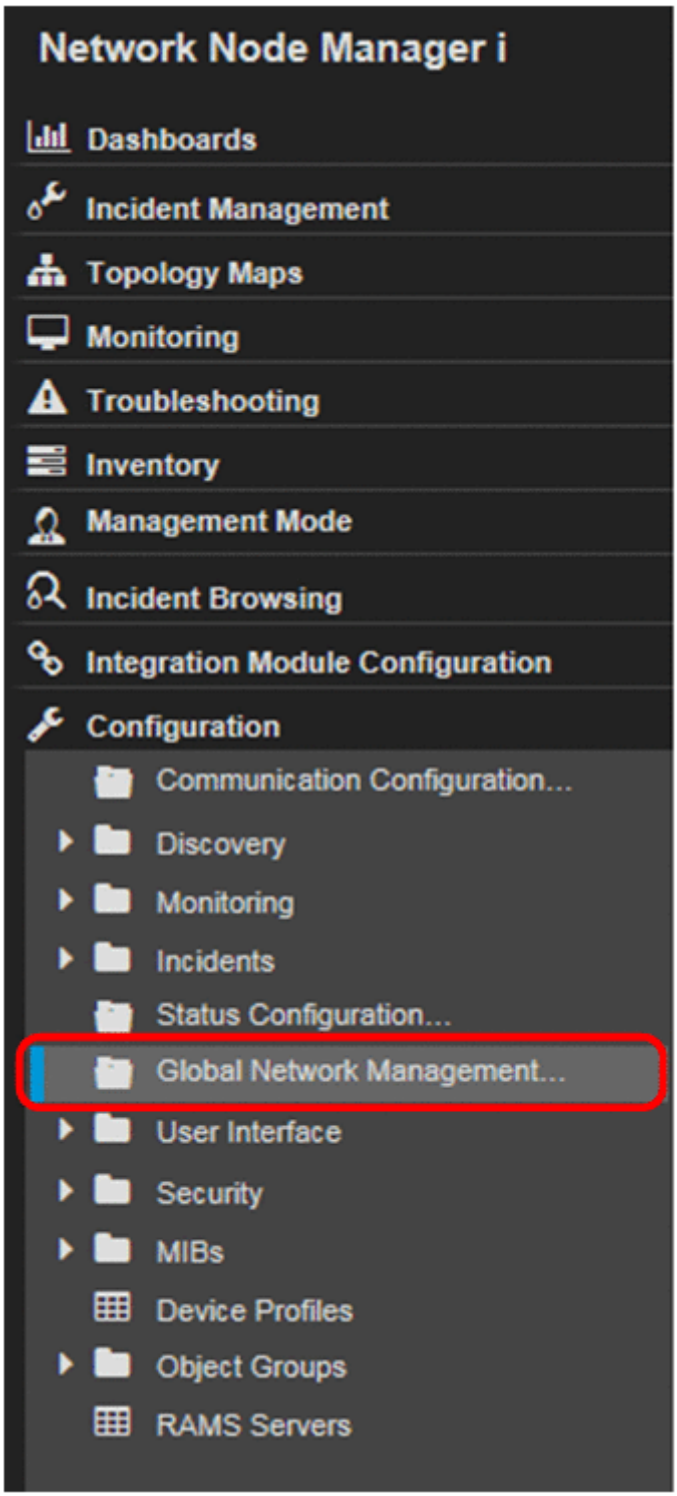
9. To test this filter, select `global1`.
10. From the **Actions** menu, choose **Node Group Details**, and then click **Show Members**.



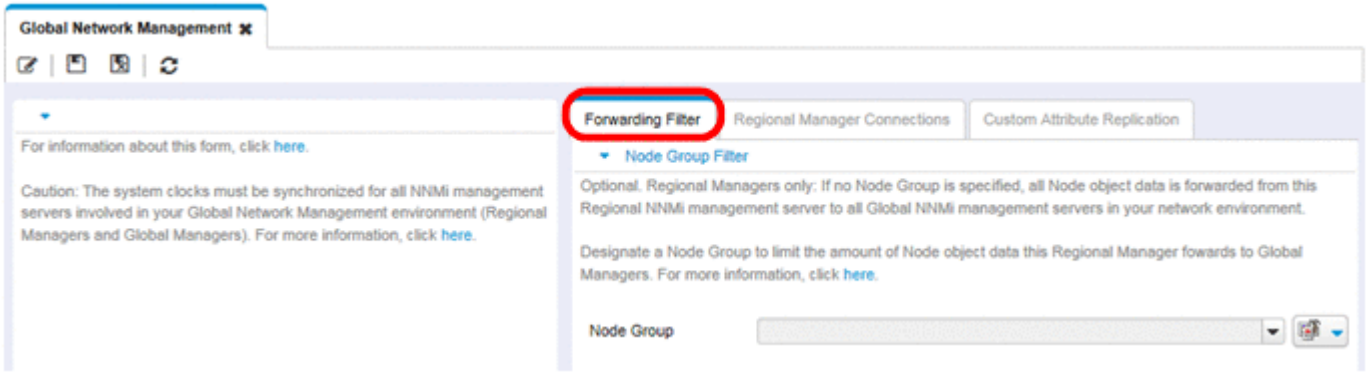
11. Notice that NNMi has already discovered one HP ProCurve 2620 switch. This indicates that the filter you created is finding the switch models you configured it for. The next step is to use this node filter you just created to configure the forwarding filter.



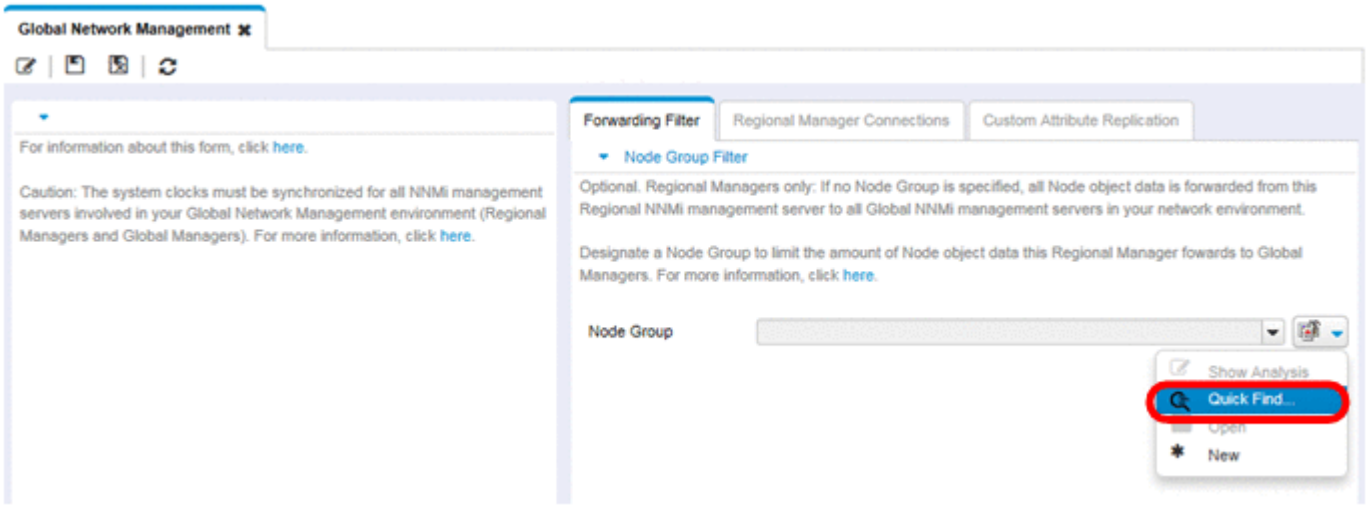
12. From `regional1`'s **Configuration** workspace on the NNMi console, click **Global Network Management**.



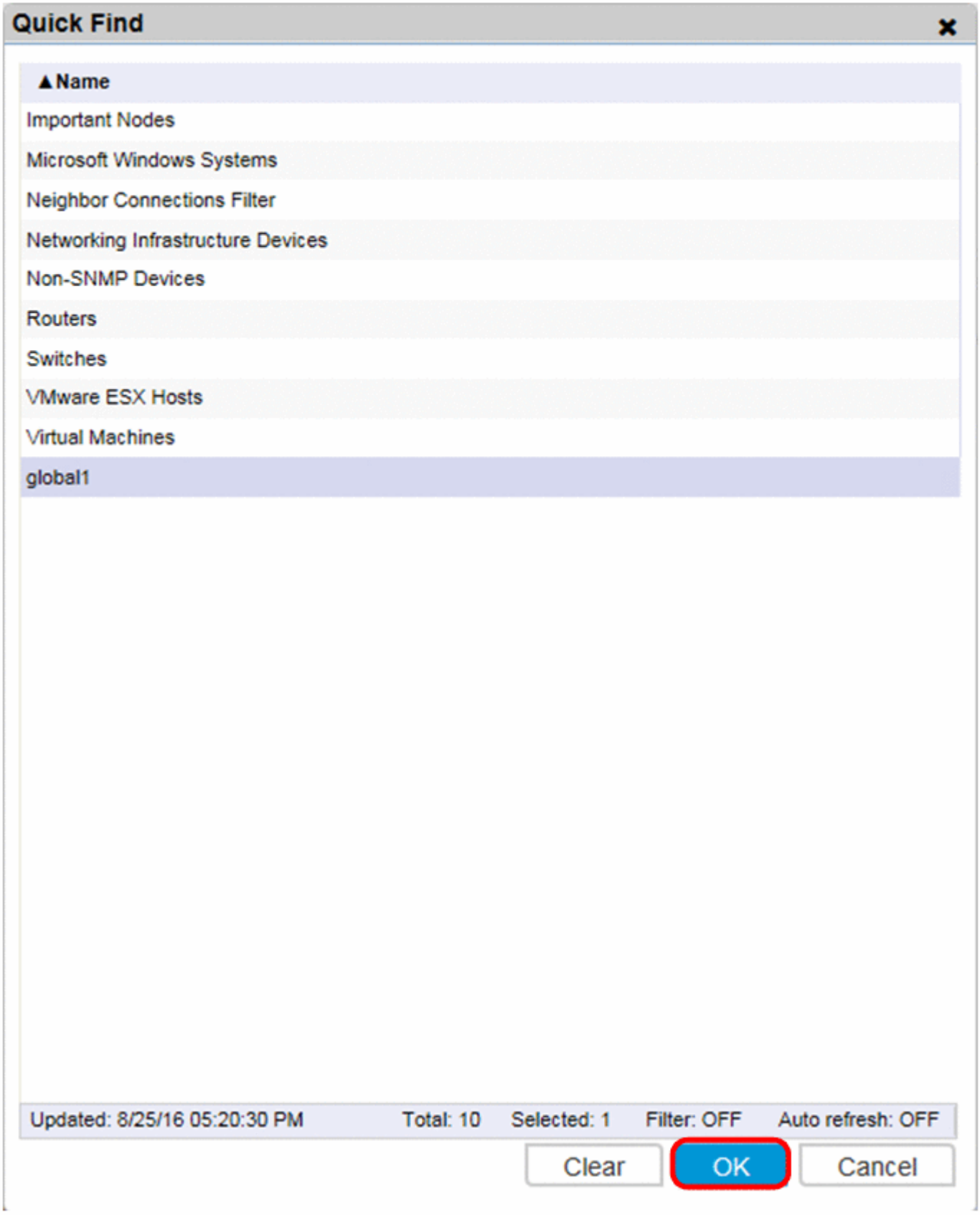
13. Click the **Forwarding Filter** tab.



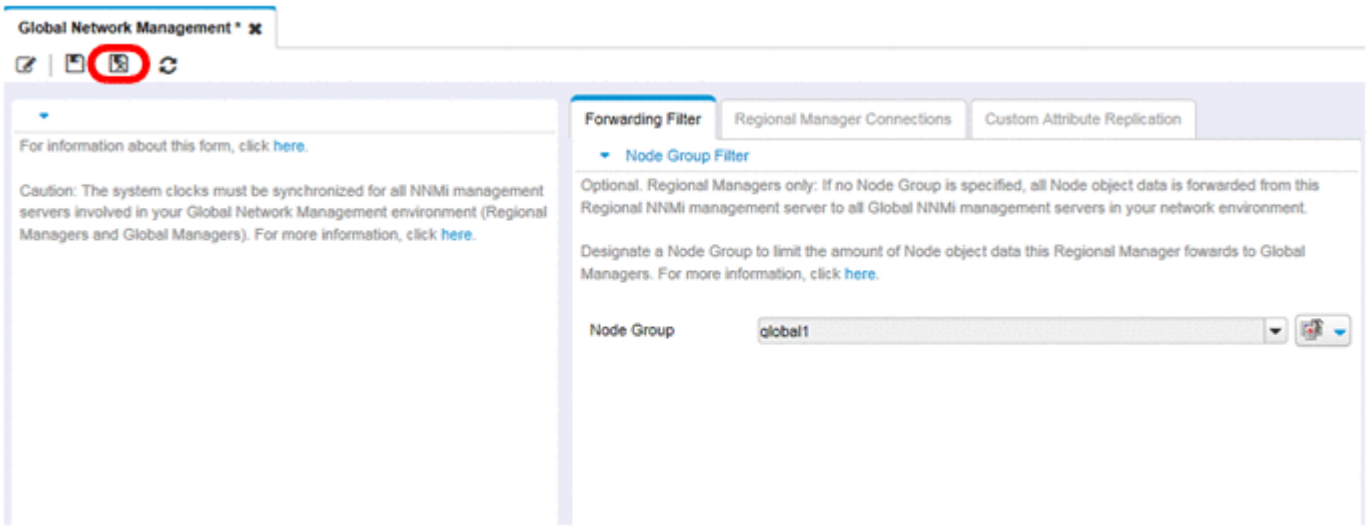
14. Click **Quick Find**.



15. Select the `global1` filter, then click **OK**.



16. Click **Save and Close**.

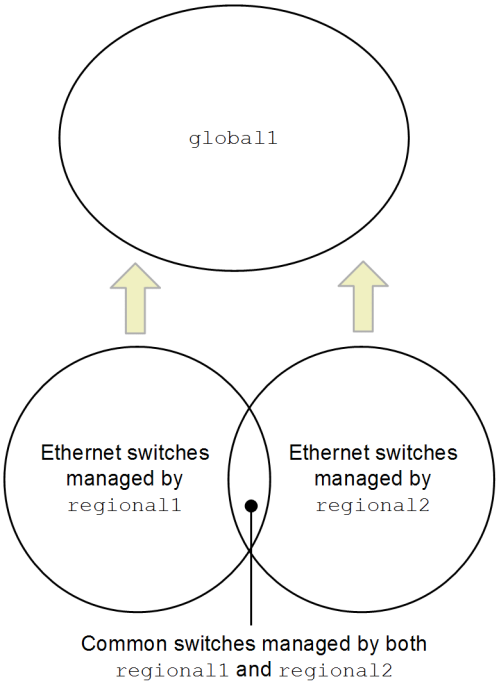


This completes the task of setting up a forwarding filter on `regional1`. Once you complete steps 1 through 16 for `regional2`, you will be ready to connect `global1` to `regional1` and `regional2` as described in 15.6 Connecting a global manager with a regional manager.

15.6 Connecting a global manager with a regional manager

In this example, `regional1` and `regional2` both manage several switches in common.

To forward this common switch information to `global1` from `regional1`, you need to set up the required connection.



To accomplish this, you must connect `global1` to `regional1` before connecting it to `regional2`. By using this connection sequence, `global1` considers `regional1` to be the NNMi management server monitoring these common switches. `global1` also ignores information about these common switches that it receives from `regional2`.

> **Note**
>
> We recommend that you use this feature on a small scale to better understand how it works, then expand it to meet your network management needs.

To connect `global1` first to `regional1`, then to `regional2`, complete the following steps:

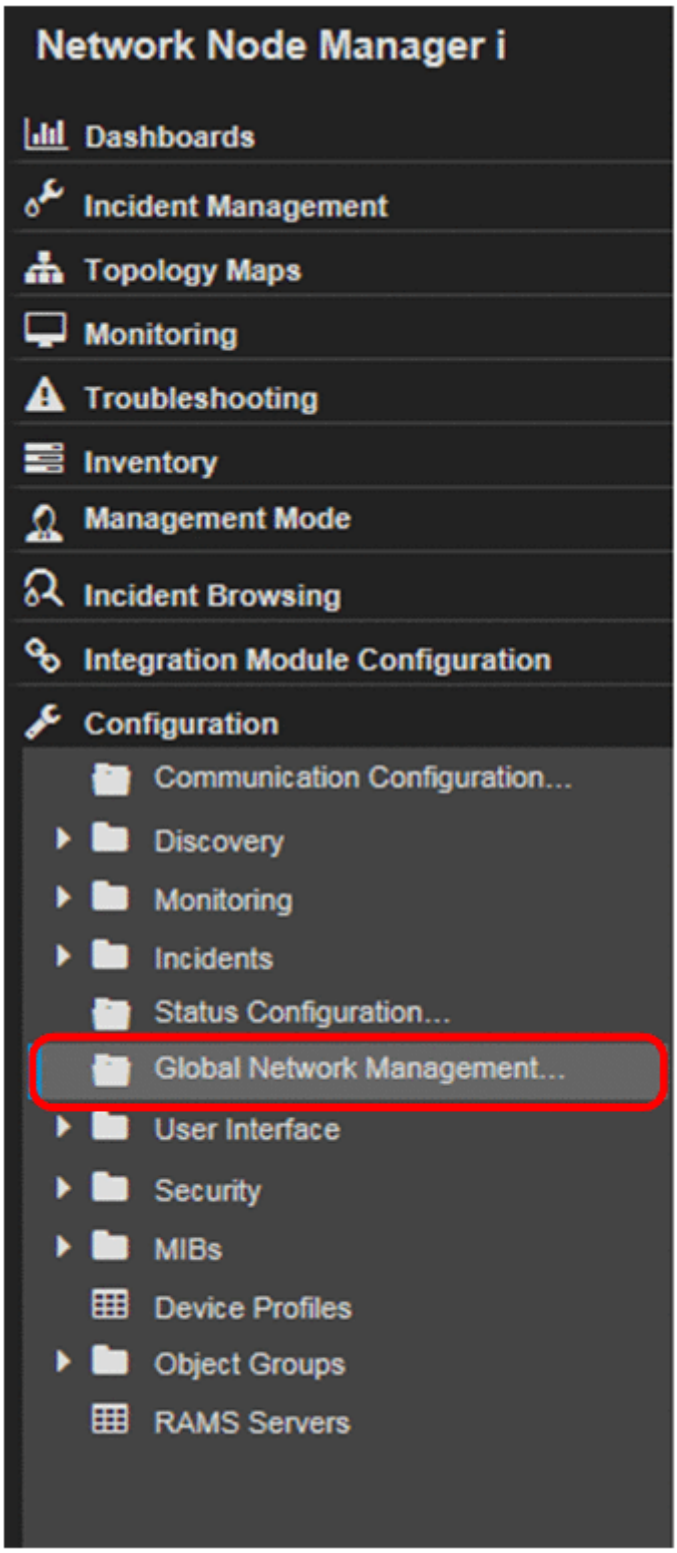
1. First, synchronize the NNMi management server clocks for `global1`, `regional1`, and `regional2` before you connect these servers in a global network management configuration.

   For details, see *Clock Synchronization Issues (SSO/Global Network Management)* in NNMi Help.

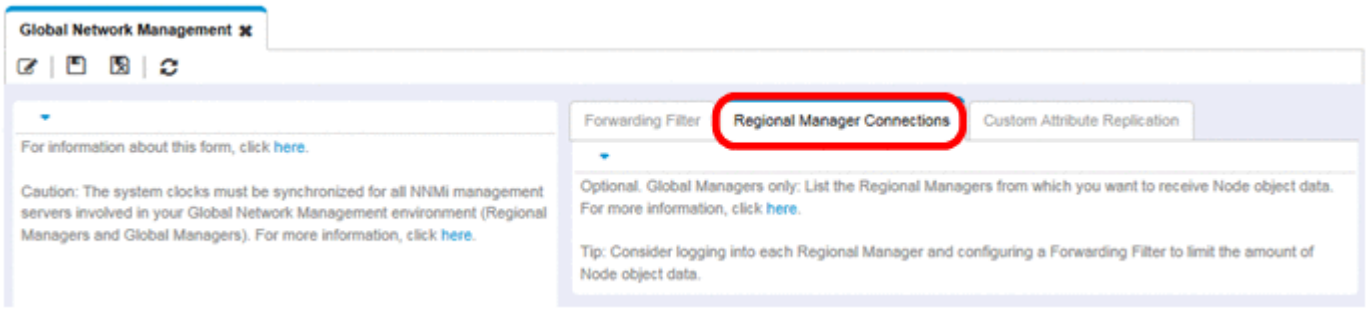
   > **Note**
   >
   > NNMi displays a warning message if there is a connection problem with a regional manager, such as a server clock synchronization issue.

2. Set up a connection from `global1` to `regional1`.

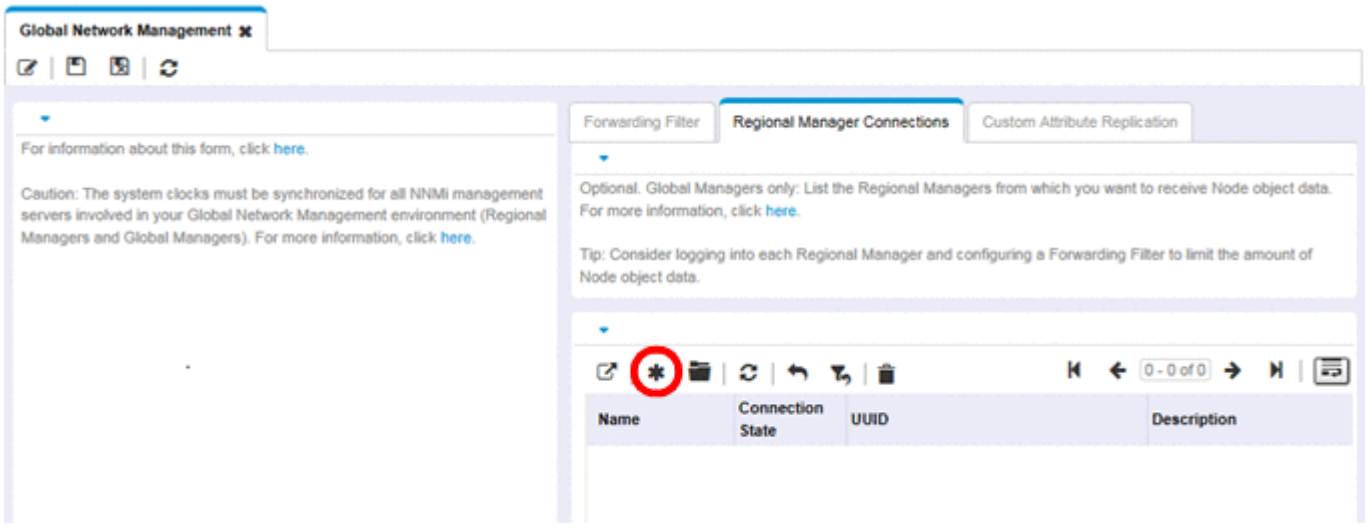
   a. From the `global1` NNMi console, click **Global Network Management** in the **Configuration** workspace.



b. Click **Regional Manager Connections**.



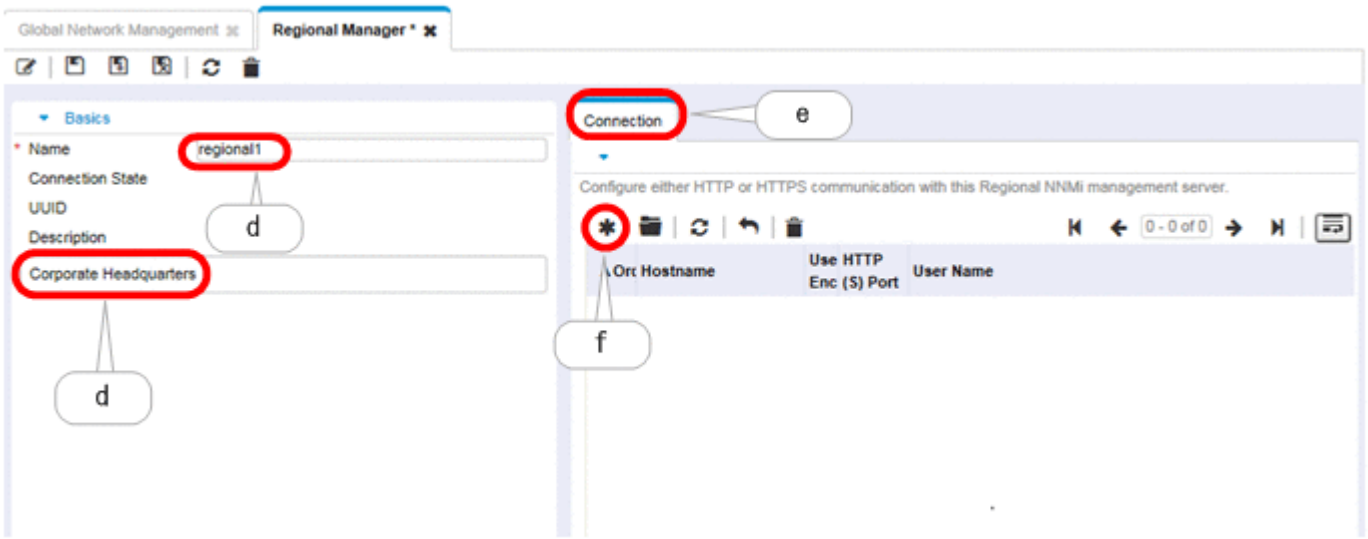
c. Click the * **New** icon to create a new regional manager.



d. Add name and description information for `regional1`.

e. Click the **Connection** tab.

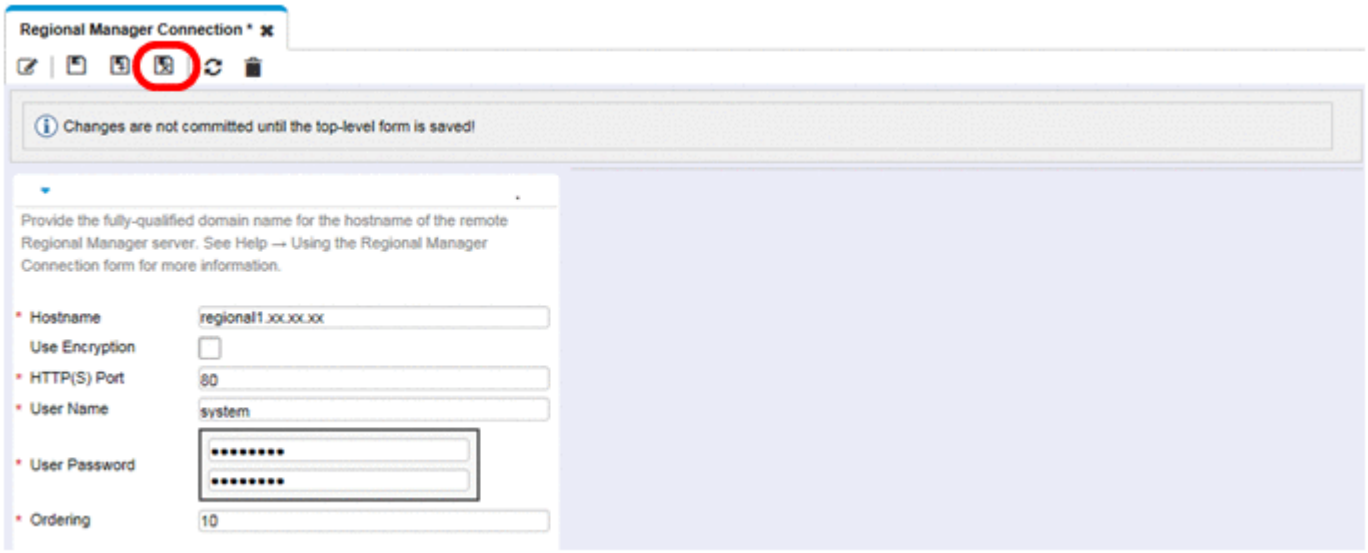
f. Click the * **New** icon.



g. Add the connection information for `regional1`.

> **Note**
>
> For specific information about completing this form, see *Global Manager: Connect to a Regional Manager* in NNMi Help.

h. Click **Save and Close** in each configuration form to save your changes.

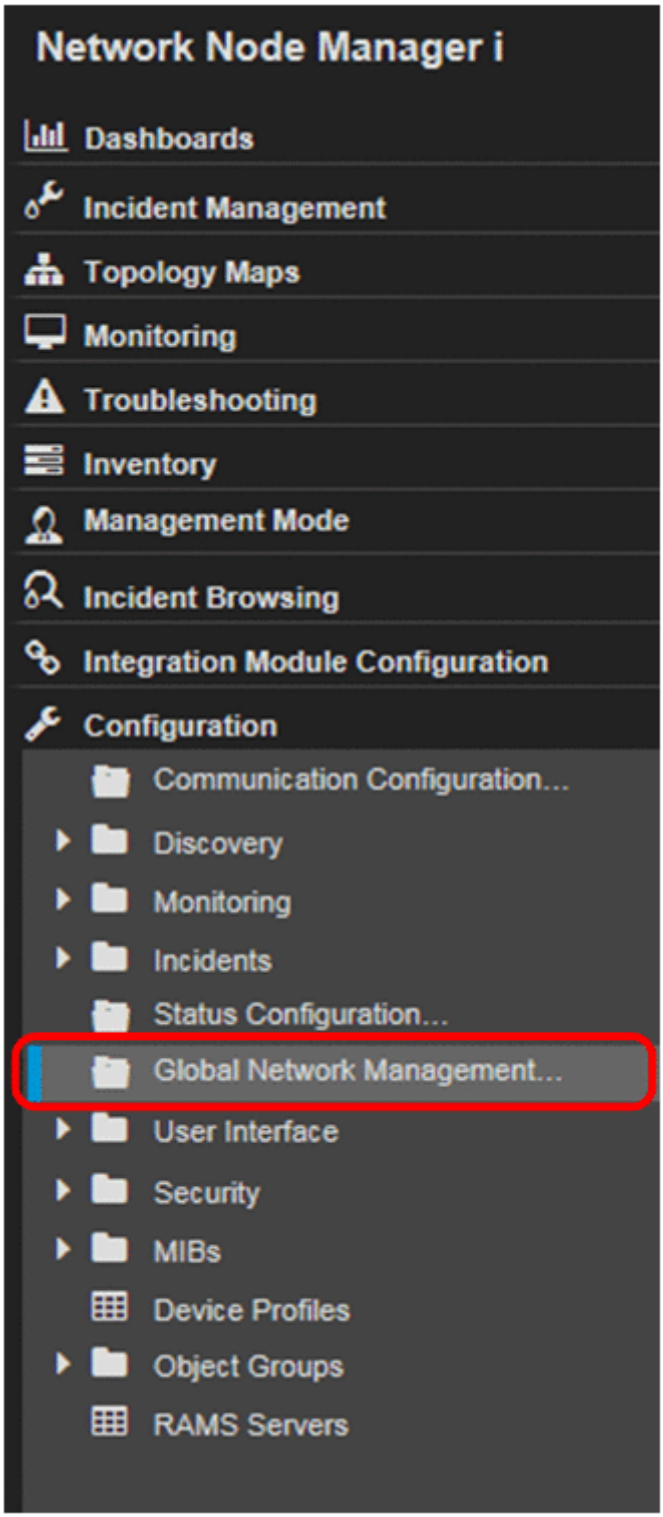


3. Complete steps a through h to establish a connection from `global1` to `regional2`.

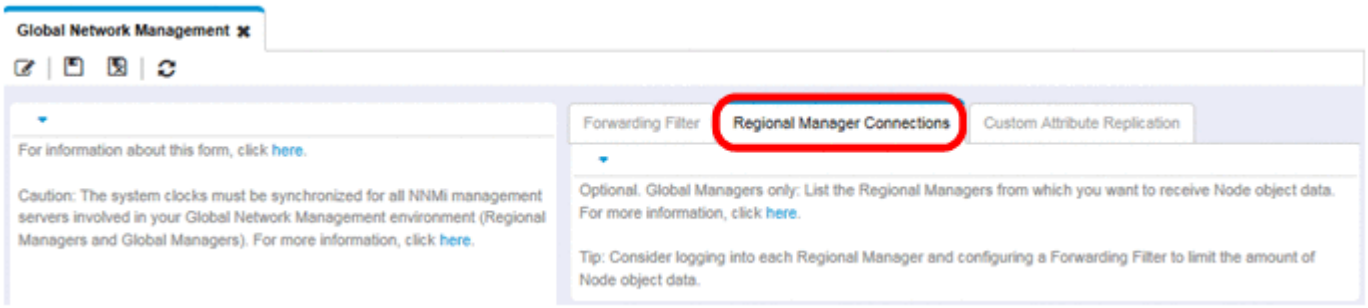
15.7 Determining the connection status from global1 to regional1 and regional2

To check the connection status from `global1` to `regional1` and `regional2`, complete the following steps:

1. From the `global1` NNMi console, click **Global Network Management** in the **Configuration** workspace.



2. Click the **Regional Manager Connections** tab.



3. Check the status of `regional1` and `regional2` by looking at their connection status.

   When their connection statuses are shown as **Connected**, it means they are functioning properly.

   For details, see *Determine the State of the Connection to a Regional Manager* in NNMi Help.

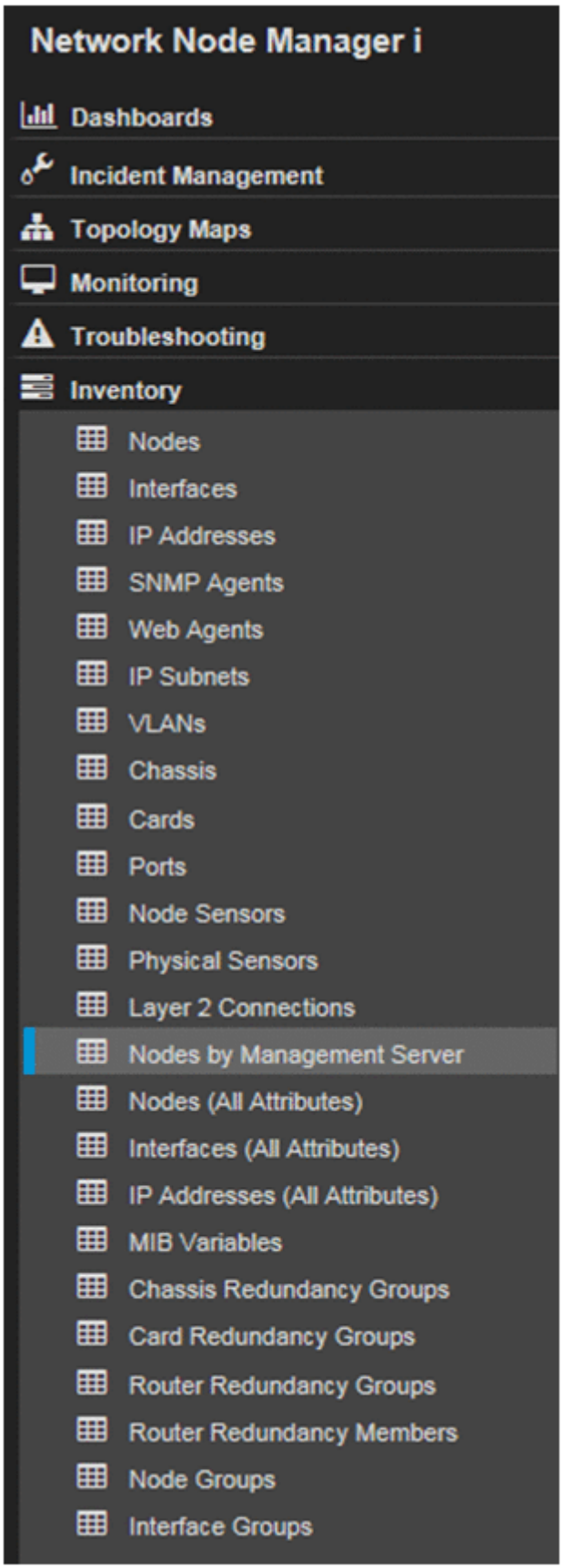
Do not continue to the next section until NNMi completes a good discovery. For details, see 3.3.3 Checking discovery progress.

15.8 Reviewing global1 inventory

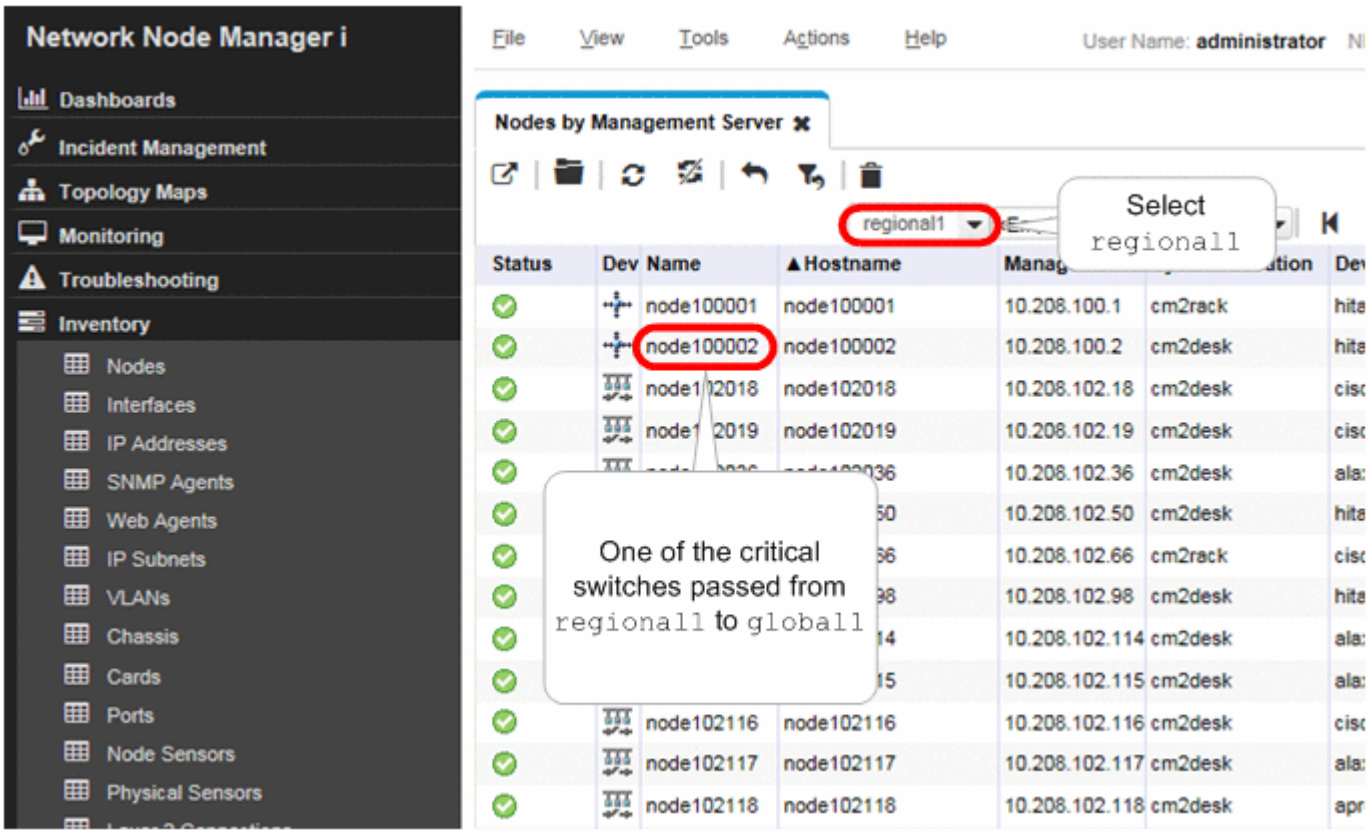
Do not complete this section until NNMi completes a good discovery. For details, see 3.3.3 Checking discovery progress.

To view the node information `regional1` has forwarded to `global1`, complete the following steps:

1. From the `global1` NNMi console, navigate to the **Nodes by Management Server** form located in the **Inventory** workspace.



2. Assume that `regional1` passed information about switch `node102130` to `global1`.
   After selecting `regional1`, the inventory might look as follows:



Repeat steps 1 through 2 to view the device inventory passed to `global1` from each other connected regional manager.

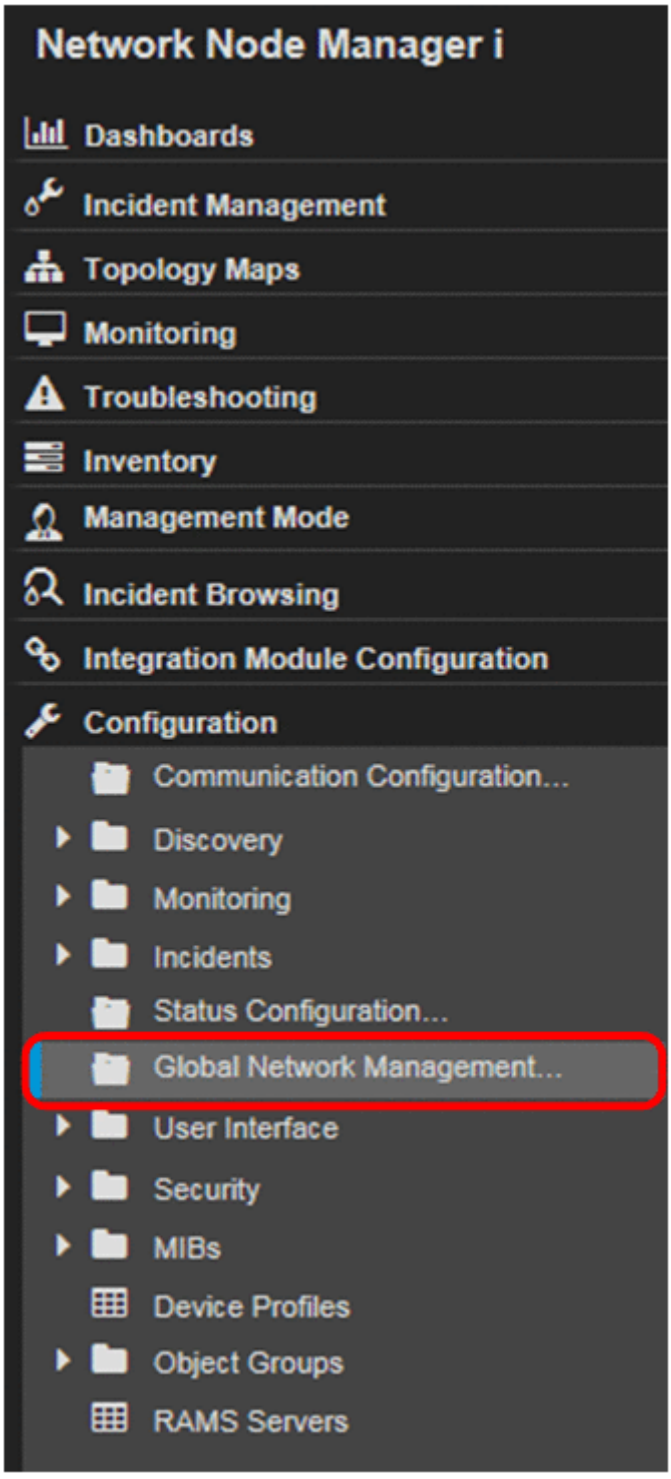
15.9 Disconnecting communication between global1 and regional1

To shut down (either temporarily or permanently) a global manager (for example, `global1`) you must disconnect communication between the global manager and the regional managers.

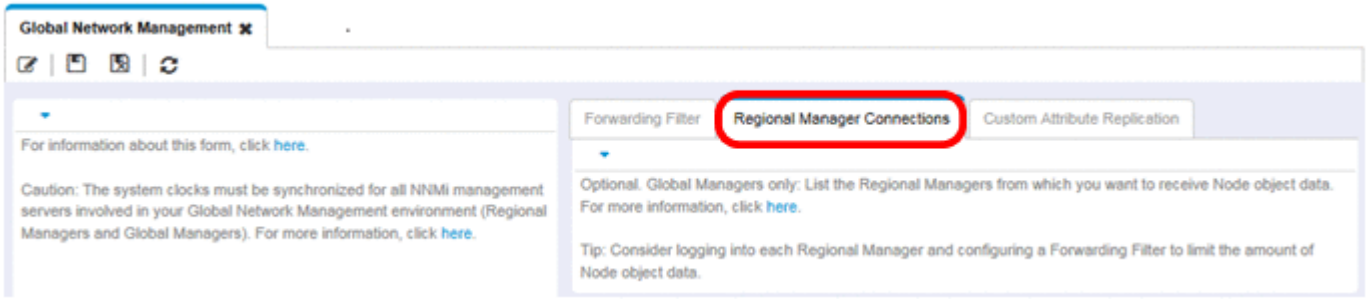
This example assumes that `global1` still has active subscriptions to the `regional1` regional manager.

To disconnect communication between `global1` and `regional1`:

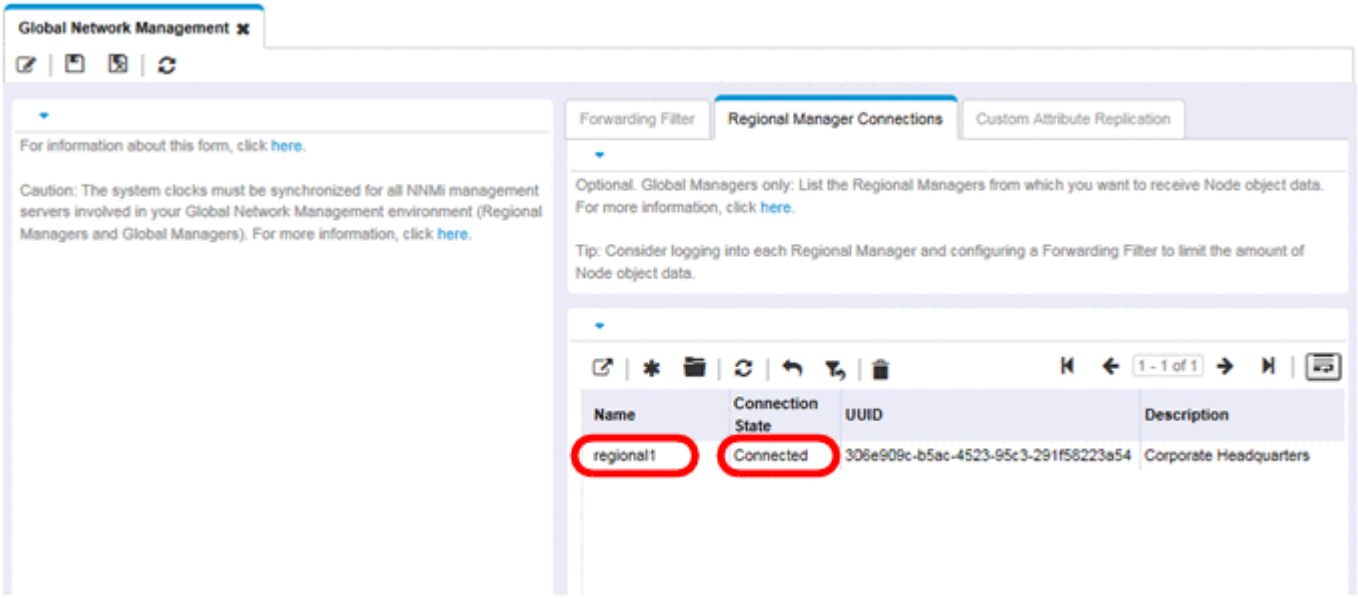
1. From the `global1` NNMi console, click **Global Network Management** in the **Configuration** workspace.



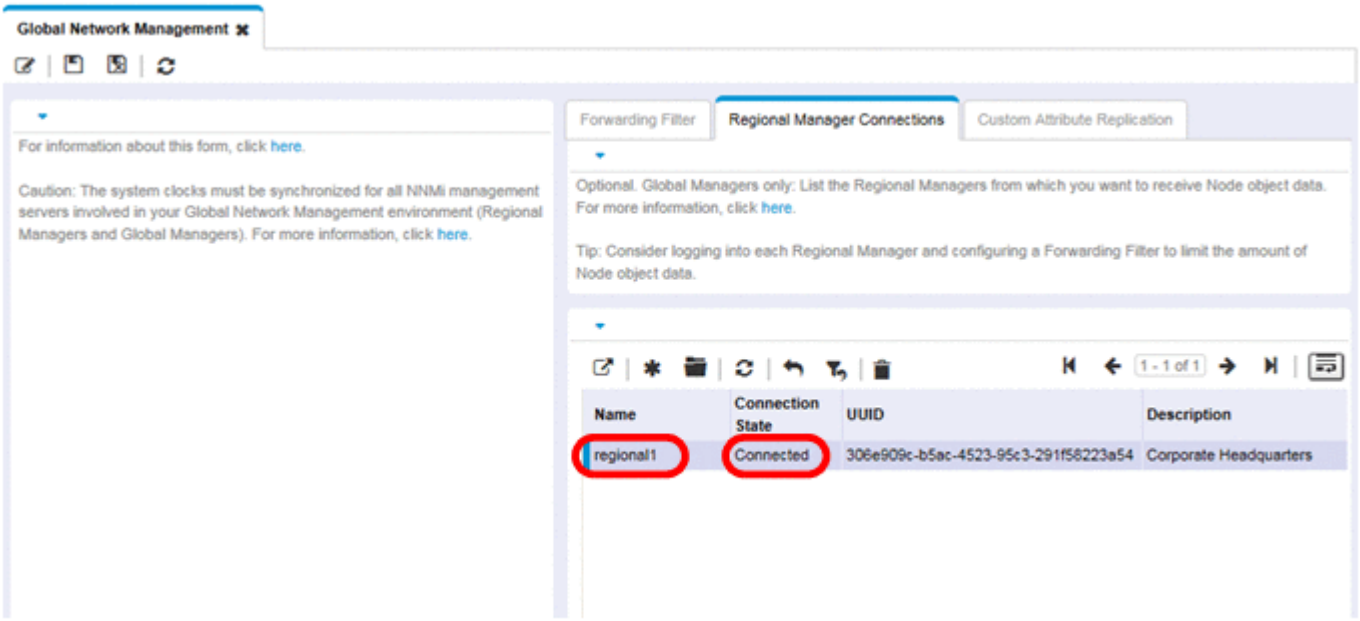
2. Click **Regional Manager Connections**.



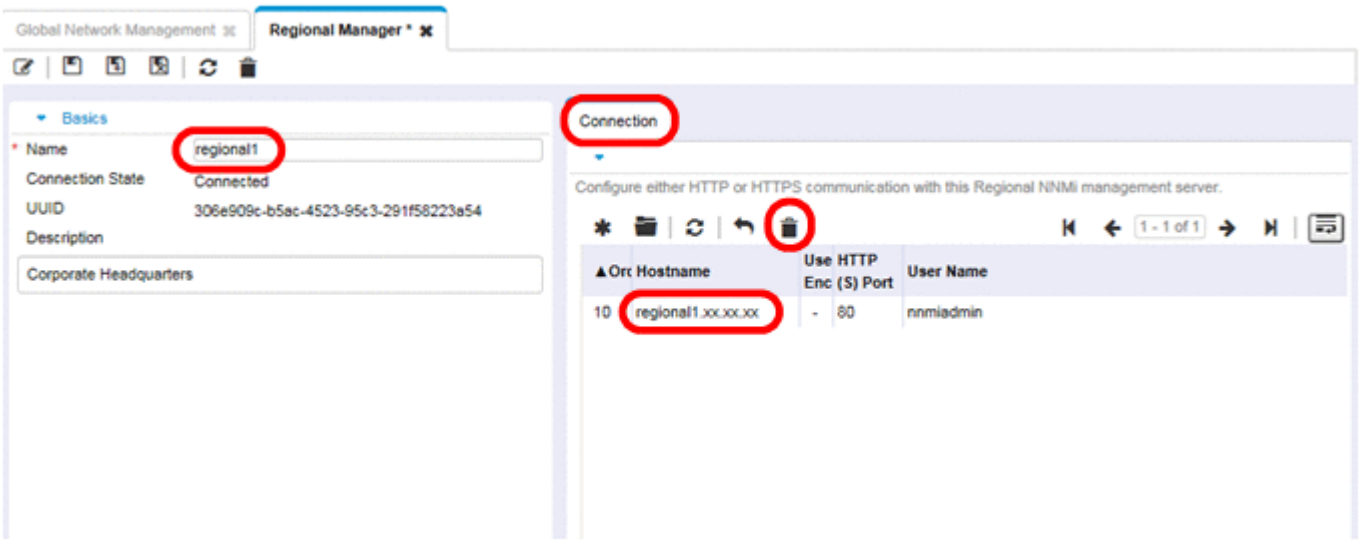
3. Check that the status is **Connected**. If the status is not **Connected**, diagnose the problem using information from the topic *Troubleshoot Global Network Management* in NNMi Help before continuing.



4. Select `regional1`, then click the **Open** icon.



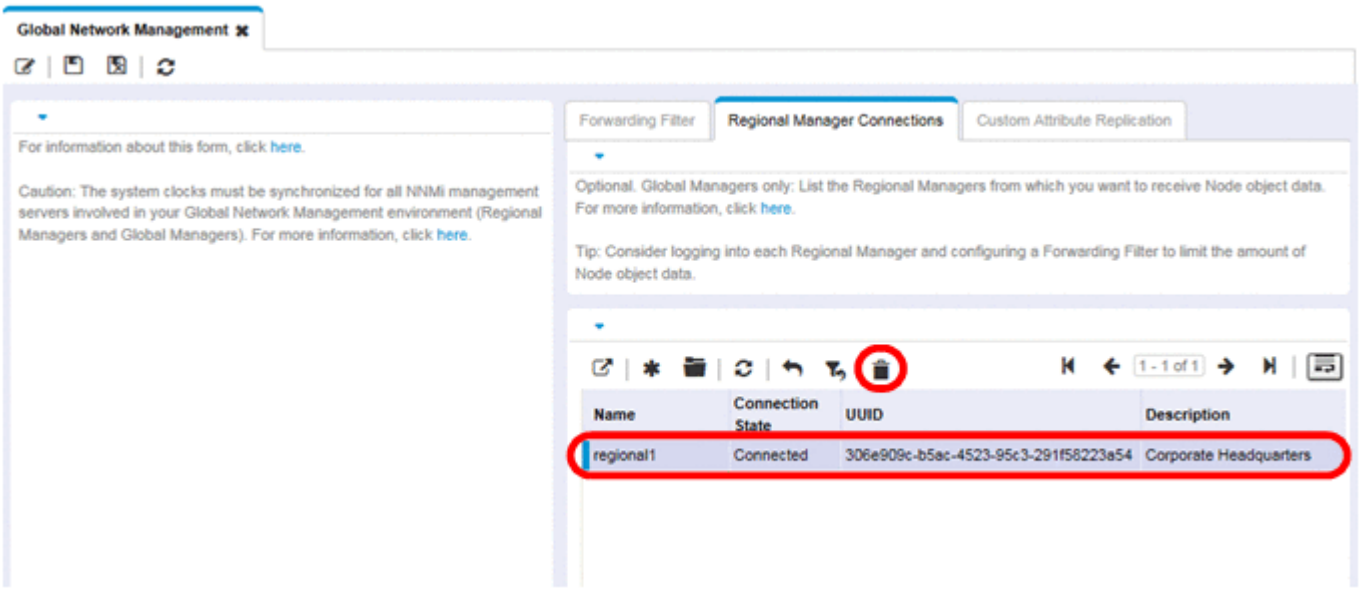
5. Click **Connection**, select `regional1.xx.x.xx`, then click the **Delete** icon.



6. Click **Save and Close**.
7. On the **Regional Manager Connections** tab, note the **Name** attribute value for `regional1` (case-sensitive).
   You will need this **Name** attribute in step 9.
8. Click **Save and Close**.
9. Type the following command on the command line on `global1`:

   ```
   nnmnodedelete.ovpl -rm regional1 -u NNMiadminUserName -p
   NNMiadminPassword
   ```

   For `-rm`, specify the name you noted in step 7.
10. This removes from `global1` the node records that `regional1` forwarded to it.
    The command also closes incidents associated with the nodes forwarded to `global1` from `regional1`. For details, see *Disconnect Communication with a Regional Manager* in NNMi Help.
11. To remove the configuration records for `regional1`, do the following.
    a. Click the **Configuration** workspace.
    b. Select the **Global Network Management** form.
    c. Click **Regional Manager Connections** tab.
    d. Select `regional1`, then click the **Delete** icon.



e. Click **Save and Close** to save your deletions.

15.10 Additional information about global network management

15.10.1 Discovery and data synchronization

As network administrators add, delete, and modify devices on a network, the regional servers, such as `regional1` and `regional2`, discover those changes and update the global server, such as `global1` in the example in this chapter. `regional1` and `regional2` also notify `global1` of changes that administrators make to the management modes of the nodes they manage.

> **Note**
>
> To maintain consistency, as `regional1` and `regional2` discover device state changes, they continuously update `global1`, thereby maintaining identical node states on both the global and regional servers.

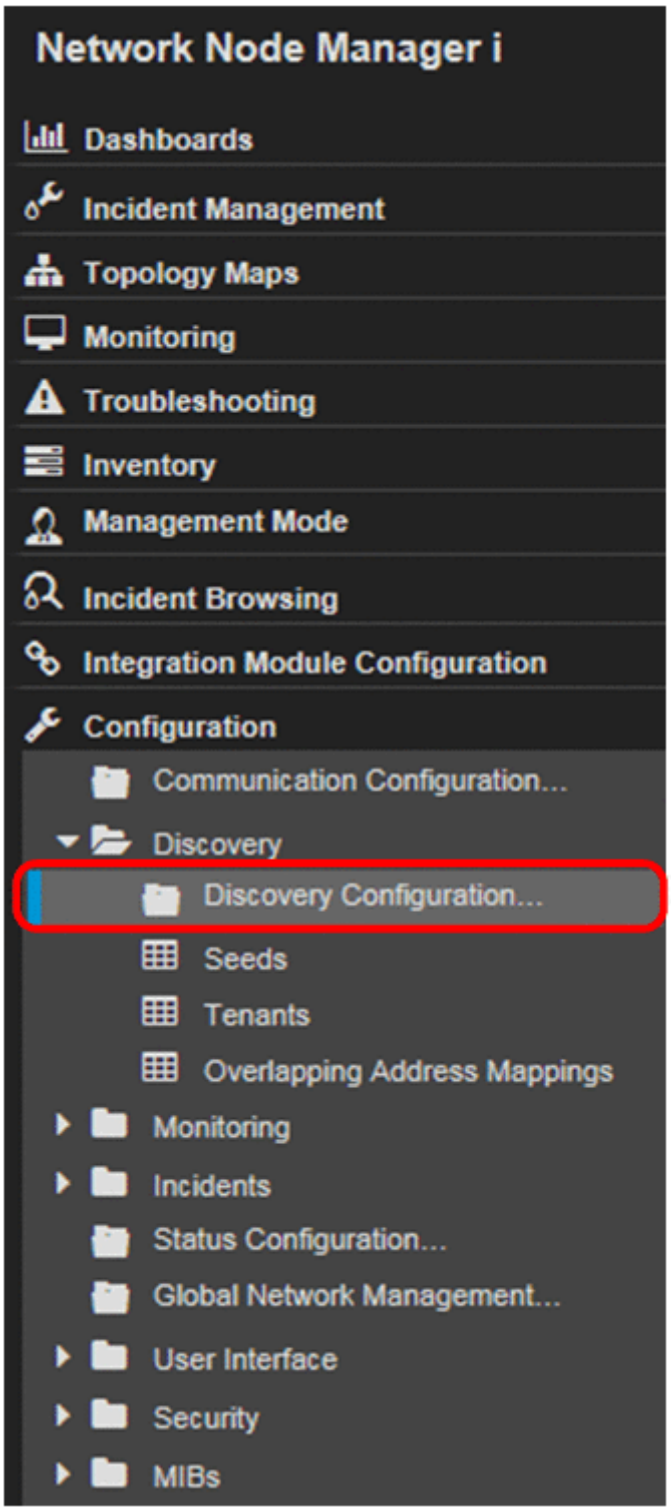
Any time `global1` requests information about a node that is managed by `regional1` or `regional2`, `regional1` or `regional2` responds to `global1` with the requested information. `global1` never talks directly to a node. There will not be duplicate SNMP queries to devices when `global1` performs a discovery.

`global1` synchronizes with `regional1` and `regional2` each time `regional1` or `regional2` completes a discovery. NNMi uses forwarding database (FDB) data to calculate Layer 2 connections. FDB data is very dynamic, and varies a lot between discoveries, especially if there are multiple regionals connected to a global server.

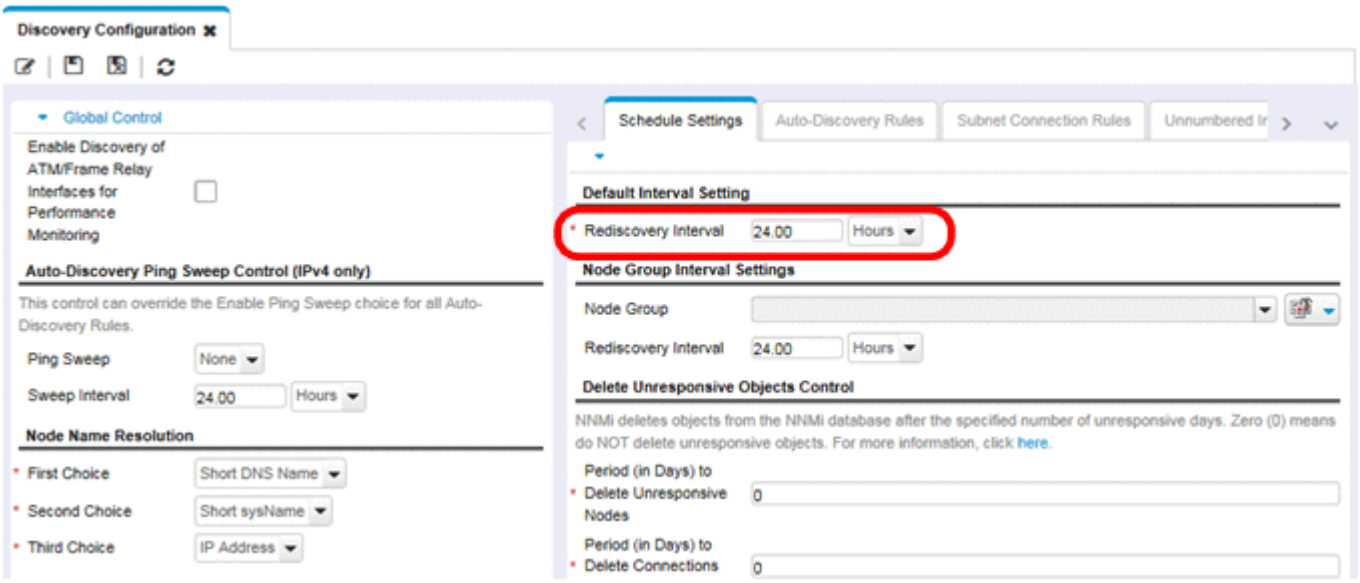
> **Note**
>
> Changes to user-modified or application-modified attributes are not updated on the global server during a synchronization.

The **Rediscovery Interval** is adjustable on each regional server, which means there might be differences in the discovery accuracy between `global1` and the regional managers. The shorter the **Rediscovery Interval**, the more accurate the discovery will be and the more NNMi-generated traffic there will be on the network. The longer the **Rediscovery Interval**, the less accurate the discovery will be and the less NNMi-generated traffic there will be on the network. This means that as your network grows larger, you might want to perform rediscovery less frequently. To set the **Rediscovery Interval**, do the following:

1. From the `regional1` or `regional2` NNMi console, click **Discovery > Discovery Configuration** in the **Configuration** workspace.



2. Adjust the **Rediscovery Interval** to reflect how often you want the regional server to initiate discovery. The global server will initiate discovery immediately after a regional server completes a discovery.



3. Click **Save and Close**.

15.10.2 Replicating custom attributes from a regional manager to the global manager

NNMi enables you to set custom attributes on a regional manager and replicate those custom attributes to the global manager. For example, you can add custom attribute data to nodes on a regional manager and, after replicating that data to the global manager, use that data to enrich incidents for those nodes.

> **Note**
>
> NNMi supports replication of custom attributes from a regional manager to a global manager for nodes and interfaces.

You can configure custom attribute replication on the NNMi console using the global manager's **Custom Attribute Replication** tab (within the **Global Network Management** configuration).

> **Note**
>
> NNMi replicates custom attributes for unnumbered interfaces without any user configuration or input. For details, see NNMi Help.

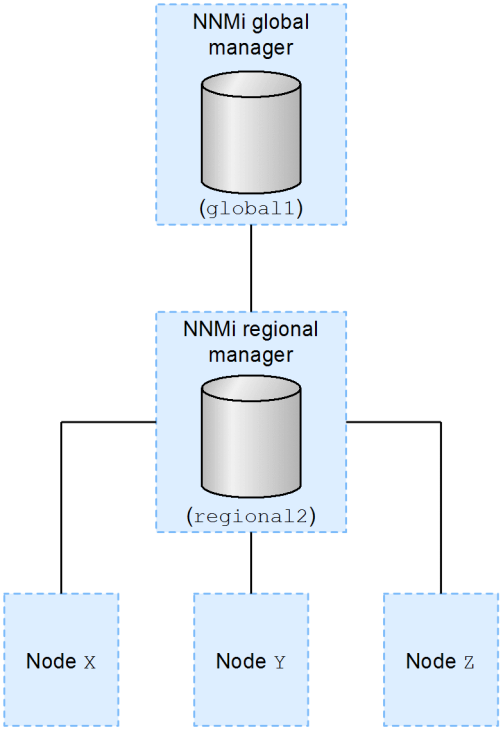
15.10.3 Status polling or configuration polling a device

This example assumes the following:

- Regional NNMi management server `regional2` discovers and manages Node `X`.
- Global NNMi management server `global1` connects with regional NNMi management server `regional2`.

See the following figure.

Figure 15-2: Status polling or configuration polling a node



To status poll Node X from global1, do the following:

1. From global1, click **Nodes** in the **Inventory** workspace.
2. Select Node X from the nodes inventory.
3. Use the **Actions** > **Polling** > **Status Poll** menu to request a status poll of Node X.
4. NNMi management server global1 requests a status poll from regional NNMi management server regional2 and shows the results on your screen.

   Initiate the status poll request from global1 or regional2.

   You will see the same status poll results whether you initiate the status poll request from global1 or regional2.

If you want global1 to have the most current discovery information for Node X, do the following to configuration poll Node X from global1:

1. From global1, click **Nodes** in the **Inventory** workspace.
2. Select Node X from the nodes inventory.
3. Use the **Action** > **Polling** > **Configuration Poll** menu to request a configuration poll of Node X.
4. NNMi management server global1 requests a configuration poll from regional NNMi management server regional2 and shows the results on your screen.

   You will see the same configuration poll results whether you initiate the configuration poll request from global1 or regional2.

15.10.4 Determining device status and NNMi incident generation using a global manager

NNMi management server `global1` monitors for state changes arriving from regional managers `regional1` and `regional2` and updates the states in its local database.

The NNMi State Poller service on each NNMi management server (`regional1` and `regional2`) calculates state values for the devices it monitors. `global1` receives state value updates from `regional1` and `regional2`. `global1` polls nodes that it discovers, and does not poll nodes being managed by `regional1` and `regional2`.

When you change the management mode of a node being managed by `regional1`, you will see that management mode change on `global1` as well. As network administrators add, remove, and modify network equipment being managed by `regional1` or `regional2`, `regional1` or `regional2` updates `global1` of these network device changes.

`global1` generates incidents using its own causal engine and topology, including the node object data forwarded to it by `regional1` and `regional2`. This means that the incidents it generates might be slightly different from the `regional1` and `regional2` incidents if there are differences in topology.

It is better to avoid using a forwarding filter on `regional1` and `regional2`, as filtering might affect the connectivity on `global1`. The result could be a difference in the root cause analysis between `global1` and the two regionals (`regional1` and `regional2`). In most cases, if you choose to avoid using forwarding filters, a global NNMi management server will have a larger topology. This helps it draw more accurate root cause analysis conclusions.

Without additional configuration, `regional1` does not forward traps to `global1`. To do this, you must configure `regional1` to forward specific traps to `global1`. We recommend that you configure regional managers to forward only low-volume, important traps so as to avoid excessive burden on the global manager. NNMi drops forwarded traps when the forwarded traps result in a `TrapStorm` incident. See the `TrapStorm Management Event` details in the NNMi console.

15.11 Troubleshooting tips for global network management

15.11.1 Troubleshooting information in NNMi Help

For global network management troubleshooting information, see *Troubleshoot Global Network Management* in NNMi Help.

15.11.2 Clock synchronization

All NNMi management servers in your network environment that participate in global network management (global managers and regional managers) or single sign-on (SSO) must have their internal time clocks synchronized in universal time. Use a time synchronization program, such as the Linux Network Time Protocol Daemon (NTPD) tool or one of the available Windows operating system tools.

If you see the following message at the bottom of the NNMi console:

```
NNMi's self monitoring has detected a problem (Minor). Please see Help > System Infor
mation > Health for details.
```

Check the `nnm.log` file on the global manager for the following message:

```
SEVERE
[com.hp.ov.nms.topo.spi.server.bridge.BridgeConnectionSelectorImpl] Not connecting to
 system server-name due to clock difference of number-of-seconds. Remote time is date
-time.
```

Perhaps the clocks have drifted apart and need to be resynchronized.

NNMi will disconnect the regional manager connection within a few minutes of output of this message to the log.

NNMi Self Monitoring will also detect the following problem:

```
[Minor] The connection to the regional manager 'name' is down.
```

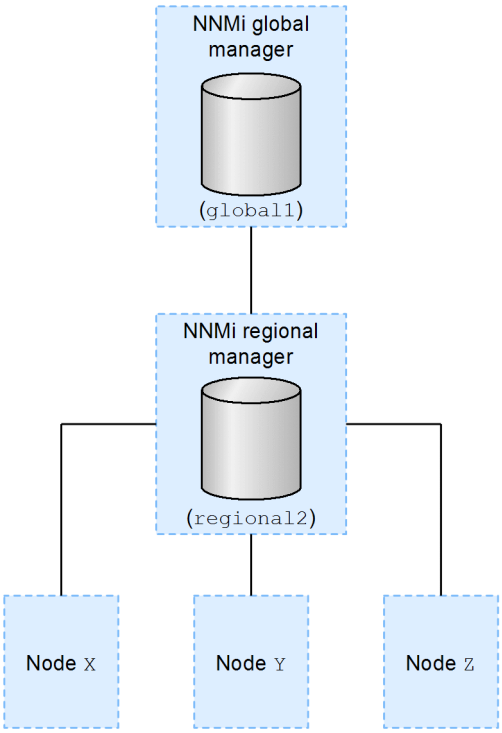
15.11.3 Global network management system information

To view information about your global network management connections, choose **Help**, **System Information**, and then click the **Global Network Management** tab.

15.11.4 Synchronizing regional manager discovery from a global manager

If you notice an information inconsistency between `global1` and `regional2`, run the `nnmnoderediscover.ovpl` script from `global1`, which will cause `global1` and `regional2` to synchronize. This also results in `regional2` updating `global1` with any new discovery results. This example uses the network shown in the following figure.

Figure 15-3: Global network management



Run the following command to synchronize nodes `X`, `Y`, and `Z` with `global1`:

```
nnmnoderediscover.ovpl -u username -p password -rm regional2
```

For details, see the *nnmnoderediscover.ovpl Reference Page*.

Note the following:

- NNMi automatically resynchronizes topology, state, and status following a manual resynchronization.

15.12 Upgrading NNMi in a global network management environment

To upgrade NNMi management servers configured in a global network management environment, see 24.3 Upgrading global and regional managers from NNMi 12-60.

15.13 Global network management and address translation protocol

Each group of dynamic network address translation (NAT) or dynamic port address translation (PAT) or dynamic network address and port translation (NAPT) requires an NNMi regional manager, in addition to a tenant that is unique within the entire NNMi global network management configuration. For details, see 13. Managing Overlapping IP Addresses in a NAT Environment and NNMi Help.

16 NNMi IPv6 Management Feature

You must purchase and install an NNMi Advanced license to use the IPv6 management feature. References to NNMi in this chapter assume an NNMi with an NNMi Advanced license installed. IPv6 management in NNMi enables the discovery and monitoring of IPv6 addresses, including their interfaces, nodes, and subnets. To provide a seamless integration, NNMi extends its IP Address model to include both IPv4 and IPv6 addresses. Whenever possible, NNMi treats all IP addresses equally; most of the features associated with an IPv4 address are also available for IPv6 addresses. However, there are some exceptions. For details about IPv6 information displayed on the NNMi console, see NNMi Help.

16.1 Overview of the NNMi IPv6 management feature

The NNMi IPv6 management feature provides the following:

- IPv6 inventory discovery for IPv6-only and dual-stacked devices
  - IPv6 addresses
  - IPv6 subnets
  - Associations between IPv6 addresses, subnets, interfaces, and nodes
- Native IPv6 SNMP communication for the following:
  - Node discovery
  - Interface monitoring
  - Trap and inform reception and forwarding
- Automatic selection of IPv4 or IPv6 communication (management addresses) for dual-stacked devices
  On the NNMi console, use **Communication Configuration** in the **Configuration** workspace to set the SNMP management address preference to IPv4 or IPv6.
- Native ICMPv6 communication for IPv6 Address fault monitoring
- Seeded device discovery using an IPv6 address or host name
- Automatic IPv6 device discovery using IPv6 Layer 3 neighbor discovery hints
- Automatic IPv6 device discovery using Layer 2 neighbor discovery hints using Link Layer Discovery Protocol (LLDP) IPv6 neighbor information
- Consolidated presentation of IPv4 and IPv6 information
  - Inventory views for nodes, interfaces, addresses, subnets, and associations
  - Layer 2 Neighbor View and Topology Maps for IPv4 and IPv6 devices
  - Layer 3 Neighbor View and Topology Maps for IPv4 and IPv6 devices
  - Incidents, conclusions, root-cause analysis
- NNMi console actions: `ping` and `traceroute` for IPv6 addresses and nodes
- NNMi configuration using IPv6 addresses and address ranges
  - Communication configuration
  - Discovery configuration
  - Monitoring configuration
  - Node & Interface Groups
  - Incident configuration
- DTK Web-services support for IPv6 inventory and incidents

The NNMi IPv6 management feature excludes the following:

- Use of IPv6 Ping sweep for discovery
- IPv6 Network Path View (Smart Path)
- IPv6 Link Local Address fault monitoring
- Using IPv6 Link Local Addresses as discovery seeds

16.2 Prerequisites for using the NNMi IPv6 management feature

For details about the management server specifications and about NNMi installation, see the *Release Notes*.

To use native IPv6 communication, the NNMi management server must be a dual-stacked system, meaning that it communicates using both IPv4 and IPv6.

Additional requirements for IPv6 include the following:

- You must enable and configure IPv4 on at least one network interface.
- You must enable IPv6 and have a unicast address (that is not a link-local unicast address), such as a global unicast address or a unique local unicast address, configured on at least one network interface that is connected to the IPv6 network you must manage.
- You must configure IPv6 routes on the NNMi management server to enable NNMi to communicate with any devices you want NNMi to discover and monitor using IPv6.

> **Note**
>
> You can use an IPv4-only NNMi management server, but doing so will limit NNMi from fully managing IPv4/IPv6 dual-stacked devices. For example, if you use an IPv4-only management server, NNMi cannot discover IPv6-only devices, cannot discover using IPv6 seeds and hints, and cannot monitor for faults on devices with IPv6 addresses.

The DNS server used by the NNMi management server must resolve host names to and from IPv6 addresses. That means the DNS server must map a host name to a 128-bit IPv6 address. If an IPv6-capable DNS server is not available, NNMi will still function correctly; however, NNMi does not determine or display DNS host names for nodes using IPv6 addresses.

16.3 Licensing to use the NNMi IPv6 management feature

As mentioned earlier, you must purchase and install an NNMi Advanced license to use the IPv6 management feature. For details about obtaining and installing an NNMi Advanced license, see 2. Installing and Uninstalling NNMi.

The NNMi product includes a temporary Instant-On license password. This is a temporary, but valid NNMi Advanced license. Make sure to obtain and install a permanent license password as soon as possible.

16.4 Environment supported by the NNMi IPv6 management feature

For details about the supported operating system configurations for NNMi, see the *Release Notes*.

16.4.1 Types of NNMi management servers and supported functions

The following table shows the capabilities of both IPv4-only and dual-stacked NNMi management servers.

Table 16-1: Management server capabilities

Feature/capability	IPv4-only	Dual-stack
IPv4 Communication (SNMP, ICMP)	Supported	Supported
IPv6 Communication (SNMP, ICMPv6)	Not supported	Supported
Dual-Stack Managed Node	Supported	Supported
Discovery using IPv4 Seed	Supported	Supported
Discovery using IPv6 Seed	Not supported	Supported
IPv4 Address and Subnet Inventory	Supported	Supported
IPv6 Address and Subnet Inventory	Supported	Supported
Interface Status and Performance using SNMP	Supported	Supported
IPv4 Address Status using ICMP	Supported	Supported
IPv6 Address Status using ICMPv6	Not supported	Supported
IPv6-only Managed Node	Not supported	Supported
IPv4-only Managed Node	Supported	Supported

16.4.2 Supported SNMP MIBs for IPv6

NNMi supports the following SNMP MIBs for IPv6:

- RFC 4293 (current IETF standard)
- RFC 2465 (original IETF proposal)
- Cisco IP-MIB

16.5 Installing NNMi and activating the IPv6 management feature

During NNMi installation, the installation script activates the IPv6 feature; however, you can deactivate this IPv6 feature manually, if desired, by editing the `nms-jboss.properties` file.

You can also reactivate the IPv6 feature after it has been deactivated. For details, see 16.6 Deactivating the IPv6 management feature and 16.7 Reactivating the IPv6 management feature.

16.6 Deactivating the IPv6 management feature

You can administratively disable the IPv6 capabilities using either of the following methods:

1. Turn off the IPv6 master switch in the `nms-jboss.properties` file, then restart NNMi.
2. Let the NNMi Advanced license expire, or replace it with a basic NNMi license.

To administratively disable the IPv6 feature by using method 1:

1. Open the `nms-jboss.properties` file.
   Locate the following line:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`

   NNMi provides a complete description of each property, showing them as comments in the `nms-jboss.properties` file.
2. To deactivate IPv6 communication in NNMi:
   a. Locate the text that begins with `# Enable Java IPv6 Communication`.
   b. Locate the following line:

   ```
   java.net.preferIPv4Stack=false
   ```

   c. Edit the line to read as follows:

   ```
   java.net.preferIPv4Stack=true
   ```

   Make sure the line is not commented.
3. To deactivate overall IPv6 management in NNMi:
   a. Locate the text that begins with `# Enable NNMi IPv6 Management`.
   b. Locate the following line:

   ```
   com.hp.nnm.enableIPv6Mgmt=true
   ```

   c. Edit the line to read as follows:

   ```
   com.hp.nnm.enableIPv6Mgmt=false
   ```

   Make sure the line is not commented.
   d. Save and close the `nms-jboss.properties` file.
4. Execute the following commands to restart NNMi:

   ```
   ovstop
   ovstart
   ```

> **Important**
>
> If you change a file while the system is operating in High Availability (HA) mode, you must make the change on both nodes in the cluster. For NNMi in an HA configuration, if the change requires you to stop and restart the NNMi management server, you must place the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

5. Check the NNMi processes by using the following command:

```
ovstatus -v ovjboss
```

The following subsections describe NNMi behavior and inventory cleanup after you disable IPv6.

16.6.1 IPv6 monitoring following deactivation of the IPv6 management feature

If IPv6 management or IPv6 communication becomes completely disabled, the State Poller service immediately stops monitoring IPv6 addresses with ICMPv6. NNMi sets the IP address state of these addresses to **Not Polled**. If you select such an address and then use the **Actions** > **Configuration Details** > **Monitoring Settings** command for that address, NNMi will display `Fault ICMP Polling enabled: false` even though the associated **Monitoring Configuration** rule has enabled **IP Address Fault Polling**.

16.6.2 IPv6 inventory following deactivation of the IPv6 management feature

Once NNMi completely discovers your IPv6 inventory, you can enable NNMi to clean it up automatically in the following scenarios:

- You turned on the master IPv6 switch, then turned it off and restarted NNMi.

  NNMi does not immediately remove the IPv6 inventory. NNMi removes the IPv6 inventory for SNMP nodes during the next discovery cycle. For nodes whose management address is an IPv6 address, their management addresses remain as is. NNMi does not remove non-SNMP IPv6 nodes. You must manually delete the nodes whose IPv6 data remains from the NNMi inventory.

16.6.3 Known issues when cleaning Up IPv6 inventory

You could experience leftover IPv6 inventory in the following situation: Suppose that NNMi successfully uses SNMP to manage an IPv6 node, then the node becomes inaccessible before the next discovery. Due to the design of the existing discovery system, the discovery process cannot update a node that loses its ability to communicate using SNMP. To remove such remaining nodes, first fix the communication problem, then, from the NNMi console, on the **Actions** menu choose **Polling**, and then the **Configuration Poll** command to obtain configuration information from these nodes. For a native IPv6 node, delete the node directly from the NNMi console.

16.7 Reactivating the IPv6 management feature

Capabilities requiring IPv6 communication, such as the discovery of only IPv6 devices and monitoring IPv6 address status, require an NNMi management server to have an IPv6 global unicast address configured and operational.

To reactive the IPv6 feature after it has been deactivated:

1. Edit the `nms-jboss.properties` file.

   Locate the following line:

   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`

   NNMi provides a complete description of each property, showing them as comments in the `nms-jboss.properties` file.
2. Locate the text that begins with `# Enable NNMi IPv6 Management`.
3. To enable IPv6 communication in NNMi, un-comment the following property:

   ```
   java.net.preferIPv4Stack=false
   ```

   To un-comment a property, remove the `#!` characters from the beginning of the line.
4. Locate the text that begins with `# Enable NNMi IPv6 Management`.
5. To enable overall IPv6 management in NNMi, un-comment the following property:

   ```
   com.hp.nnm.enableIPv6Mgmt=true
   ```
6. Save and close the `nms-jboss.properties` file.
7. Execute the following commands to restart NNMi:

   ```
   ovstop
   ovstart
   ```

   Important

   If you change a file while the system is operating in High Availability (HA) mode, you must make the change on both nodes in the cluster. For NNMi in an HA configuration, if the change requires you to stop and restart the NNMi management server, you must place the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.
8. Check the NNMi processes by using the following command:

   ```
   ovstatus -v ovjboss
   ```

   Successful startup will look something like the following:

   ```
   object manager name: ovjboss
   state: RUNNING
   PID: process-ID-number
   last message: Initialization complete.
   exit status: -
   additional info:
   SERVICE STATUS
   CommunicationModelService Service is started
   CommunicationParametersStatsService Service is started
   ```

```
CustomPoller Service is started
IslandSpotterService Service is started
ManagedNodeLicenseManager Service is started
MonitoringSettingsService Service is started
NamedPoll Service is started
msApa Service is started
NmsCustomCorrelation Service is started
NmsDisco Service is started
NmsEvents Service is started
NmsEventsConfiguration Service is started
NmsExtensionNotificationService Service is started
NnmTrapService Service is started
PerformanceSpiAdapterTopologyChangeService Service is started
PerformanceSpiConsumptionManager Service is started
RbaManager Service is started
RediscoverQueue Service is started
SpmdjbossStart Service is started
StagedIcmp Service is started
StagedSnmp Service is started
StatePoller Service is started
TrapConfigurationService Service is started
TrustManager Service is started
```

9. After you reactivate IPv6, NNMi views immediately include the IPv6 inventory for newly discovered nodes.

   During the next discovery cycle, NNMi views will show the IPv6 inventory associated with previously discovered nodes.

10. Optionally, you can set the SNMP management address preference for dual-stacked managed nodes.

    Dual-stacked managed nodes are nodes that can communicate using either IPv4 or IPv6. To do this, complete the following steps:

    a. From the NNMi console, click **Communication Configuration** located in the **Configuration** workspace.

    b. Locate the **Management Address Selection** section. Select `IPv4`, `IPv6`, or `Any` in the **IP Version Preference** field.

    c. Save your changes.

    d. Execute the following commands to restart NNMi:

```
ovstop
ovstart
```

> **Important**
>
> If you change a file while the system is operating in High Availability (HA) mode, you must make the change on both nodes in the cluster. For NNMi in an HA configuration, if the change requires you to stop and restart the NNMi management server, you must put the nodes in maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

To speed things up, select nodes that you know are dual-stacked nodes, and then use the **Actions** > **Configuration Poll** command located on the NNMi console. You can also use the `nnmnoderediscover.ovpl` script to add nodes to the NNMi discovery queue. For details, see the *nnmnoderediscover.ovpl Reference Page*.

After you enable IPv6 communication on the NNMi management server, NNMi begins using ICMPv6 to monitor nodes for IPv6 address faults.

17 NNMi Data Resilience

This chapter describes how NNMi protects the NNMi data in case of hardware failure.

17.1 Approaches to NNMi data resilience

NNMi supports two approaches to protecting the NNMi data in case of hardware failure:

- Application failover

  NNMi application failover provides for disaster recovery by maintaining a copy of the NNMi database transaction logs on an identically configured system. For details, see 18. Configuring NNMi for Application Failover.

- Running in a high availability (HA) cluster

  Running NNMi in an HA cluster provides for nearly 100 percent availability of the NNMi management server by maintaining the NNMi database and configuration files on a shared disk. For details, see 19. Configuring NNMi in a High Availability Cluster.

In both approaches, if the current NNMi management server fails, the second system automatically becomes the NNMi management server.

17.2 Comparison of approaches to NNMi data resilience

The following table compares several aspects of these two approaches to NNMi data resilience.

Table 17-1: NNMi data resilience comparison

Comparison item	NNMi application failover	NNMi running in an HA cluster
Required software products	NNMi	• NNMi • A separately purchased HA product
Time to failover	Time needed to process the transaction logs (under normal conditions, 10 to 60 minutes)	Under normal conditions, 5 to 30 minutes
Transparency of failover	Partial. The IP address of the NNMi management server changes to the physical address of what was the standby server. Users must use the new IP address to connect to the NNMi console.	Complete. All connections use the virtual IP address of the HA cluster, which does not change in the event of failover.
Relative proximity of active and standby servers	LAN or WAN	LAN or WAN (some HA products only)
Interaction with global network management	Application failover Global and regional managers cannot be configured for application failover. HA • Each global manager and each regional manager can be configured for HA. • Each of these configurations requires two physical systems. • When failover occurs on a global manager or regional manager, NNMi re-establishes the connections between the global managers and regional managers.	
NNMi maintenance	NNMi must be taken out of the application failover cluster before applying a patch or upgrading.	NNMi can be patched and upgraded without unconfiguring HA.

18 Configuring NNMi for Application Failover

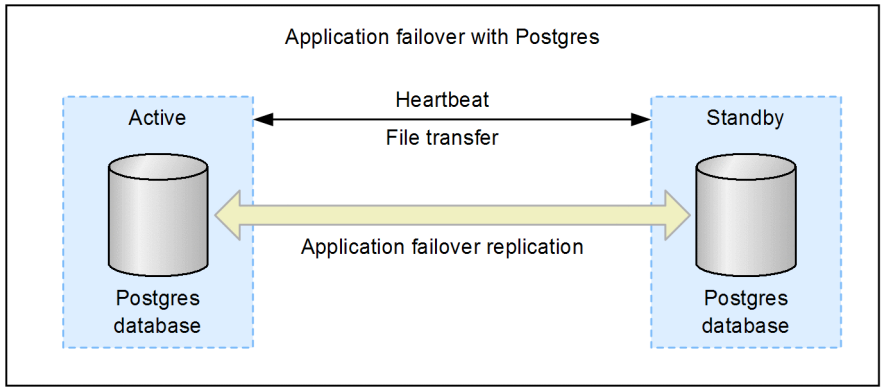
Many information technology professionals depend on NNMi to notify them when critical network equipment fails and to provide them with a root cause for the failure. They also need NNMi to continue to notify them of network equipment failures, even when the NNMi management server fails. *NNMi application failover* meets this need, transferring application control of NNMi processes from an active NNMi management server to a standby NNMi management server, providing continuance of NNMi functionality.

18.1 Application failover overview

The application failover feature multiplexes the NNMi management server without using a shared disk or cluster software.

When you configure two NNMi management servers, one as the active server and the other as a standby server, you can continue monitoring the network by transferring the NNMi functionality to the standby server when an error occurs in the active server.

This application failover feature is implemented based on NNMi's unique cluster manager (`nnmcluster` process) control and has features that differ from those of an HA configuration, which links to cluster software. Note that the application failover configuration is sometimes referred to as the *NNMi cluster* (or simply the *cluster*) in the manual and in Help.



The application failover feature is available for NNMi installations that use an NNMi database. After configuring your systems to use the application failover feature, NNMi detects an NNMi management server failure and triggers a standby server to assume NNMi functionality.

The following terms and definitions apply to configuring NNMi for application failover:

- Active: The server that is running network monitoring.
- Standby: The server in the NNMi cluster that is waiting for a failover event; this server is not running network monitoring.
- Cluster member: A Java process running on a system that is using JGroups technology to connect to a cluster; you can have multiple members on a single system.
- Postgres: The database NNMi uses to store information such as topology, incidents, and configuration information.
- Cluster manager: The `nnmcluster` process and tool used to monitor and manage the servers for the application failover feature.

18.2 Application failover basic setup

To deploy the application failover feature, install NNMi on two servers. These two NNMi management servers are referred to in this chapter as the *active* server and the *standby* server. During normal operation, only the active server is running network monitoring.

The active and standby NNMi management servers are part of a cluster that monitors a heartbeat signal from both of the NNMi management servers. If the active server fails, resulting in loss of its heartbeat, the standby server becomes the active server.

You can use either of the following methods to configure the application failover feature:

- Configuring application failover manually
- Configuring application failover with the NNMi Cluster Setup Wizard

18.2.1 Prerequisites for setting up application failover

For application failover to work successfully, the NNMi management servers must meet the following requirements:

- Only a configuration in which NNMi is used alone is supported.

  A configurations in which NNMi is linked to another related program product, such as JP1, is not supported. In such a case, use an HA configuration using cluster software.
- It must be possible to resolve the host name and IP address of the active server and of the standby server at both NNMi management servers.
- On the network, all IPv4 addresses of both NNMi management servers must not overlap.
- Both NNMi management servers must be running the same operating system. For example, if the active server's operating system is Microsoft(R) Windows Server(R) 2012 R2 Datacenter, the standby server's operating system must also be Microsoft(R) Windows Server(R) 2012 R2 Datacenter.
- Both NNMi management servers must be running the same NNMi version. The NNMi patch levels must also be the same on both servers. For example, if NNMi 12-00 is running on the active server, the identical NNMi version, NNMi 12-00, must be on the standby server.
- The system password must be the same on both NNMi management servers.
- Do not completely disable HTTP access to NNMi before configuring application failover. For details, see 21.18 Configuring NNMi to require encryption for remote access. After successfully configuring the application failover cluster, you can disable HTTP and other unencrypted access.
- For an installation on Windows, NNMi must be installed in the same directory in both NNMi management servers and the `%NnmDataDir%` and `%NnmInstallDir%` system variables must be set to identical values on both servers.
- Both NNMi management servers must have identical licensing attributes (number of nodes managed, and whether NNMi or NNMi Advanced is used). For example, the node counts and licensed features must be identical.

  Important

  The standby server must also have the identical license.
- Do not enable application failover until NNMi is in an advanced stage of initial discovery. For details, see 6.4 Evaluating discovery.

- For application failover to function correctly, the active and standby servers must have unrestricted network access to each other. Any software that locks files or restricts network access can cause NNMi communication problems. Configure these applications to ignore the files and ports used by NNMi.
- The active server and the standby server must be able use all of the IPv4 addresses of the NIC used for cluster communication to communicate with the other NNMi management server for which application failover is configured. If there is any IPv4 address that cannot be used to communicate with the other management server, application failover configuration might fail, or the behavior of a configured application failover environment might become corrupted. For details on how to specify the NICs to be used for cluster communication, see 18.3.3 Setting application failover communications.
- We do not recommend that you set up a firewall between the active and standby servers. When setting up a firewall, configure the systems such that both servers can use all ports for communication.
- To run a firewall in an NNMi management server, permit communication between processes in the local server and communication with remote servers at all ports. Application failover performs communication dynamically using any available port.
  - If you are using a firewall that permits communication on a process-by-process basis (such as Windows Firewall), permit communication by the cluster manager (`nnmcluster.exe`).
  - If you are using a firewall that permits communication on a port-by-port basis, permit the following types of communication:

    IP addresses: All IP addresses assigned to the local server and remote servers

    Ports: All ports
- The same password must be set for the NNMi databases on both the active and standby servers.

  If you have changed the password for an NNMi database, set the same password on all servers before you start configuring application failover.

If all these conditions are satisfied, complete the steps shown in 18.3 Configuring NNMi for application failover. For details, see E. List of Ports Used by NNMi.

18.2.2 Notes on application failover

This subsection provides additional useful information about application failover.

- In the application failover configuration, NNMi fails over when its server stops, but does not fail over when an NNMi process stops (except for `nnmcluster`). For details, see 18.4.2 Application failover scenarios.

  If you want NNMi to fail over when an NNMi process stops, use an HA configuration that is based on HA cluster software.
- There is no functionality for providing a report when the standby server stops (the state in which no switchover target is available).
- There is no functionality for executing user-specified commands for performing some processing when failover occurs.
- The IP address of the server on which NNMi runs switches when failover occurs. The IP address is not inherited. Therefore, note the following points:
  - Set up the SNMP trap transmission target in both NNMi management servers.
  - Register the bookmarks of both NNMi management servers in the Web browser, and connect it to the active server.

- Back up data periodically so that you will be able to use the backed up data in the unlikely event of a system failure. The data duplicated in the standby server by the application failover feature cannot be used as a substitute for a backup.
- In the application failover configuration, the database requires three times the amount of disk space that would be needed in an ordinary configuration. For details about database configuration, see 18.4.1 Application failover behavior.

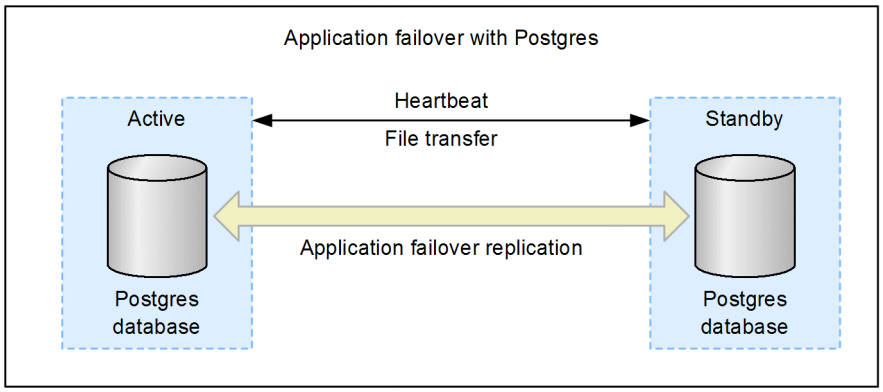
18.3 Configuring NNMi for application failover

This section explains how to configure NNMi for application failover.

18.3.1 Configuring application failover manually

To configure NNMi for application failover:

1. Install NNMi on the active server (server X) and the standby server (server Y).



2. Install a permanent license in each server, as described in 2.3 Licensing NNMi.
3. Run the `ovstop` command on each server to shut down NNMi.
4. Configure server X (active) and server Y (standby) for the application failover feature using guidance from the detailed instructions contained in the `nms-cluster.properties` file.

   Use the procedure shown below. *Edit* in the following steps means to uncomment (remove the leading `#!` from) the lines in the text block within the file and to modify the text.

   a. Edit the following file:

   Windows:

   ```
   %NnmDataDir%shared\nnm\conf\props\nms-cluster.properties
   ```

   Linux:

   ```
   $NnmDataDir/shared/nnm/conf/props/nms-cluster.properties
   ```

   b. Declare a unique name for the NNMi cluster. Use the same name when configuring both the active and standby servers. Specify alphanumeric characters for the name, which is case-sensitive.

   Specifying this parameter enables the application failover feature:

   ```
   com.hp.ov.nms.cluster.name=MyCluster
   ```

   c. Add the host names of all nodes in the cluster to the `com.hp.ov.nms.cluster.member.hostnames` parameter in the `nms-cluster.properties` file:

   ```
   com.hp.ov.nms.cluster.member.hostnames = fqdn_for_active,fqdn_for_standby
   ```

   > **Important**
   >
   > If either of the nodes has multiple IPv4 addresses, enter the IPv4 address to be used for each node's NNMi communication in the `com.hp.ov.nms.cluster.member.hostnames` parameter.

5. Configure the NNMi certificate (use `nnm-key.p12` and `nnm-trust.p12` files or a certification organization).

Depending on the method you selected, complete the set of instructions described in 10.3.5 Working with Certificates in Application Failover Environments.

> **Important**
>
> When configuring the application failover feature, you must merge the `nnm-trust.p12` file content for both nodes into a single `nnm-trust.p12` file. You must choose your approach and complete one set of instructions.

6. Back up the source files, which will be used when canceling the application failover configuration, and then copy the following file from server X to server Y:

   Windows:

   ```
   %NnmDataDir%shared\nnm\conf\nnmcluster\cluster.keystore
   ```

   Linux:

   ```
   $NnmDataDir/shared/nnm/conf/nnmcluster/cluster.keystore
   ```

7. Configure the NIC that is used for cluster communication between both nodes.

   For details, see 18.3.3 Setting application failover communications.

   > **Important**
   >
   > Make sure to specify the setting if either of the nodes has multiple NICs.

8. Run the following command on both server X and server Y:

   ```
   nnmcluster
   ```

   Each server displays something similar to the following:

   ```
   ================== Current cluster state ==================
   State ID: 0000000010000000005
   Date/Time: 15 3 2011 - 09:37:58 (GMT+0900)
   Cluster name: ThisCluster (key CRC:626,187,650)
   Automatic failover: Enabled
   NNM database type: Embedded
   NNM configured ACTIVE node: NO_ACTIVE
   NNM current ACTIVE node: NO_ACTIVE
   Cluster members are:

    Local?  NodeType State OvStatus Hostname/Addresses
   -------  -------- ----- -------- -------------------------
   * REMOTE ADMIN     N/A   N/A      serverX.xxx.yyy.yourcompany.com/16.78.61.68:7800
   (SELF)   ADMIN     N/A   N/A      serverY.xxx.yyy.yourcompany.com/16.78.61.71:7800
   ============================================================+
   ```

   > **Important**
   >
   > To terminate the command, press the **Enter** key and then enter the command `quit`.

   If NNMi is configured correctly, the display lists both server X and server Y. If information about both nodes is not displayed, the nodes are not communicating with each other. Here are some things to check for and correct before continuing:

   - Specify the same cluster name in `com.hp.ov.nms.cluster.name` on both servers, as follows:
     - Windows: `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`
     - Linux: `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`

- The key CRCs might be different on server X and server Y.

  Check the contents of the following file on both server X and server Y:

  - Windows:

  `%NnmDataDir%shared\nnm\conf\nnmcluster\cluster.keystore`

  - Linux:

  `$NnmDataDir/shared/nnm/conf/nnmcluster/cluster.keystore`

  If the key CRCs are different, perform step 6.
- A firewall on server X or server Y might be preventing the nodes from communicating.

  Configure the nodes so that they can communicate.
- Make sure you merged the `nnm-trust.p12` files.

  You should see this error displayed after running the `nnmcluster` command.
- Make sure that the IP address that is obtained from the NIC specified in `com.hp.ov.nms.cluster.interface` matches the IP address that will be resolved from the host name specified in `com.hp.ov.nms.cluster.member.hostnames`.

  Specify `com.hp.ov.nms.cluster.interface` in the following file:

  - Windows: `%NnmDataDir%Conf\nnm\props\nms-cluster-local.properties`

  - Linux: `$NnmDataDir/conf/nnm/props/nms-cluster-local.properties`

  Specify `com.hp.ov.nms.cluster.member.hostnames` in the following file:

  - Windows: `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`

  - Linux: `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`
- Make sure that the remote server's standby IP address matches the IP address specified for the remote server.

  Check that the IP address available to the remote server for cluster communication matches the IP address specified for the remote server for cluster communication.

  The default for the port used for cluster communication is `7800`.

  You can use the `netstat` command to check the standby IP address.

  To determine the IP address specified for the remote server for cluster communication, check the `com.hp.ov.nms.cluster.member.hostnames` parameter in the `nms-cluster.properties` file.

  If a host name is specified in `com.hp.ov.nms.cluster.member.hostnames`, check the IP address that can be resolved from the host name.
- Server X and server Y are running different operating systems.

  For example, server X might be running a Linux operating system and server Y a Windows operating system. Specify the configuration in an environment in which the same operating system is running.
- Server X and server Y are running different NNMi versions.

  For example, server X might be running NNMi 11-00 and server Y a patched version of NNMi 11-00. Specify the configuration in an environment in which the same version of NNMi is installed.

9. On server X, start the NNMi cluster manager:

```
nnmcluster -daemon
```

   After you run the `nnmcluster -daemon` command on NNMi management server X, the NNMi cluster manager goes through the following startup routine:

   - Connects NNMi management server X to the cluster.
   - Detects that there are no other NNMi management servers present.

- NNMi management server X assumes the active state.
- Starts the NNMi services on NNMi management server X (the active server).
- Creates a database backup.

For details, see the *nnmcluster Reference Page*.

10. Wait a few minutes for server X to become the first active server in the cluster. Run the `nnmcluster -display` command on server X and search the displayed results for the term `ACTIVE`, such as `ACTIVE_NNM_STARTING` or `ACTIVE_SomeOtherState`. Do not continue with step 11 until you have confirmed that server X is the active server.
11. On server Y, start the NNMi cluster manager:

    ```
    nnmcluster -daemon
    ```

    After you run the `nnmcluster -daemon` command on NNMi management server Y, the NNMi cluster manager goes through the following startup routine:

    - Connects NNMi management server Y to the cluster.
    - Detects that NNMi management server X is present and is in the active state. The display shows `STANDBY_INITIALIZING`.
    - Compares the database backup on NNMi management server Y to the backup on NNMi management server X. If these do not match, a new database backup is sent from NNMi management server X (active) to NNMi management server Y (standby). The display shows `STANDBY_RECV_DBZIP`.
    - NNMi management server Y receives a minimal set of transaction logs, which is the minimum necessary for the backup to be applicable for its standby state. The display shows `STANDBY_RECV_TXLOGS`.
    - NNMi management server Y goes into a waiting state, continuously receiving new transaction logs and heartbeat signals from NNMi management server X. The display shows `STANDBY_READY`.

    For details, see the *nnmcluster Reference Page*.
12. If a failover occurs, the NNMi console for server X no longer functions. Close the NNMi console session for server X and log on to server Y (the new active server).

    Instruct NNMi users to store two bookmarks in their browsers, one to server X (the active NNMi management server) and one to server Y (the standby NNMi management server). If a failover occurs, users can connect to server Y (the standby NNMi management server).
13. Change the configuration of the devices being monitored by NNMi to send traps to both server X and server Y.

    While server X (active) is running, it processes the forwarded traps and server Y (standby) ignores the forwarded traps.

18.3.2 Configuring application failover with the NNMi Cluster Setup Wizard

The NNMi Cluster Setup Wizard automates the process of configuring a cluster within NNMi for use with application failover. The wizard enables you to do the following:

- Specify and validate cluster nodes
- Define cluster properties and ports
- Merge the `nnm-key.p12` file and `nnm-trust.p12` file content for both nodes into a single `nnm-key.p12` file and `nnm-trust.p12` file

1. Launch the Cluster Setup Wizard by entering the following URL into a supported Web browser:

   ```
   http://NNMi-server:port/cluster
   ```

   - *NNMi-server* is the value of the NNMi host.
   - *port* is the value of the NNMi port.
2. Enter your system **User Name** and **Password**, and then click the **Login** button to sign into NNMi.
3. Enter **Local Hostname** and **Remote Cluster Node** values to define the cluster nodes, and then click **Next**.

   Important

   If either of the nodes has multiple IPv4 addresses, enter the IPv4 address to be used for each node's NNMi communication in **Local Hostname** and **Remote Cluster Node**.
4. On the **Communication Results** page, review the communication verification results. If an error is detected, click **Previous** and fix the problem; otherwise, click **Next**.

   A green status message indicates that connection to the remote cluster node was successful.
5. On the **Define Cluster Properties** page, enter the **Cluster Name** and define the **Backup Interval (in hours)**. Specify **Cluster Name** in alphanumeric characters. Next, specify whether to enable automatic failover. Click **Next**.
6. On the **Define Cluster Ports** page, enter **Starting Cluster Port** and **File Transfer Port** values.

   The NNMi cluster uses four contiguous ports beginning with the **Starting Cluster Port**.
7. Click **Next**.
8. Review the summary information that was entered on the **Summary** page.

   Click **Previous** to go back and change configuration information; otherwise, click **Commit** to save the cluster configuration.

   The final summary indicates that the information was written successfully to the configuration files.
9. Immediately stop NNMi on both nodes by running the `ovstop` command on both nodes.
10. Configure the NIC that will be used for cluster communication between the nodes.

    For details, see 18.3.3 Setting application failover communications.

    Important

    Make sure to specify the setting if either of the nodes has multiple NICs.
11. Verify that the two nodes are able to cluster by running the `nnmcluster` command on both nodes.

    If the nodes are not able to cluster, see 18.3 Configuring NNMi for application failover.
12. Start NNMi on the desired active node with the `nnmcluster -daemon` command. Wait for NNMi to report `ACTIVE`.

    For details, see 18.3 Configuring NNMi for application failover.
13. Start the standby node with the `nnmcluster -daemon` command.

18.3.3 Setting application failover communications

During installation, NNMi queries all network interface cards (NICs) on the system to find one to use for cluster communications. If your system has multiple NICs, you can use the following procedure to choose the NIC to use for `nnmcluster` operations:

Important

Make sure to specify the setting if either of the nodes has multiple NICs.

1. Run `nnmcluster -interfaces` to list all available interfaces.

   For details, see the *nnmcluster Reference Page*.

2. Edit the following file:

   - Windows: `%NnmDataDir%conf\nnm\props\nms-cluster-local.properties`
   - Linux: `$NnmDataDir/conf/nnm/props/nms-cluster-local.properties`

3. Locate the line containing text similar to the following:

   ```
   com.hp.ov.nms.cluster.interface=value
   ```

4. Change the value as desired.

   The interface value must pertain to a valid interface; if it does not, the cluster might not start.

   An example of the value is `eth3` that was output by `nnmcluster -interfaces` in step 1.

   In Windows, the description of the system interface is displayed following the value such as `eth3`.

   Map the interface to be used with the value such as `eth3` by checking the description of the interface by using a command such as `ipconfig /all`.

   In Linux, the name of the interface is displayed. Check the name of the interface to be used by using a command such as `ifconfig`.

   Important

   The active server and the standby server must be able use all of the IPv4 addresses of the NIC used for cluster communication to communicate with the other NNMi management server for which application failover is configured. If there is any IPv4 address that cannot be used to communicate with the other management server, application failover configuration might fail, or the behavior of a configured application failover environment might become corrupted.

5. Save the `nms-cluster-local.properties` file.

   The `com.hp.ov.nms.cluster.interface` parameter permits an NNMi administrator to select the communication interface to be used for `nnmcluster` communication. Make sure that the IP address obtained from the NIC specified in `com.hp.ov.nms.cluster.interface` matches the IP address that can be resolved from the host name specified in `com.hp.ov.nms.cluster.member.hostnames`. In an environment where multiple IP addresses are resolved to the same host name, specify the IP address used for application failover communication, not the host name, in the `com.hp.ov.nms.cluster.member.hostnames` parameter. Specify the `com.hp.ov.nms.cluster.member.hostnames` parameter in the following file:

   - Windows: `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`
   - Linux: `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`

18.4 Using the application failover feature

Now that you have both NNMi management servers running the cluster manager, with one active server and one standby server, you can use the cluster manager to view the cluster status. The cluster manager has three modes:

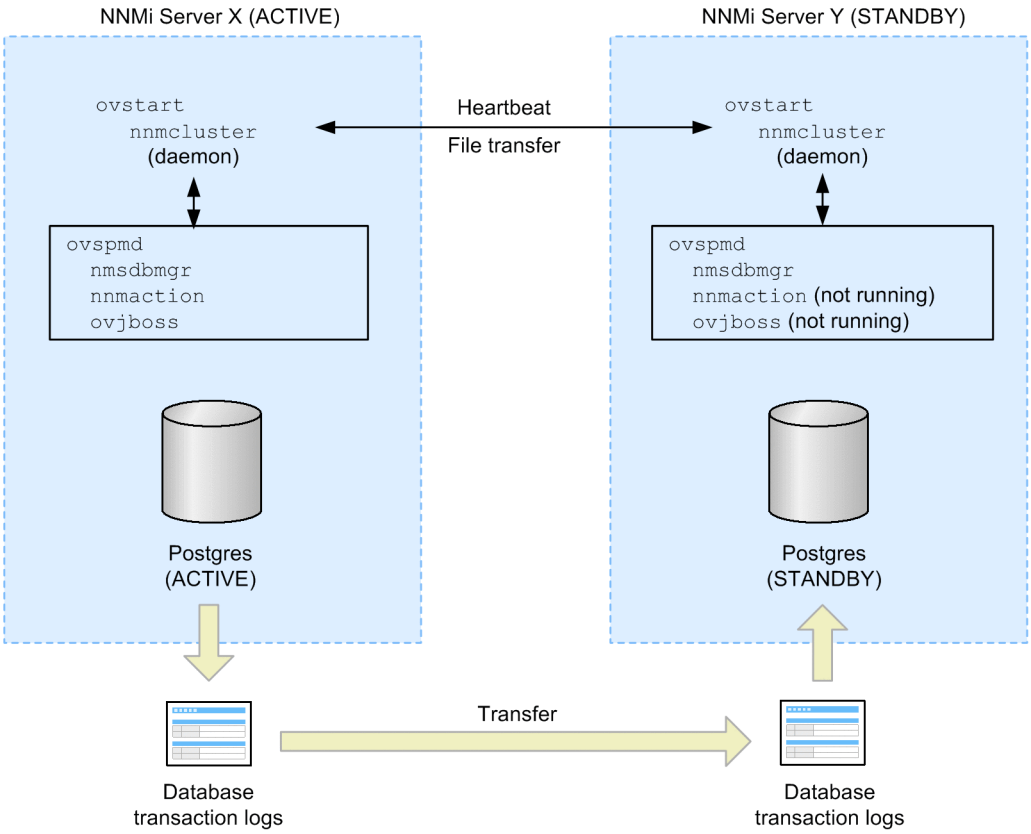
- Daemon mode: The cluster manager process runs in the background, and uses the `ovstop` and `ovstart` commands to start and stop the NNMi services.
- Interactive mode: The cluster manager runs an interactive session in which the NNMi administrator can view and change cluster attributes. For example, the NNMi administrator can use this session to enable or disable the application failover feature or shut down the daemon processes.
- Command line mode: The NNMi administrator views and changes cluster attributes at the command prompt.

For details, see the *nnmcluster Reference Page*.

18.4.1 Application failover behavior

The figure below shows the application failover configuration for two NNMi management servers using the NNMi database. Refer to this figure while reading the rest of this chapter.

Figure 18-1: Application failover configuration (NNMi database)



A database error might result if you remove a standby server from a cluster and run that server as a stand-alone server, and then you add it back into the cluster. If this occurs, run the following command from the command line:

```
nnmcluster dbsync
```

NNMi 11-00 includes a streaming replication feature within application failover whereby database transactions are sent from the active server to the standby server, keeping the standby server in sync with the active server. This eliminates the need for database transaction logs to be imported to the standby server during failover (as was the case in earlier NNMi versions), thus greatly reducing the time needed for the standby server to take over as the active server. Another benefit of this feature is that database backup files are sent from one node to another only if and when needed. This means that, given the regular transmission of database transaction files, the need for sending large database backup files will normally be infrequent.

After you start both servers (active and standby), the standby server detects the active server and requests a database backup from the active server, but does not start network monitoring. This database backup is stored as a single ZIP file. If the standby server already has a ZIP file from a previous cluster-connection, and NNMi finds that the file is already synchronized with the active server, the file is not retransmitted.

While both the active and standby servers are running, the active server periodically sends database transaction logs to the standby server. You can modify the frequency of this data transfer by changing the value of the `com.hp.ov.nms.cluster.timeout.archive` parameter in the `nms-cluster.properties` file. These transaction logs accumulate on the standby server and are available on the standby server any time it needs to become active.

The standard data transfer frequency is as follows:

- A full backup of the database is transferred every 6 hours.
- Transaction logs (database update information) are transferred every 15 minutes. When a large volume of data in the database is updated, transaction logs are transferred more frequently in some cases.

  Updates made while data is being transferred are not inherited.

When the standby server receives a full database backup from the active server, it places the information into the NNMi database. The standby server also creates a `recovery.conf` file to inform the NNMi database that it must incorporate all received transaction logs before it becomes available to other services. If the active server becomes unavailable for any reason, the standby server becomes active by executing the `ovstart` command to start the NNMi services. The standby NNMi management server imports the transaction logs before starting the remaining NNMi services.

Database files are stored under the following directory:

Windows: `%NnmDataDir%shared\nnm\databases\`

Linux: `$NnmDataDir/shared/nnm/databases/`

In the application failover configuration, three directories (`Postgres`, `Postgres_standby`, and `Postgres_OLD`) are created under this directory. These directories are used for the following purposes:

- `Postgres`: Stores database data received during operation or for a standby purpose.
- `Postgres_standby`: Stores data sent from the active server to the standby server.
- `Postgres.OLD`: Used by the standby server for saving old Postgres data when new data is received.

If the active server fails, the standby server begins discovery and polling activities. This transition keeps NNMi monitoring and polling your network while you diagnose and repair the failed system.

Important

- NNMi performs resynchronization following a failover in an application failover configuration. This might delay the updating of statuses and incidents.

- During resynchronization, a message similar to the following might be displayed, but this is not a problem:

Updating of statuses and incidents was delayed because the Causal Engine queue is full. This might be due to resynchronization performed after a failover, restoration of a backup, or manual resynchronization in an application failover configuration.

18.4.2 Application failover scenarios

There are several possible problems that can cause the active NNMi management server to stop sending heartbeats and to initiate a failover.

This subsection explains failover of the NNMi management server because an error occurred under various scenarios.

Table 18-1: Correspondence between possible errors and scenarios

Possible error		Error location	
		Active server	Standby server
Server	Server failure[#1]	Scenario 1	Scenario 6
	OS stoppage	Scenario 2	Scenario 6
Process	`nnmcluster` stoppage	Scenario 3	Scenario 6
	Stoppage of process other than `nnmcluster`	Scenario 5	N/A[#2]
Network	Communication error	Scenario 4	Scenario 4

#1: Server failure assumes a server stoppage caused by a hardware or OS error.

#2: Not applicable because the standby server's NNMi is stopped.

(1) When a failover occurs

In the following scenarios 1 through 3, NNMi fails over to the standby server if automatic failover is enabled and continues to monitor the network:

- Scenario 1: The active NNMi management server fails.

  A hardware or OS error causes the active server to stop without going through the OS's shutdown process. The standby server detects that the other server has stopped, goes active to automatically start NNMi, and continues to monitor the network. The original active server runs as a standby server if started.
- Scenario 2: The system administrator shuts down or restarts the active NNMi management server.

  The active server has stopped after going through the OS's shutdown process. The standby server detects that the other server has stopped, goes active to automatically start NNMi, and continues to monitor the network. The original active server runs as a standby server if started.

  Note that if the NNMi management server is running a Linux operating system and a termination script is run when the OS is shut down, the `ovstop` command will be executed automatically. This will result in the application failover being disabled and failover will not occur.
- Scenario 3: The NNMi administrator shuts down the cluster.

The administrator or some other cause has stopped the cluster manager (`nnmcluster` process). The standby server detects that the other server has stopped, goes active to automatically start NNMi, and continues to monitor the network.

> **Important**
>
> If some factor causes only the `nnmcluster` process of the active server to stop and other NNMi processes continue to remain active, the state is the same as in scenario 3. As a result, NNMi might become active on both the original active server and the new active server. In such a case, recover from the problem by restarting the OS of the original active server.

(2) When no failover occurs

If an event occurs that is not covered by any of the scenarios described in (1) When a failover occurs, failover does not occur. The following are examples:

- Scenario 4: The network connection between the active and the standby NNMi management servers fails.

  The two servers can no longer communicate with each other. Because heartbeat communications cannot be performed between the cluster managers (`nnmcluster` process), the following states result:

  - The active server detects that the other server has stopped; the active server continues to run.
  - The standby server also detects that the other server has stopped, goes active, and starts NNMi.

  In scenario 4, both NNMi management servers run in the active state. When the network device comes back online, the two NNMi management servers automatically negotiate which server will become the new active server. The other server becomes the standby server and stops NNMi.

  The state in which both servers become active causes a problem called *split brain* in HA configurations based on cluster software. However, because application failover uses a different framework, it recovers without any problem, as described below, when communication is restored:

  - When communication is restored, one of the servers becomes the standby server, restoring the normal configuration.
  - In application failover, the database does not use a shared disk. Instead, the standby server requests the active server to transfer the database and synchronizes it. Therefore, no consistency problem occurs even if NNMi runs on both servers.

- Scenario 5: The NNMi processes have stopped.

  Stoppage for any reason of an NNMi process other than the cluster manager (`nnmcluster` process) does not result in failover.

  This is because NNMi processes on the local server are not monitored, although server operations are monitored mutually by the cluster manager's heartbeat communications.

  If you want failover to occur whenever an NNMi process stops, employ an HA configuration using cluster software.

- Scenario 6: A failure occurred on the standby server.

  An error described in scenarios 1 through 3 (server failure, OS stoppage, or stoppage of the `nnmcluster` process) has occurred on the standby server. In such a case, the standby server is removed as a cluster configuration member, but NNMi on the active server continues to run and continues to monitor the network.

  > **Important**
  >
  > No report is sent even when the standby server becomes available (resulting in single server operation).

18.4.3 ovstart and ovstop commands used on NNMi management servers configured for application failover

When you use the `ovstop` and `ovstart` commands on NNMi management servers configured for application failover, NNMi actually runs the commands listed below. These commands terminate immediately without waiting for completion of the NNMi startup or termination.

- `ovstart:` `nnmcluster -daemon`
- `ovstop:` `nnmcluster -disable -shutdown`

> **Note**
>
> - When you run the `ovstop` command, NNMi does not fail over to the standby server. The `ovstop` command is designed to support temporary stoppage for maintenance. To manually initiate a failover, use the `-failover` option with the `ovstop` command. For details, see the *ovstop Reference Page*.
> - Note that when you run the `ovstop` command, automatic failover becomes disabled because the `-disable` option of `nnmcluster` is specified. To check whether failover is enabled, run `nnmcluster -display` to check the Automatic failover column. To enable failover, run `nnmcluster -enable`.

The following options to the `ovstop` command apply to NNMi management servers configured in an application failover cluster:

- `ovstop -failover`: This command stops the local daemon-mode cluster process and forces a failover to the standby NNMi management server. If the failover mode was previously disabled, it is re-enabled. This command is equivalent to `nnmcluster -enable -shutdown`
- `ovstop -nofailover`: This command disables the failover mode and then stops the local daemon-mode cluster process. No failover occurs. This command is equivalent to `nnmcluster -disable -shutdown`
- `ovstop -cluster`: This command stops both the active and standby servers, removing them both from the cluster. This command is equivalent to `nnmcluster -halt`

> **Important**
>
> If the NNMi management server is running a Linux operating system and a termination script is run when the OS is shut down, the `ovstop` command will be executed automatically. This will result in the application failover being disabled. To control application failover during maintenance periods, use the `nnmcluster -acquire` and `nnmcluster -relinquish` commands before executing the OS shutdown command to set the active and standby servers the way you want them. For details, see the *nnmcluster Reference Page*.

18.4.4 Application failover incidents

Any time the `nnmcluster` process or someone using the `nnmcluster` command starts a node as active, NNMi generates one of the following incidents:

- `NnmClusterStartup`: The NNMi cluster was started when there was no active server, so the server was started in the active state. This incident has a `NORMAL` severity.

- `NnmClusterFailover`: The NNMi cluster detected a failure of the active server. The standby server was then enabled and NNMi services started on the new active server. This incident has a `MAJOR` severity.

18.5 Returning to the original configuration following a failover

If the active node has failed and the standby node is functioning as the active node, you can restore the original configuration after the former active node has been fixed.

To restore the original configuration following a failover:

1. Fix the problem at the former active node.
2. Run the following command on the desired active node to restore the original configuration:

```
nnmcluster -acquire
```

For details, see the *nnmcluster Reference Page*.

18.6 Disabling application failover

Suppose you configure application failover, use it for a few days, and then decide to completely disable it. The following explains how to completely disable application failover. Complete these instructions, which include actions on both the active and standby NNMi management servers configured in the application failover cluster.

1. Run the `nnmcluster -enable` command on the active NNMi management server.
2. Run the `nnmcluster -shutdown` command on the active NNMi management server.
3. Wait a few minutes for the old standby NNMi management server to become the new active NNMi management server.
4. Run the `nnmcluster -display` command on the new active (old standby) NNMi management server.
5. Search the displayed results for the `ACTIVE_NNM_RUNNING` status. Repeat step 4 until you see the `ACTIVE_NNM_RUNNING` status.
6. Run the `nnmcluster -shutdown` command on the new active (old standby) NNMi management server.
7. Run the `nnmcluster -display` command repeatedly on the new active (old standby) NNMi management server until you no longer see a `DAEMON` process in any node's type column.
8. Edit the following file both NNMi management servers configured in the cluster:

   Windows:

   `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`

   Linux:

   `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`
9. Comment out the `com.hp.ov.nms.cluster.name` option on both NNMi management servers (by adding the characters `#!` at the beginning of the line) and save each file.
10. Edit the following file on both NNMi management servers:

    Windows:

    `%NnmDataDir%shared\nnm\databases\Postgres\postgresql.conf`

    Linux:

    `$NnmDataDir/shared/nnm/databases/Postgres/postgresql.conf`

    To edit `postgresql.conf`, use an editor that can edit files in which only `LF` (`0x0A`) is used as the linefeed code (in Windows, do not use Notepad, use WordPad instead; in Linux, use *vi*).
11. Remove in each file the lines shown below.

    Shown here is how these lines might appear on a Windows NNMi management server; they might be slightly different on your server:

    ```
    # The following lines were added by the NNM cluster.
    archive_command = 'nnmcluster.exe -archive  -logCONFIG "%p" "file:/C:/ProgramData/
    Hitachi/Cm2NNMi/shared/nnm/databases/Postgres_standby/TxWALs_send/%f"'
    archive_timeout = 900
    max_wal_senders = 4
    archive_mode = 'on'
    wal_level = 'hot_standby'
    hot_standby = 'on'
    wal_keep_segments = 500
    listen_addresses = 'localhost,XX.XX.XX.XX'
    ```

    Make sure to save your changes.

12. If these are Windows NNMi management servers, navigate to the **Services** (**Local**) console and do the following on each server:
    a. Set **Startup type** for the NNM Cluster Manager to **Disabled**.
    b. Set **Startup type** for the NNM Process Manager to **Automatic**.
13. Create the following trigger file, which tells Postgres to stop running in standby mode and to start running normally:
    - Windows: `%NnmDataDir%tmp\postgresTriggerFile`
    - Linux: `$NnmDataDir/tmp/postgresTriggerFile`
14. Run the `ovstart` command on both NNMi management servers.
15. If both NNMi management servers start successfully, remove the following directory from both the standby and active NNMi management servers:
    - Windows: `%NnmDataDir%shared\nnm\databases\Postgres_standby`
    - Linux: `$NnmDataDir/shared/nnm/databases/Postgres_standby`

    > **Note**
    >
    > This directory is a default directory and is the value of the `com.hp.ov.nms.cluster.archivedir` parameter located in the `nms-cluster.properties` file. These instructions assume you did not change this value. If you changed the value of the `com.hp.ov.nms.cluster.archivedir` parameter in the `nms-cluster.properties` file, and then remove the directory that equates to the new value.

16. Remove the following directory from both the standby and active NNMi management servers:
    - Windows: `%NnmDataDir%shared\nnm\databases\Postgres.OLD`
    - Linux: `$NnmDataDir/shared/nnm/databases/Postgres.OLD`

18.7 Administrative tasks and application failover

This section explains how to effectively manage application failover when performing administrative tasks such as patching and restarting NNMi management servers.

18.7.1 Upgrading NNMi (including applying a patch)

To upgrade NNMi management servers configured for application failover, see 24.4 Upgrading to NNMi 13-00 configured for application failover.

18.7.2 Starting, stopping, and restarting NNMi

(1) Starting and stopping NNMi

When you use the `ovstop` or `ovstart` command to stop or start NNMi configured for application failover, NNMi actually runs `nnmcluster` commands. For details about the actual commands that run, see 18.4.3 ovstart and ovstop commands used on NNMi management servers configured for application failover.

With NNMi configured for application failover, whether a server becomes the active or standby server is adjusted automatically during the startup. The server on which the `nnmcluster` command runs first becomes the active server. For details about the behavior during the startup, see 18.4 Using the application failover feature.

When the startup process is completed, the servers go into the states described below for normal operation. To check the server state, run the `nnmcluster` command without any option (in the interactive mode) or run the `nnmcluster -display` command, and check the display in the **State** column.

States during normal operation

Active server: `ACTIVE_NNM_RUNNING`

Standby server: `STANDBY_READY`

When you start NNMi, confirm that the servers go into these states for normal operation. The following table describes the major server states:

State displayed	Role	Explanation
`ACTIVE_NNM_STARTING`	Active	NNMi is starting.
`ACTIVE_DB_BACKUP`	Active	NNMi database is being backed up.
`ACTIVE_NNM_RUNNING`	Active	NNMi is running.
`STANDBY_RECV_DBZIP`	Standby	Database is being transferred from the NNMi of the active server.
`STANDBY_READY`	Standby	Server with NNMi is ready as the standby server.

Before performing an application failover, for example switching between the active and standby servers, make sure that the servers are in the states for normal operation. If you perform a failover before the servers go into these states, the servers cannot be correctly synchronized, and as a result NNMi might fail to start and will go into the `ACTIVE_NNM_FAILED` state. In this case, stop both servers and restart NNMi. If a database problem prevents NNMi from starting, reset the database, restore the backup data, and then restart NNMi.

(2) Restarting NNMi

You can restart the standby NNMi management server at any time with no special instructions. If you are restarting both the standby and active NNMi management servers, restart the active NNMi management server first.

To restart either the active or the standby NNMi management server:

1. Run the `nnmcluster -disable` command on the NNMi management server to disable the application failover feature.
2. Restart the NNMi management server by executing the following commands:

```
ovstop
ovstart
```

3. Run the `nnmcluster -enable` command on the NNMi management server to enable the application failover feature.

> **Important**
>
> For important information about NNMi's `TrapReceiver` process and how it relates to failovers, see 21.16 NNMi NmsTrapReceiver process.

Application failover control after a communication failure

Once a communication failure between the two cluster nodes has been resolved, the NNMi management server that had been running the longest before the communication failure occurred (that is, the previous active NNMi management server) is designated as the active server.

(3) NNMi failover

When a system configured for application failover fails, a failover automatically occurs according to a scenario described in 18.4.2 Application failover scenarios and NNMi starts on the active server.

To manually initiate a failover:

1. Run the `ovstop -failover` command on the active server.

   After NNMi stops, the cluster manager (`nnmcluster`) stops and the standby server becomes the new active server, and then NNMi starts.
2. When step 1 is performed, the original active server is removed as a cluster configuration member. To bring back this server into the cluster as a standby server, run the `ovstart` command.

   The `ovstart` command is replaced with the `nnmcluster -daemon` command before being executed.

18.7.3 Backing up and restoring NNMi

(1) Backing up NNMi

You can back up NNMi configured for application failover by using the same procedure as is used for ordinary systems. However, you cannot use the `-force` option (for forcing NNMi into a state suitable to backup). Place NNMi in a state appropriate for backing up before starting backup.

Do the following on the active server:

1. Place NNMi in a state appropriate for backing up.

   Using `nnmbackup.ovpl`:

   For online backup: Start the NNMi service.

   For offline backup: Stop the NNMi service.

   Using `nnmbackupembdb.ovpl`:

   Start the NNMi service.

2. Make a backup.

   Run the `nnmbackup.ovpl` or `nnmbackupembdb.ovpl` command.

> **Important**
>
> - Make the backup on the active server (the server that was previously running if you stopped NNMi for an offline backup).
> - Make the backup on both the active server and standby server if restoring NNMi failover environment on a different set of servers.

(2) Restoring NNMi

To restore your NNMi database from an original backup when active and standby NNMi management servers are configured for application failover, follow these steps:

1. Run the `nnmcluster -halt` command on the active NNMi management server.

   This stops NNMi on both the active and standby servers. To verify that the NNMi service has stopped, run the `nnmcluster` command with no options specified (interactive mode) or the `nnmcluster -display` command.

2. Delete or move the following directories on both the active and standby NNMi management servers:

   - Windows:

     `%NnmDataDir%shared\nnm\databases\Postgres_standby`

     `%NnmDataDir%shared\nnm\databases\Postgres.OLD`

   - Linux:

     `$NnmDataDir/shared/nnm/databases/Postgres_standby`

     `$NnmDataDir/shared/nnm/databases/Postgres.OLD`

3. Restore the database on the active NNMi management server:

   a. Temporarily cancel the application failover configuration setting.

   Modify the following file to comment out the cluster name `com.hp.ov.nms.cluster.name` (by adding the characters `#!` at the beginning of the line):

   Windows:

   `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`

   Linux:

   `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`

   b. Restore the database as normal. Run the `nnmrestore.ovpl` command or the `nnmrestoreembdb.ovpl` command with the `-force` option. After the services necessary for restoration are started by the specification of the `-force` option, restoration is performed. For details about these commands, see 20.3 Restoring NNMi data.

If you restore data that was backed up using `nnmbackup.ovpl`, the change made in step a might be overwritten in the restored files. Therefore, do step a again.

c. Run the `ovstop` command on the active NNMi management server. This stops the services that were started in step b for restoration processing.

d. Reset the application failover configuration.

Modify the following file to uncomment the cluster name `com.hp.ov.nms.cluster.name` (by deleting the `#!` characters added in step a):

Windows:

```
%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties
```

Linux:

```
$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties
```

4. Run the `ovstart` command on the active NNMi management server.
5. Wait until the active NNMi management server generates a new backup (a ZIP file for synchronizing the active and standby servers).

To verify that this step is complete, run the `nnmcluster -display` command and look for an `ACTIVE_NNM_RUNNING` message.

6. Run the `ovstart` command on the standby NNMi management server.

The standby NNMi management server copies and extracts the new backup (the ZIP file created in step 5). To verify that this step is complete, run the `nnmcluster -display` command and look for a `STANDBY_READY` message.

(3) Restoring NNMi Failover Environment on a different set of servers

Restoring NNMi failover environment on a different set of servers requires obtaining backup of both NNMi active and standby systems, restoring them on the required servers, and also changing the hostnames in certain property files.

To restore NNMi failover environments, follow these steps:

1. Obtain a complete offline backup of all NNMi data on both Active and Standby systems in the source failover environment. For more information, see 20.2 Backing up NNMi data.
2. Copy the backup files to the respective destination Active and Standby systems.
3. Install NNMi to the same version and patch level as were in place for the backup.
4. Restore NNMi data on both Active and Standby systems.

Perform the step 3 described in (2) Restoring NNMi on both Active and Standby systems.

5. On both active and standby NNMi management servers, do the following:

a. Identify hostnames of both active and standby NNMi management servers.

b. Open the following file.

Windows:

```
%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties
```

Linux:

```
$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties
```

c. Add the hostnames of both active and standby nodes to the `com.hp.ov.nms.cluster.member.hostnames` parameter.

```
com.hp.ov.nms.cluster.member.hostnames = fqdn_for_active, fqdn_for_standby
```

6. Configure NNMi failover environment to use SSL certificates for secure communication. For more information, see 10. Working with Certificates for NNMi.

18.7.4 Modifying the NNMi settings

(1) Modifying the settings

This subsection explains how to modify the NNMi settings in the application failover configuration.

(a) NNMi settings files

When modifying the NNMi settings files, make the same modification on both the active and standby servers so that the files are identical in content.

> **Important**
>
> If a setting modification will result in a restart of NNMi, stop both servers before modifying the setting.

To modify settings without stopping NNMi operation, follow the procedure described below. In each step, run the `nnmcluster -display` command to verify that the processing has been completed before proceeding to the next step.

1. Run the `ovstop -failover` command on server A.
   Server A stops and server B becomes active.
2. Modify the settings on server A.
3. Run the `ovstart` command on server A to start it as the standby server.
4. Run the `ovstop -failover` command on server B.
   Server B stops and server A becomes active.
5. Modify the settings on server B.
6. Run the `ovstart` command on server B to start it as the standby server.

(b) NNMi database

Because the active and standby servers automatically maintain synchronization with each other on the NNMi database, no operation by the system administrator is required.

For details about this behavior, see 18.4 Using the application failover feature.

(2) Database reset

To perform the database reset explained in 4.8 Resetting the NNMi configuration and database, you must cancel the application failover configuration temporarily by doing the following:

1. (Optional) If you wish to save the current NNMi settings, do the following on the active server:
   - Use the `nnmconfigexport.ovpl` command to output the NNMi settings to an XML file.
   - Use the `nnmtrimincidents.ovpl` command to archive the NNMi incidents.
2. Run the `nnmcluster -halt` command on the active server.

NNMi stops on both the active and standby servers.

To verify that the NNMi service has stopped, run the `nnmcluster` command with no options specified (interactive mode) or the `nnmcluster -display` command.

3. Reset the NNMi database on the active server.

   a. Temporarily cancel the application failover configuration settings.

   Modify the following file to comment out the cluster name `com.hp.ov.nms.cluster.name` (by adding the characters `#!` at the beginning of the line):

   Windows:

   `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`

   Linux:

   `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`

   b. (Optional) Before the database data is deleted, use the following command to back up the existing database as needed:

   `nnmbackup.ovpl -type offline -target` *backup-directory*

   c. Delete the NNMi database and then re-create it:

   `nnmresetembdb.ovpl -nostart`

   d. Run the `ovstop` command on the active NNMi management server. The service that was started in step c stops.

   e. Reconfigure application failover.

   Modify the following file to uncomment the cluster name `com.hp.ov.nms.cluster.name` (by deleting the `#!` characters added in step a):

   Windows:

   `%NnmDataDir%shared\nnm\conf\props\nms-cluster.properties`

   Linux:

   `$NnmDataDir/shared/nnm/conf/props/nms-cluster.properties`

4. Delete or move the following directories on both the active and standby servers:

   - Windows:

     `%NnmDataDir%shared\nnm\databases\Postgres_standby`

     `%NnmDataDir%shared\nnm\databases\Postgres.OLD`

   - Linux:

     `$NnmDataDir/shared/nnm/databases/Postgres_standby`

     `$NnmDataDir/shared/nnm/databases/Postgres.OLD`

5. Run the `ovstart` command on the active NNMi management server.

   To verify that this step is complete, run the `nnmcluster -display` command and look for an `ACTIVE_NNM_RUNNING` message.

6. Run the `ovstart` command on the standby NNMi management server.

   To verify that this step is complete, run the `nnmcluster -display` command and look for a `STANDBY_READY` message.

This leaves the NNMi database in the default settings only.

Set up NNMi on the active server. To import the NNMi settings saved in step 1, use the `nnmconfigimport.ovpl` command.

18.7.5 Changing the NNMi database password

1. Perform the procedure described in 18.6 Disabling application failover to temporarily disable the application failover configuration.
2. On each NNMi management server, change the password.

   For details about the procedure, see the *nnmchangeembdbpw.ovpl Reference Page*.
3. Perform the procedure described in 18.3.2 Configuring application failover with the NNMi Cluster Setup Wizard to reactivate the application failover configuration.

18.8 Network latency/bandwidth considerations

NNMi application failover works by exchanging a continuous heartbeat signal between the nodes in the cluster. It uses this same network channel for exchanging other data files, such as the NNMi database, database transaction logs, and other NNMi configuration files. We recommend using a high performance, low latency connection for NNMi application failover when implementing it over a WAN (wide area network).

The NNMi database can become quite large and can grow to 1GB or more even though this file is always compressed. Also, NNMi generates hundreds, or even thousands, of transaction logs during the built-in backup interval (a configuration parameter that defaults to six hours). Each transaction log can be several megabytes, up to a maximum size of 16 MB (these files are also compressed). Example data collected from a Hitachi test environments is shown here:

```
Number of nodes managed: 15,000
Number of interfaces: 100,000
Time to complete spiral discovery of all expected nodes: 12 hours
Size of database: 850MB (compressed)
During initial discovery: ~10 transaction logs per minute (peak of ~15/min)
----------------------------------------
10 TxLogs/minute X 12 hours = 7200 TxLogs @ ~10MB = ~72GB
```

This is a lot of data to send over the network. If the network between the two nodes is unable to keep up with the bandwidth demands of NNMi application failover, the standby server can fall behind in receiving these database files. This could result in a larger window of potential data loss if the active server fails.

Similarly, if the network between the two nodes has a high latency or poor reliability, this could result in a false loss-of-heartbeat between the nodes. For example, this can happen when the heartbeat signal does not respond in a timely manner, and the standby server assumes that the active server has failed. There are several factors involved in detecting loss-of-heartbeat. NNMi avoids false failover notification as long as the network keeps up with the application failover data transfer needs.

18.8.1 Application failover and the NNMi database

After you configure NNMi using the database for application failover, NNMi does the following:

1. The active server performs a database backup, storing the data in a single ZIP file.
2. NNMi sends this ZIP file across the network to the standby server.
3. The standby server extracts the ZIP file and configures the database to import transaction logs at the first startup.
4. The database on the active server generates transaction logs, depending on database activity.
5. Application failover sends the transaction logs across the network to the standby server, where they accumulate on the disk.
6. When the standby server becomes active, NNMi starts and the database imports all transaction logs across the network.

   The amount of time this takes depends on the number of files and the complexity of the information stored within those files.
7. After the standby server imports all the transaction logs, the database becomes available and the standby server starts the remaining NNMi processes.
8. The original standby server is now active, and the procedure starts over at step 1.

(1) Network traffic in an application failover environment

NNMi transfers many items across the network from the active server to the standby server in an application failover environment:

- Database activity (the database backup as a single ZIP file)
- Transaction logs
- A periodic heartbeat so that each application failover node verifies that the other node is still running.
- File comparison lists so that the standby server can verify that its files are in synchronization with those on the active server
- Miscellaneous events, such as changes in parameters (enable/disable failover and others) and nodes joining or leaving the cluster

The first two items generate 99% of the network traffic used by application failover. This subsection explores these two items in more detail.

Database activity

NNMi generates transaction logs for all database activity.

Database activity includes everything in NNMi. This activity includes, but is not limited to, the following database activities:

- Discovering new nodes
- Discovering attributes about nodes, interfaces, VLANs, and other managed objects
- State polling and status changes
- Incidents, events, and root cause analysis
- Operator actions on the NNMi console

Database activity is outside of your control. For example, an outage on the network results in NNMi generating many incidents and events. These incidents and events trigger state polling of devices on the network, resulting in updates to device status in NNMi. When the outage is restored, additional node up incidents result in further status changes. All of this activity updates entries in the NNMi database.

Although the NNMi database itself grows with database activity, it will reach a stable size for your environment and will exhibit only moderate growth over time.

Database transaction logs

The NNMi database works by creating an empty 16-megabyte file, and then writing database transaction information into that file. NNMi closes this file, and then makes it available to application failover after 15 minutes or after writing 16 megabytes of data to the file, whichever comes first. That means that a completely idle database will generate one transaction log file every 15 minutes, and this file will be essentially empty. Application failover compresses all transaction logs, so an empty 16-megabyte file compresses down to under 1 megabyte. A full 16-megabyte file compresses to about 8 megabytes. Keep in mind that during periods of higher database activity, application failover generates more transaction logs in a shorter period of time, because each file gets full faster.

(2) An application failover traffic test

The following test resulted in an average of about two transaction log files per minute, with an average file size of 7 megabytes per file. This was due to the database activity associated with discovery of an additional 5,000 nodes added with each failover event. The database in this test case eventually stabilized at about 1.1 gigabytes (as measured by the size of the backup ZIP file), with 31,000 nodes and 960,000 interfaces.

Testing method

During the first 4 hours, test personnel seeded NNMi with 5,000 nodes and waited until discovery stabilized. After 4 hours, test personnel induced failover (the standby server became active, and the previously active server became the standby). Immediately after failover, test personnel added approximately 5,000 more nodes, waited another 4 hours to let the NNMi discovery process stabilize, and then induced another failover (failed back to the original active server).

Test personnel repeated this cycle several times with some variation in the time between failovers (4 hours, then 6 hours, then 2 hours). After each failover event, test personnel measured the following:

- Size of the database created when the node first became active
- Size of the backup ZIP file
- Transaction logs
- Total number of files and the amount of disk space used
- Number of nodes and interfaces in the NNMi database immediately before inducing failover
- Elapsed time to complete failover

  This was the time from the initial `ovstop` command on the active server until the standby server became fully active with NNMi running.

Results

The following table summarizes the results:

Table 18-2: Application failover test results

Hours	DB.zip size (MB)	No. of transaction logs	Transaction log size (GB)	Nodes	Interfaces	Failover time (minutes)
4	6.5	50	0.3	5,000	15,000	5
8	34	500	2.5	12,000	222,000	10
12	243	500	2.5	17,000	370,000	25
16	400	500	3.5	21,500	477,000	23
20	498	500	3.5	25,500	588,000	32
26	618	1,100	7.5	30,600	776,000	30
28	840	400	2.2	30,600	791,000	31
30	887	500	2.5	30,700	800,000	16

Observations

When NNMi transferred files from the active server to the standby server, the transfer averaged about 5 gigabytes every 4 hours, which is a continuous throughput of approximately 350 kilobytes/sec or 2.8 megabits/sec.

Note

- This data does not include any other application failover traffic, such as the heartbeat, file consistency checks, or other application failover communications. This data also excludes the overhead of network I/O, such as packet headers. This data only included the actual network payload of each file's contents moving across the network.
- The traffic volume generated by an NNMi application failover environment is extremely large. Application failover identifies new transaction logs on the active server every five minutes and sends these logs to the standby server. Depending on network speed, the standby server might receive all

the new files in a short time, resulting in a relatively idle network for the remainder of that 5-minute interval.

Each time the active and standby servers switch roles (the standby server becomes active and the active server becomes standby), the new active server generates a complete database backup that it sends across the network to the new standby server. Such a database backup also occurs periodically, backing up every 24 hours by default. Each time NNMi generates a new backup, it sends the backup to the standby server. Having this new backup available on the standby server reduces the failover time, as all transaction logs NNMi generated in that 24-hour interval are already in the database and do not need to be imported at the time of a failover.

The information provided in this section will help you understand how the network might perform after a failover when using NNMi with application failover using the NNMi database.

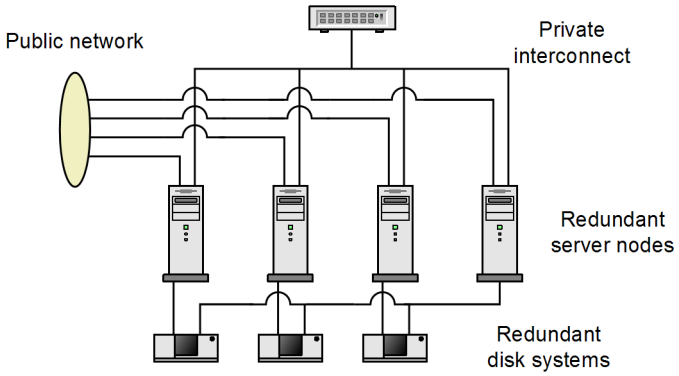
19 Configuring NNMi in a High Availability Cluster

High availability (HA) refers to a hardware and software configuration that provides for uninterrupted service in the event some aspect of the running configuration fails. An HA cluster defines a grouping of hardware and software that works together to ensure continuity in functionality and data when failover occurs. This chapter provides a template for configuring NNMi to run in an HA environment. This chapter does not provide end-to-end instructions for configuring your HA product. The HA configuration commands that NNMi provides are wrappers around the commands for the supported HA products. If you prefer, you can substitute commands specific to the HA product where these instructions specify NNMi-provided commands.

19.1 HA concepts

Cluster architecture provides a single, globally coherent process and resource management view for the multiple nodes of a cluster. The following figure shows an example of cluster architecture.

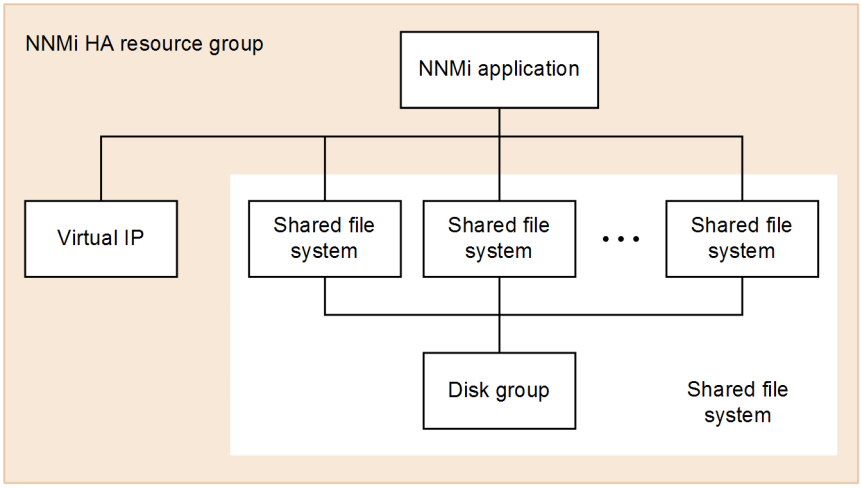
Figure 19-1: Architecture of a high availability cluster



Each node in a cluster connects to one or more public networks and also connects to a private interconnect, representing a communication channel for transmitting data between cluster nodes.

In modern cluster environments, such as Veritas Cluster Server, Symantec Cluster Server, or Windows Server Failover Cluster, applications are represented as compounds of resources, which are simple operations that enable applications to run in a cluster environment. The resources construct an HA resource group, which represents an application running in a cluster environment. The following figure shows an example HA resource group.

Figure 19-2: Typical HA resource group layout



This manual uses the term *HA resource group* to designate a set of resources in any cluster environment. Each HA product uses a different name for the HA resource group. The following table lists for each supported HA product the term that equates to *HA resource group* in this manual.

Table 19-1: Terminology for HA resource group in the supported HA products

HA product	Abbreviation	Equivalent term for HA resource group
Veritas Cluster Server	VCS	Service group
Symantec Cluster Server	SCS	Service group
Windows Server Failover Cluster	WSFC#	Resource group

HA product	Abbreviation	Equivalent term for HA resource group
HA Monitor	HA Monitor	Server

#

WSFC is also referred to as MSFC (Microsoft Failover Cluster), but in this manual *WSFC* is used.

Not all the HA products listed in Table 19-1 are supported by all OSs.

For the supported cluster software and versions, visit Hitachi's home page.

19.1.1 HA terms

The following table lists and defines some common HA terms.

Table 19-2: Common HA terms

Term	Description
HA resource group	A group of resources running in a cluster environment (under an HA product).
Volume group	One or more disk drives that are configured to form a single large storage area.
Logical volume	An arbitrary-size space in a volume group that can be used as a separate file system or as a device swap space.
Primary cluster node	The first system on which the software product is installed, *and* the first system on which HA is configured. The shared disk is mounted on the primary cluster node for initial setup. The primary cluster node generally becomes the first active cluster node, but you do not need to maintain the primary designation after HA configuration is complete. The next time you update the HA configuration, another node might become the primary cluster node.
Secondary cluster node	Any system that is added to the HA configuration after the primary cluster node has been fully configured for HA.
Active cluster node	The system that is currently running the HA resource group.
Passive cluster node	Any system that is configured for HA but is not currently running the HA resource group. If the active cluster node fails, the HA resource group fails over to the passive cluster nodes, which then becomes the active cluster node for that HA resource group.

19.1.2 NNMi HA cluster scenarios

For NNMi HA configuration, NNMi is installed on each system that will become part of an HA resource group. The NNMi database is installed on a separate disk that is accessed by the NNMi programs running on each system. (Only one system, the active cluster node, accesses the shared disk at any given time.)

Note

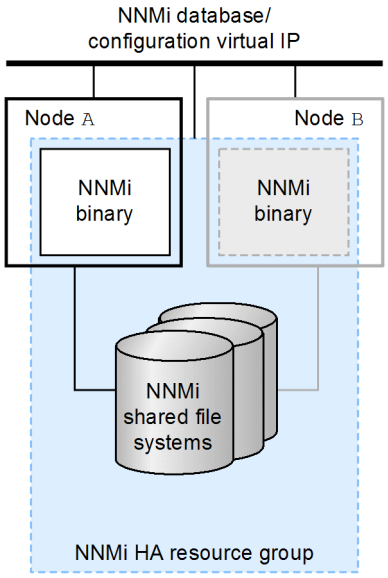
Run the NNMi database backup and restore scripts on the active cluster node only.

NNMi-only scenario

The figure below shows a graphical representation of the NNMi HA cluster scenario.

Node A and node B are each a fully installed NNMi management server that contains the NNMi program that runs on that system. The active cluster node accesses the shared disk for runtime data. Other products connect to NNMi by way of the virtual IP address of the HA resource group.

Figure 19-3: Basic scenario for NNMi HA cluster



For details about how to implement this scenario, see 19.4.2 Configuring NNMi for HA.

19.1.3 Manpages

NNMi provides the following manpages to assist you with an NNMi High Availability configuration:

- nnm-ha
- nnmhaconfigure.ovpl
- nnmhaunconfigure.ovpl
- nnmhadisk.ovpl
- nnmhaclusterinfo.ovpl
- nnmhastartrg.ovpl
- nnmhastoprg.ovpl

On the Windows operating system, these manpages are available as text files.

19.2 Verifying the prerequisites to configuring NNMi for HA

An HA cluster in which NNMi is to be run must satisfy the requirements shown in this section.

Overall system configuration

- NNMi cannot be used in a configuration that includes multiple HA products. NNMi might not be able to correctly recognize the applicable HA product, resulting in a malfunction.
  - Windows: The NNMi installation target (`%NnmDataDir%` and `%NnmInstallDir%`) must be the same in all cluster nodes.
- Both NNMi management server must be running the NNMi of the same version (including a version of the modified version).
- In Windows: NNMi uses the `cluster.exe` command in the cluster system. However, this command is not installed by default.

  To install the command, from **Server Manager** > **Add Roles and Features**, select **Features** > **Remote Server Administration Tools** > **Feature Administration Tools** > **Failover Clustering Tools** > **Failover Cluster Command Interface**.
- Refer to the following items in the *Release Notes* described in the table of *Chapter 4. Memory and Disk Space Requirements* for disk space requirements.
  - Disk space of the local disk

    The value of "Disk space for application installation" and the value of "Disk space for database and data during execution"
  - Disk space of the shared disk

    The value of "Disk space for database and data during execution"

Resource group

- NNMi setup must be initiated when there is no resource group to be configured. NNMi cannot be added to an existing resource group.
- Make sure that the configuration supports virtual IP addresses and shared disks and that it allows NNMi to access them.

Shared disk

- NNMi's shared disk is stored at the location shown below. The directory name cannot contain any spaces; it must always be `NNM`.
  - Windows: *drive-letter*`:\NNM` (example: `Y:\NNM`) or *drive-letter*`:\`*any-directory*`\NNM` (example: `Y:\JP1\NNM`)
  - Linux: *mount-point*`/NNM` (example: `/shdsk1/NNM`)
- For a shared disk, use a storage connected by Fibre (FC-SAN), SCSI, or iSCSI. NNMi does not support a configuration that uses NAS with NFS or CIFS connection.
- In Windows: For a shared disk, use a disk with a drive letter assigned. Do not use a disk that has been mounted by using the mount settings in **Disk Manager** or the `mountvol` command. In this manual, information regarding *mount* applies to Linux.
- In Windows: In Windows Server, dynamic disks are not supported for clustering using Microsoft Cluster Service.

Virtual IP addresses

- Configure virtual IP addresses and virtual host names in such a manner that host names can be converted to IP addresses and vice versa for a name service such as DNS and `hosts` file.

- Even if you use a name service such as DNS, the virtual IP addresses and virtual host names must be configured in the `hosts` file in such a manner that the names can be resolved. This prevents a failover error resulting from a name resolution error in the event of a communication error that leads to failover.
- If you configure IPv6's logical IP address as a resource, add it manually after you have finished the procedure described in 19.4 Configuring HA. For the configuration procedures, see the cluster software documentation.

  The cluster software versions that support IPv6, a configuration using IPv6, and whether IPv6 and IPv4 can be intermixed depend on the cluster software specifications.

Virtual host names

When you configure your cluster environment, set virtual host names to be resolved as IPv4 addresses.

19.3 Notes about HA configurations

This section provides notes about HA configurations.

19.3.1 Notes about using related products

Note the following when you use NNMi-related products such as JP1/SNMP System Observer (JP1/SSO), JP1/Integrated Management 3 - Event Gateway for Network Node Manager i (JP1/IM-EG), etc.:

- Set up NNMi first, and then set up the related products.
- Register NNMi and the related products into the same resource group.

  The resource dependencies that are set in the cluster software must be as follows:

  - For related products, set the dependency so that NNMi is required.
  - For NNMi, set the dependency so that the shared disk and virtual IP address are required. In Windows, also set the dependency for network name resources.
  - If you use custom UI display function of JP1/Integrated Management 2 (JP1/IM2) or JP1/Integrated Management 3 (JP1/IM3), register NNMi and JP1/IM2 or JP1/IM3 into the same resource group. However, the dependency with NNMi is optional.

For details about how to configure related products, see the applicable documentation, *Release Notes*, and instruction manuals.

19.3.2 Notes about configuration tasks and operations

Note the following when you configure and run NNMi for HA:

- The OS user who runs NNMi must have the permissions needed to perform all cluster software operations. The OS user must be able to perform various operations using the cluster software, including creation of NNMi resources and starting and stopping resource groups.
- Operations must be performed with the cluster software running. Various NNMi commands for HA configuration are used on the cluster software to perform processes, such as configuration and verification of configuration. If the cluster software is not running, these processes will result in an error.
- If you restart the NNMi service using the procedure described in this manual and in the *Release Notes*, set NNMi in the maintenance mode in the cluster environment before restarting the NNMi service, unless instructed otherwise.
- When you execute commands and edit local files, make sure that the NNMi resource group is online, unless instructed otherwise in the documentation.

  Also make sure that failover will not occur within three minutes of a command's execution or of local file editing.

  If a command is executed or a local file is edited while the resource group is offline and failover occurs within three minutes of that operation, the settings might be overwritten by the old configuration.
- The NNMi resources assume that failover will occur in the event of a failure.

  Configure NNMi to result in a failover if a failure occurs in the resource group; do not restart NNMi on the system resulting in a failure.

  For details about the configuration method, see *Help* for the cluster software.
- In an environment that a failover is occurred by a failure, when you perform a failback, perform a failback after you recover all failures and stop all NNMi processes.

- In an HA environment, NNMi database is corrupted only occasionally due to process down and disk failure. Therefore back up NNMi settings and data periodically.

19.3.3 Other notes

- Depending on the environment, it might take 10 minutes or more to start the NNMi services.
- Windows: Neither `Online Pending` nor `Offline Pending` is displayed as the status of *resource-group*`-APP` on the Failover Cluster Management console. To make sure that *resource-group*`-APP` is in wait status, verify that the following status is `Pending` on the Failover Cluster Management console:
  - *cluster-name* > **Services and Applications** > *resource_group* > Summary of *resource_group* > Status
- Windows: When you use the data collection tool, create `cluster.log` by executing `cluster.exe log /g`.

19.4 Configuring HA

This section describes the procedures for configuring a new HA configuration for NNMi.

19.4.1 Configuring NNMi certificates for HA

The NNMi installation process configures a self-signed certificate for secure communications between the NNMi console and the NNMi database. The process for configuring NNMi for HA correctly shares the self-signed certificate among the primary and secondary cluster nodes. You do not need to take any extra steps to use the default certificate with NNMi running under HA.

If you want to use a different self-signed certificate or a Certificate Authority (CA)-signed certificate for NNMi communications, you must do some additional work. After obtaining the new certificate, complete the steps shown in 10.3.6 Working with Certificates in High-Availability Environments. You can complete this procedure before or after configuring NNMi for HA.

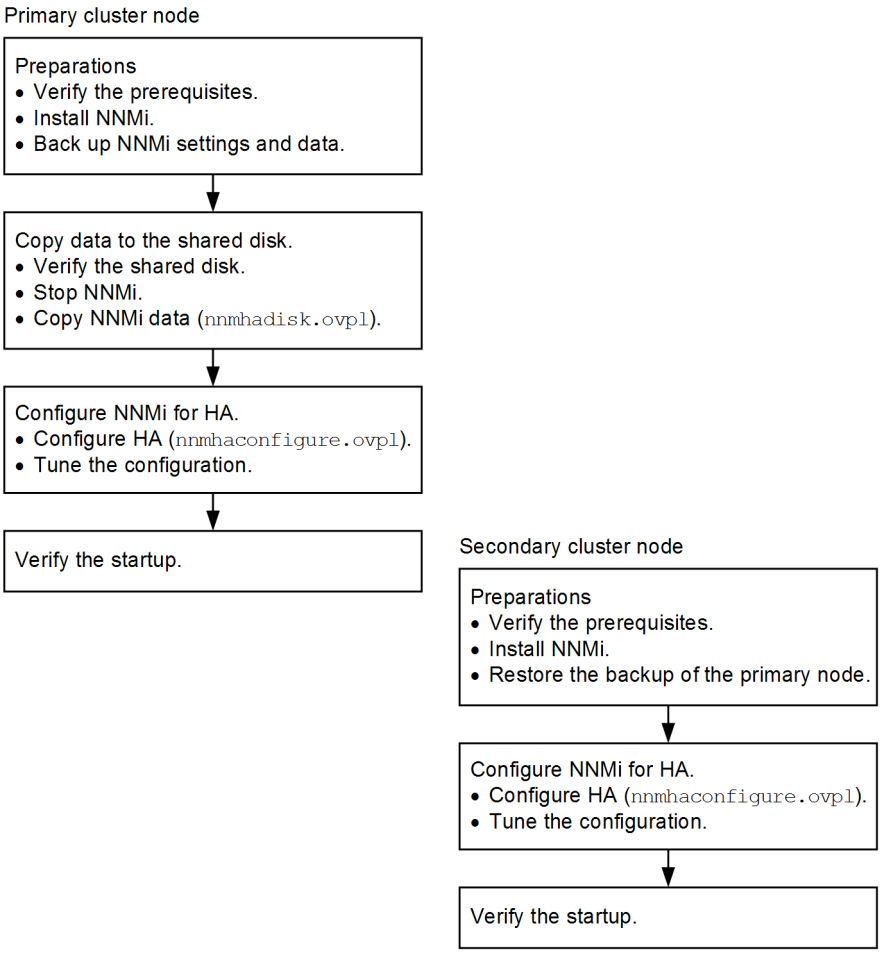
19.4.2 Configuring NNMi for HA

This subsection explains the procedure for configuring NNMi for HA and the settings that must be determined at the evaluation stage.

The two distinct phases of configuring NNMi for HA are as follows:

1. Copy the NNMi data files to the shared disk.
   Perform this task on the primary cluster node.
2. Configure NNMi to run under HA.
   - Perform this task on the primary cluster node.
   - Perform this task on the secondary cluster node.

The following shows the configuration procedure.



Designate one HA cluster node as the primary NNMi management server. This is the node you expect to be active most of the time. First, configure the primary cluster node, then configure the other node in the HA cluster as secondary cluster nodes.

Important

If you use HTTPS communication to access NNMi servers, you must set up to use a certificate before you verify startup of the primary cluster node. For details, see 10.3.6 Working with Certificates in High-Availability Environments.

Note

- You cannot configure NNMi for HA simultaneously on multiple cluster nodes. In a cluster environment, configure nodes for HA one by one, so that the HA setting process on the primary cluster node finishes before the HA setting process on the secondary cluster node starts.
- For HA Monitor, you perform the configuration procedure without using `nnmhaconfigure.ovpl`. For details about the configuration procedure, see the *Release Notes*.

During failover, the NNMi console is unresponsive. After failover completes, NNMi users must sign in to continue their NNMi console sessions.

For important information about NNMi's `TrapReceiver` process and how it relates to failovers, 21.16 NNMi NmsTrapReceiver process.

(1) NNMi HA configuration information

The HA configuration script (`nnmhaconfigure.ovpl`) collects information about the NNMi HA resource group. The table below lists and describes the information that you will need for configuring the primary cluster node. Gather this information before you begin the configuration procedure.

You will enter this information interactively during the configuration process by running an HA configuration script (`nnmhaconfigure.ovpl`). The information requested depends on the OS in use, the type of HA product, and the system configuration. Enter the requested information by following the instructions.

Table 19-3: NNMi HA primary cluster node configuration information

HA configuration item	Description
HA resource group	The name of the resource group for the HA cluster that contains NNMi. This name must be unique, specific to NNMi, and not currently in use. Example: `nnmtest1` **Note:** The HA resource group name cannot contain any space characters. **Note:** The character set and the number of characters permitted for the name depend on the cluster software specifications. For details, see the information provided following this table. **Note:** Make sure that the HA resource group name is unique among all other resource names and resource group names (including any substring of a resource name or a resource group name). For example, if there is a resource group named `testA`, a name containing any substring of `testA`, such as `test` or `est`, cannot be used. **Note:** Once the HA resource group has been created, it cannot be renamed. To rename the HA resource group, you must cancel HA configuration for NNMi, and then perform HA configuration again using a new name.
Virtual host name	The name of the virtual host. This is the short name, not the FQDN name containing the domain name. This host name must map to the virtual IP address for the HA resource group. The virtual host short name and the virtual IP address must be resolvable. **Note:** The virtual host cannot be renamed after the HA configuration has been completed. If you want to rename the virtual host, cancel HA configuration for NNMi, and then perform HA configuration again a new name. **Note:** If NNMi is unable to resolve the virtual host short name or the virtual host IP address, the HA configuration script could leave the system in an unstable state. Therefore, we recommend that you implement a secondary naming strategy (such as entering the information in the `%SystemRoot%\system32\drivers\etc\hosts` file on the Windows operating system or `/etc/hosts` file on Linux operating systems) in case DNS is not available during NNMi HA configuration.
Virtual host netmask	The subnet mask that is used with the virtual host IP address, which must be an IPv4 address.
Virtual host network interface	The network interface on which the virtual host IP address is running. Examples: • Windows: Local Area Connection • Linux: `eth0`
Shared file system type	The type of shared disk configuration being used for the HA resource group. The following are the possible values: • `disk`: The shared disk is a physically attached disk that uses a standard file system type. The HA configuration script can configure the shared disk. For details, see the *File system type* entry in this table. • `none`: The shared disk uses a configuration other than that described for the disk option, such as SAN or NFS. The HA configuration script configures the shared disk. **Note:** Because JP1/NNMi does not support the operation when `none` is specified, you must specify `disk`.
File system type	(Linux only)

HA configuration item	Description
File system type	The file system type of the shared disk (when the shared file system type is `disk`). The HA configuration scripts pass this value to the HA product so that it can determine how to validate the disk. The following shared disk formats have been tested: • `ext2`, `ext3`, and `vxfs` for VCS or SCS
Disk group	(Linux only) The name of the disk group for the NNMi shared file system. Example: `shdg01`
Volume group	(Linux only) The name of the volume group for the NNMi shared file system. Example: `vg03`
Mount directory (mount point)	The directory location for mounting the NNMi shared disk. This mount point must be consistent among systems (that is, all nodes must use the same name for the mount point). In Windows, specify *drive-letter* or *drive-letter*`:\`*any-directory*. The directory name cannot contain any spaces. Example: • Windows: `Y:` or `Y:\JP1` • Linux: `/nnmmount` **Note:** NNMi's shared data is stored in the directory named `NNM` that is created immediately below the directory specified here (path of the storage directory is shown below). The storage directory name (`NNM`) is fixed. • Windows: *drive-letter*`:\NNM` or *drive-letter*`:\`*any-directory*`\NNM` • Linux: *mount-point*`/NNM` **Note:** You will not be able to change the mount point after HA configuration for the relevant NNMi instance is complete. In a Windows environment, you will also not be able to change the drive letter of the mount point after HA configuration for the relevant NNMi instance is complete. If it is necessary to change the mount point, perform the procedure in 19.7 Unconfiguring NNMi from an HA cluster to undo the HA configuration, and then perform the procedure in 19.4 Configuring HA to configure HA again.

The character set and the number of characters permitted for the name of the HA resource group for NNMi must comply with the cluster specifications. The following characters are available to name your HA resource group for NNMi:

- In Windows WSFC
  - Characters:
    Alphabetic characters (`a` to `z`, `A` to `Z`), numeric characters (`0` to `9`), hyphen (`-`), underscore (_), period (`.`)
  - Number of characters: Maximum of 247 characters including the path name `%NnmDataDir%hacluster\`*resource-group*
- In Linux VCS or Linux SCS
  - Characters:
    Alphabetic characters (`a` to `z`, `A` to `Z`), numeric characters (`0` to `9`), hyphen (`-`), underscore (_)
    The name must begin with an alphabetic character.
  - Number of characters: Maximum of 255 characters
- In Linux HA Monitor
  - Characters:
    Alphabetic characters (`a` to `z`, `A` to `Z`), numeric characters (`0` to `9`)
    The name must begin with an alphabetic character.

- Number of characters: Maximum of 8 characters

19.4.3 Configuring NNMi for HA (Windows)

This subsection explains how to configure NNMi for HA in a Windows environment.

In HA configuration for NNMi, you create a new resource group for NNMi. Therefore, you must begin the configuration procedure when there is no resource group to be configured.

The script (`nnmhaconfigure.ovpl`) used to configure NNMi for HA internally creates a resource group and individual resources for the cluster software. When the configuration procedure is completed, the following resource group has been configured.

Table 19-4: Components of resource group for NNMi in WSFC

Resource name	Resource type	Description
virtual-host-name	Network name	Controls virtual host names.
resource_group`-IP`	IP address	Controls virtual IP addresses.
resource_group`-mount`	Physical disk	Controls the shared disk.
resource-group`-APP`	General-purpose script	Controls the start, stop, and monitoring of NNMi.

In WSFC, `nnmhaconfigure.ovpl` configures the above resources by internally executing commands such as `cluster.exe`.

- *resource-group* is replaced with the HA resource group name.
- Set the resource dependency so that the general-purpose script resource *resource-group*`-APP` requires *IP-address-resource*, *disk-resource*, and *network-name-resource*.

(1) Example of settings for each resource in WSFC

This subsection provides an example of the settings for each resource in WSFC when the configuration is completed. Replace *resource-group* with the actual HA resource group name.

Table 19-5: network-name-resource

Item	Details
General	• Resource name: *virtual-host-name* • Resource type: Network name • DNS name: *virtual-host-name* • Full name: *virtual-host-name*`.test.com` • Network: `192.168.100.0/24` • IP address: `192.168.100.24` • NetBIOS status: `OK` • DNS status: `OK` • kerberos status: `OK`
Dependencies	*IP-address-resource*
Policies	• **If all the restart attempts fail, begin restarting again after the specified period (***hh*:*mm***)** is enabled. **Period**: `15:00`

Item	Details
Policies	**Maximum restarts in the specified period**: 0 • **If restart is unsuccessful, fail over all resources in this service or application** is enabled. **Period**: 03:00
Advanced Policies	• **Basic resource health check interval**: **Use standard time period for the resource type** • **Thorough resource health check interval**: **Use the standard time period for the resource type** • **Run this resource in a separate Resource Monitor** is disabled.

Table 19-6: IP-address-resource

Item	Details
General	• Resource name: *resource-group*-IP • Resource type: IP address • Network: 192.168.100.0/24 • Static IP address: 192.168.100.24# • **Enable NetBIOS for this address** is enabled.
Dependencies	No dependencies
Policies	• **If all the restart attempts fail, begin restarting again after the specified period (***hh*:*mm***)** is enabled. **Period**: 15:00 **Maximum restarts in the specified period**: 0 • **If restart is unsuccessful, fail over all resources in this service or application** is enabled. **Period**: 03:00
Advanced Policies	• **Basic resource health check interval**: **Use the standard time period for the resource type** • **Thorough resource health check interval**: **Use the standard time period for the resource type** • **Possible owners** is disabled.

#: DHCP is not enabled.

Table 19-7: physical-disk-resource

Item	Details
General	• Resource name: *resource_group*-mount • Resource type: Physical disk • Volume: Y:
Dependencies	No dependencies
Policies	• **If all the restart attempts fail, begin restarting again after the specified period (***hh*:*mm***)** is enabled. **Period**: 15:00 **Maximum restarts in the specified period**: 0 • **If restart is unsuccessful, fail over all resources in this service or application** is enabled. **Period**: 03:00
Advanced Policies	• **Basic resource health check interval**: **Use the standard time period for the resource type** • **Thorough resource health check interval**: **Use the standard time period for the resource type** • **Possible owners** is disabled.

Table 19-8: general-purpose-script-resource

Item	Details
General	• Resource name: *resource-group*-APP

Item	Details
General	• Resource type: General-purpose script • Script path#: `%NnmDataDir%hacluster/`*resource-group*`/hamscs.vbs`
Dependencies	*network-name-resource*, *IP-address-resource*, and *disk-resource*
Policies	• **If all the restart attempts fail, begin restarting again after the specified period** (*hh*:*mm*) is enabled. **Period**: `15:00` **Maximum restarts in the specified period**: `0` • **If restart is unsuccessful, fail over all resources in this service or application** is enabled. **Period**: `30:00`
Advanced Policies	• **Basic resource health check interval: Use the standard time period for the resource type** • **Thorough resource health check interval: Use the standard time period for the resource type** **Possible owners** is enabled.

#

For the script path, the full path with the environment variable expanded is set.

Example:

```
C:/ProgramData/Hitachi/Cm2NNMi/hacluster/jp1ha1/hamscs.vbs
```

(2) Configuring NNMi on the primary cluster node

Complete the procedure described below on the primary cluster node.

(a) Preparations

To start with the preparations:

1. If you have not already done so, complete the procedure described in 19.2 Verifying the prerequisites to configuring NNMi for HA.
2. If you have not already done so, install NNMi, and then verify that NNMi is working correctly.
3. Use the following command to back up all NNMi settings and data:

   Example:

   ```
   nnmbackup.ovpl -scope all -target nnmi_backups
   ```

   For details about this command, see 20. NNMi Backup and Restore Tools.

   In the initial status of NNMi cluster environment configuration, the data in the primary cluster node must exactly match the data in the secondary cluster node. Therefore, restore the backup data obtained here during the secondary cluster node configuration procedure.

(b) Copying data to the shared disk

Next, copy data to the shared disk.

1. Provide a shared disk for the NNMi HA resource group.

   Use Windows Explorer and the Disk Management tool to assign a drive letter.

   Important

   Verify that the provided shared disk satisfies the following conditions:

- Use the Disk Management tool to make sure that the shared disk displays `online`. If `reserved` is displayed, it indicates that WSFC has control of the shared disk. Use the **Delete** action from the WSFC user interface to remove the shared disk from WSFC control. Also use the Disk Management tool to confirm that the `reserve` flag has changed to `online`.
- It has already been formatted.
- It has enough free space.
- It is not being used by any other resource group.
- A user with administrator permissions has the **Full Control** permission, and a built-in Local Service user (Users group) has the **Read & execute** permissions.

2. Stop NNMi:

```
%NnmInstallDir%bin\ovstop -c
net stop NnmTrapReceiver
```

3. Copy the NNMi files to the shared disk:

```
%NnmInstallDir%misc\nnm\ha\nnmhadisk.ovpl NNM -to HA-mount-point
```

Important

Specify for *HA-mount-point* the drive of the shared disk or any directory under the shared disk drive (example: `Y:` or `Y:\JP1`).

The directory name cannot contain any spaces.

The directory `NNM` is created immediately below the specified path (example: `Y:\NNM` or `Y:\JP1\NNM`).

The storage directory cannot be renamed.

(c) Configuring NNMi for HA

Next, run NNMi's HA configuration.

1. Create an NNMi HA resource group:

```
%NnmInstallDir%misc\nnm\ha\nnmhaconfigure.ovpl NNM
```

For details about the configuration items for this command, see 19.9.2 NNMi-provided HA configuration scripts. Make sure that you specify `disk`, not `none`, for the shared disk type. Specify for the shared disk the path specified in step 3 in subsection (b).

Configuration example

The HA configuration items are listed below in the order they are entered interactively to `nnmhaconfigure.ovpl`. Enter appropriate values based on the information provided in Table 19-3: NNMi HA primary cluster node configuration information in 19.4.2 Configuring NNMi for HA.

HA configuration item	Example setting
HA resource group name	`jp1ha1`
Virtual host name	`lhost1`

HA configuration item	Example setting
Network interface of the virtual host	Local area connection
Type of shared file system	`disk` (make sure that you specify `disk`)
Directory to be mounted	`Y` drive

Important

Before you execute the configuration command, check the following notes:

- If a value specified in `nnmhaconfigure.ovpl` is already in use by another resource group or resource, a resource creation error occurs. Before you execute `nnmhaconfigure.ovpl`, verify that the specified values are not already in use.
- If a specified resource group name, IP address, or disk is already in use, the cluster software command executed to create resources results in an error. If an error occurs, `nnmhaconfigure.ovpl` terminates abnormally at that point, in which case the resource group and resources that had been created up to that point remain. Delete those remaining resources before you resolve the error and re-execute `nnmhaconfigure.ovpl`.
- For the network interface for which a virtual address is set, verify the following:
- In **Networks** in the Failover Cluster Management console, verify the resources that include a network address of logical IP address.

Execution example

The following shows an example screen display in which the example configuration values are specified, where each input item follows a question mark (`?`).

```
C:\Program Files (x86)\Hitachi\Cm2NNMi\misc\nnm\ha>nnmhaconfigure.ovpl NNM
QUESTION: Enter the name of HA resource group:  ? jp1ha1

A primary node configuration has been discovered.

QUESTION: Enter a valid virtual host name:  ? lhost1
Available network interface:

Network subnet mask  Network interface
255.255.255.0           Cluster network 3
255.255.255.0           Cluster network 1

Available value:
1: Cluster network 3
2: Cluster network 1
QUESTION: Enter the type of shared file system:  ? 2
Available value:
1: disk
2: none
QUESTION: Enter the type of shared file system (disk, none):  ? 1
QUESTION: Enter the directory to mount disk:  ? Y:
Creating a resource group.

Creating the resource group 'jp1ha1'...

Group              Node          Status
------------------- --------------- ------
jp1ha1               NNMX64-33       Offline
```

```
Creating the resource group 'lhost1'...

Resource              Group              Node          Status
--------------------------------------------------------------
lhost1                jp1ha1               NNMX64-33       Offline


Making the resource 'lhost1' dependent on the resource 'jp1ha1-IP'...

Configuring the HA value  C:/ProgramData/Hitachi/Cm2NNMi/shared/nnm/conf/ov.conf.
Disabling the automatic startup of HP OpenView Process Manager service.
[SC] ChangeServiceConfig SUCCESS
Note: Updating NNMi FQDN to match the specified virtual host name. Configuring fqd
n to lhost1.xxx.xxx.

Configuring the domain to xxx.xxx.

Microsoft (R) Windows Script Host Version 5.7
Copyright (C) Microsoft Corporation 1996-2001. All rights reserved.

Generating a new SSL certificate.

Generating a key store certificate of lhost1.xxx.xxx.selfsigned.
[Completed successfully]

Exporting the generated certificate to the trust store.

The certificate has been saved in temporary.cert.
The certificate has been added to the key store.

C:\Program Files (x86)\ Hitachi\Cm2NNMi\misc\nnm\ha
```

2. Configure *resource-group* in such a manner that failover occurs in the event of a monitoring process error.

   Open the properties of *resource-group*`-APP`, and then click the **Policies** tab.

   Verify that **If restart is unsuccessful, fail over all resources in this service or application** is selected, and then set **Maximum restarts in the specified period** to `0`.

   If it is selected, clear the check box **If all the restart attempts fail, begin restarting again after the specified period (*hh*:*mm*)**.

   > **Important**
   >
   > Configuration of *resource-group* and the resources registered to *resource_group* is used to specify actions such as error handling. For details about the role of each configuration item, see the cluster service Help.

3. On the primary cluster node, disable the NNMTrapReceiver service automatic start feature.

   From the **Start** menu, select **Administrative Tools** > **Services**, and select **NNM Trap Receiver** and **NNM Trap Receiver Manager**, and then set **Startup type** to `Manual`.

4. By restarting, the specified configuration settings are applied and the NNMi environment variables are loaded. You can start and stop the service by executing the `net start ClusSvc` and `net stop ClusSvc` commands, respectively.

   > **Important**
   >
   > If you use HTTPS communications to access the NNMi server, you must configure the cluster to use an appropriate certificate. For details, see 10.3.6 Working with Certificates in High-Availability Environments.

(d) Verifying the startup

Lastly, verify the startup.

1. Start the NNMi HA resource group.
   Execute the start command on the primary cluster node.
   - Execute the following start command:

```
%NnmInstallDir%misc\nnm\ha\nnmhastartrg.ovpl NNM resource-group
```

   - Verify that *resource-group* has started.
     If NNMi does not start successfully, see 19.8 Troubleshooting the HA Configuration.

   NNMi is now running under HA.

> **Important**
>
> Do not use the `ovstart` and `ovstop` commands for normal NNMi operation in the HA configuration. Use these commands only when instructed to do so for HA maintenance purposes. To start and stop NNMi in the HA configuration, start or stop the HA resource group by using the cluster software.

(3) Configuring NNMi on the secondary cluster node

(a) Preparations

Start with the preparations:

1. If you have not already done so, complete the procedure described in 19.2 Verifying the prerequisites to configuring NNMi for HA
2. If you have not already done so, install NNMi, and then verify that NNMi is working correctly.
3. Restore the backup data.
   Restore onto the secondary cluster node the backup data obtained in step 3 in subsection (a) in (2) Configuring NNMi on the primary cluster node.

```
%NnmInstallDir%bin\nnmrestore.ovpl -force -partial -source backup-data
```

   For details about this command, see 20. NNMi Backup and Restore Tools.

(b) Configuring NNMi for HA

Next, run NNMi's HA configuration.

1. Stop NNMi.

```
%NnmInstallDir%bin\ovstop -c
net stop NnmTrapReceiver
```

2. Configure the NNMi HA resource group:

```
%NnmInstallDir%misc\nnm\ha\nnmhaconfigure.ovpl NNM
```

   Specify the HA resource group name when prompted by the command.

   Execution example

```
C:\Program Files (x86)\Hitachi\Cm2NNMi\misc\nnm\ha>nnmhaconfigure.ovpl NNM
QUESTION: Enter the name of HA resource group:  ? jp1ha1
a secondary node configuration has been discovered.

Disabling the automatic startup of HP OpenView Process Manager service.
[SC] ChangeServiceConfig SUCCESS
Note: Updating NNMi FQDN to match the specified virtual host name. Configuring fqd
n to lhost1.xxx.xxx.

Configuring the domain to xxx.xxx.

Microsoft (R) Windows Script Host Version 5.7
Copyright (C) Microsoft Corporation 1996-2001. All rights reserved.

Generating a new SSL certificate.

C:\Program Files (x86)\ Hitachi\Cm2NNMi\misc\nnm\ha
```

3. On the secondary cluster node, disable the NNMTrapReceiver service automatic start feature.

   From the **Start** menu, select **Administrative Tools** > **Services**, and select **NNM Trap Receiver** and **NNM Trap Receiver Manager**, and then set **Startup type** to `Manual`.

4. Verify that configuration was successful:

   ```
   %NnmInstallDir%misc\nnm\ha\nnmhaclusterinfo.ovpl -group resource-group -nodes
   ```

   This command outputs a list of all nodes that are in the specified HA resource group.

5. On the secondary cluster node, restart the cluster service.

   By restarting, the specified configuration settings are applied and the NNMi environment variables are loaded. You can start and stop the service by executing the `net start ClusSvc` and `net stop ClusSvc` commands, respectively.

6. Optionally, test the configuration by taking the HA resource group on the primary node offline and then bringing the HA resource group on the secondary node online.

Important

Problems might occur in the created resource group, such as the service no longer starts successfully if the NNMi default values for resource group and resource configuration are changed.

Special care is needed if the following configuration item is changed to a value that is smaller than its default value:

- Length of period during which the cluster service waits until it restarts a resource

WSFC standard installation:

Period on the **Policies** tab for the *resource-group*`-APP` properties (default value: 30:00 minutes)

`DeadlockTimeout` value for the *resource-group*`-APP` properties (default value: 2,700,000 milliseconds)

19.4.4 Configuring NNMi for HA (Linux)

This subsection explains how to configure NNMi for HA in a Linux environment.

In HA configuration for NNMi, you create a new resource group for NNMi. Therefore, you must begin the configuration procedure when there is no resource group to be configured.

The script (`nnmhaconfigure.ovpl`) used to configure NNMi for HA internally creates a resource group and individual resources for the cluster software. When the configuration procedure is completed, the following resource group has been configured.

Table 19-9: Components of resource group for NNMi in Veritas Cluster Server or Symantec Cluster Server

Resource name	Resource type	Description
resource-group`-ip`	IP	Controls virtual IP addresses.
resource-group`-dg`	DiskGroup	Controls disk groups.
resource-group`-volume`	Volume	Controls volumes.
resource-group`-mount`	Mount	Controls shared file systems.
resource-group`-app`	Application	Controls the start, stop, and monitoring of NNMi.

In VCS or SCS, `nnmhaconfigure.ovpl` configures the above resources by internally executing commands, such as `hagrp` and `hares`.

- *resource-group* is replaced with the HA resource group name.
- The resource dependency is set so that Volume requires DiskGroup and IP, Mount requires Volume, and Application requires Mount and IP.
- The resources for monitoring network interfaces by VCS or SCS (NIC of VCS or SCS) are not configured. If necessary, add configurations.
- If it takes too long for NNMi to start and a timeout results, tune the `OnlineTimeout` setting of the *resource-group*`-app` by referencing 19.8 Troubleshooting the HA Configuration.

The following shows an example of configuration for each resource.

Example: Definition of VCS or SCS configuration file `main.cf`

Angle brackets (< >) enclose the setting values specified in `nnmhaconfigure.ovpl`.

```
group <resource_group> (
  SystemList = { <node1> = 1 , <node2> = 1}
  UserStrGlobal = "NNM_INTERFACE=<virtual_host>;HA_LOCALE=<LOCALE>;HA_MOUNT_POINT=<mo
untpoint>"
  )

  Application <resource_group>-app (
     StartProgram = "/opt/OV/misc/nnm/ha/nnmharg.ovpl NNM -start <resource_group>"
     StopProgram = "/opt/OV/misc/nnm/ha/nnmharg.ovpl NNM -stop <resource_group>"
     CleanProgram = "/opt/OV/misc/nnm/ha/nnmharg.ovpl NNM -clean <resource_group>"
     MonitorProgram = "/opt/OV/misc/nnm/ha/nnmharg.ovpl NNM -monitor
                      <resource_group>"
     OnlineTimeout = 1800
     )
  DiskGroup <resource_group>-dg (
     DiskGroup = <disk_group>
     )
  IP <resource_group>-ip (
     Device = <network_interface_of_virtual_host>
     Address = "10.208.228.159"
```

```
    NetMask = "255.255.255.0"
    )
Mount <resource_group>-mount (
    MountPoint = "<mountpoint>"
    BlockDevice = "/dev/vx/dsk/<disk_group>/<volume_group>"
    FSType = <type_of_shared_file_systems>
    FsckOpt = "-y"
    )
Volume <resource_group>-volume (
    Volume = <volume_group>
    DiskGroup = <disk_group>
    )
<resource_group>-app requires <resource_group>-ip
<resource_group>-app requires <resource_group>-mount
<resource_group>-mount requires <resource_group>-volume
<resource_group>-volume requires <resource_group>-dg
<resource_group>-volume requires <resource_group>-ip
```

Table 19-10: Components of resource group for NNMi in HA Monitor

Configuration item	Setting (control script)
name (start)	/var/opt/OV/hacluster/*resource-group*/cm2_start.sh
termcommand (stop)	/var/opt/OV/hacluster/*resource-group*/cm2_stop.sh
patrolcommand (monitoring)	/var/opt/OV/hacluster/*resource-group*/cm2_monitor.sh

- *resource-group* is replaced with the HA resource group name.

Important

For HA Monitor, configure NNMi without using `nnmhaconfigure.ovpl`. For details about the procedure, see the *Release Notes*.

(1) Configuring NNMi on the primary cluster node

Complete the procedure described below on the primary cluster node.

(a) Preparations

Start with the *preparations*:

1. If you have not already done so, complete the procedure described in 19.2 Verifying the prerequisites to configuring NNMi for HA
2. If you have not already done so, install NNMi, and then verify that NNMi is working correctly.
3. Use the following command to back up all NNMi settings and data:

   Example:

   ```
   /opt/OV/bin/nnmbackup.ovpl -scope all -target directory
   ```

   For details about this command, see 20. NNMi Backup and Restore Tools.

   In the initial status of NNMi cluster environment configuration, the data in the primary cluster node must exactly match the data in the secondary cluster node. Therefore, restore the backup data obtained here during the secondary cluster node configuration procedure.

(b) Copying data to the shared disk

Next, copy data to the shared disk.

1. Create the directory mount point for the shared disk.
2. Provide a shared disk for the NNMi HA resource group.

   Important

   Verify that the provided shared disk satisfies the following conditions:

   - It has already been formatted
   - It has enough free space
   - It is not being used by any other resource group

3. Activate the shared disk and then mount.

   Example:

   - Using VxVM/VxFS for disk management in Linux VCS or SCS

   ```
   vxdg import disk-group
   vxvol -g disk-group startall
   mount -t vxfs /dev/vx/dsk/disk-group/volume HA-mount-point
   ```

   Verify that the shared disk directory mount point has been created with `root` as the user, `root` as the group, and the permissions set to `755`.

   Example:

   ```
   ls -l
   ```

4. Stop NNMi:

   ```
   /opt/OV/bin/ovstop -c
   /opt/OV/bin/nettrap stop
   ```

5. Copy the NNMi files to the shared disk:

   ```
   /opt/OV/misc/nnm/ha/nnmhadisk.ovpl NNM -to HA-mount-point
   ```

   Important

   The directory `NNM` is created immediately below the specified mount point (*HA-mount-point*`/NNM`).

   The storage directory cannot be renamed.

6. Unmount the shared disk and deactivate it.

   Example:

   - Configuration using VCS or SCS and VxVM/VxFS

     `umount` *HA-mount-point*

     `vxvol -g` *disk-group* `stopall`

     `vxdg deport` *disk-group*

(c) Configuring NNMi for HA

Next, run NNMi's HA configuration.

1. Create an NNMi HA resource group:

```
/opt/OV/misc/nnm/ha/nnmhaconfigure.ovpl NNM
```

For details about the configuration items for this command, see 19.9.2 NNMi-provided HA configuration scripts.

For the shared disk type, make sure that you specify `disk`, not `none`.

Configuration example

The HA configuration items are listed below in the order they are entered interactively to `nnmhaconfigure.ovpl`. Enter appropriate values based on the information provided in Table 19-3: NNMi HA primary cluster node configuration information in 19.4.2 Configuring NNMi for HA.

HA configuration item	Example setting
HA resource group name	`jp1ha1`
Virtual host name	`lhost1`
Network interface of the virtual host	`lan0`
Type of shared file system	`disk` (make sure that you specify `disk`)
Disk type	`vxfs`
Disk group (VCS or SCS only)	`shdg3`
Volume group	`vg03`
Directory to be mounted	`/shdsk1`

Important

Before you execute the configuration command, check the following notes:

- NNMi in an HA configuration starts by using the `nnmhaconfigure.ovpl` runtime locale. Verify that the window used during the execution of `nnmhaconfigure.ovpl` is set to the correct locale (`LANG` environment variable):

  Linux VCS or Linux SCS: `ja_JP.utf8`, `ja_JP.UTF-8`, `C`, `en_US.utf8`, `en_US.UTF-8`, or `zh_CN.utf8`

  To change the locale after HA configuration, see 19.6 Maintaining the HA Configuration.
- If a value specified in `nnmhaconfigure.ovpl` is already in use by another resource group or resource, a resource creation error occurs. Before you execute `nnmhaconfigure.ovpl`, verify that the specified values are not already in use.
- If a specified resource group name, IP address, or disk is already in use, the cluster software command executed to create resources results in an error. If an error occurs, `nnmhaconfigure.ovpl` terminates abnormally at that point, in which case the resource group and resources that had been created up to that point remain. Delete those remaining resources before you resolve the error and re-execute `nnmhaconfigure.ovpl`.
- While `nnmhaconfigure.ovpl` is running, the message shown below might be displayed. This is a message for internal processing and no action is needed.

  `The disk group was not found. Import will be attempted.`

Unable to perform the security token exchange with cmclconfd on node *xxxxx*

Cannot connect to configuration daemon (cmclconfd) on node *xxxxx*

Execution example

The following shows an example screen display in which the example configuration values are specified, where each input item follows a question mark (?).

- Example for VCS or SCS (Linux)

```
# /opt/OV/misc/nnm/ha/nnmhaconfigure.ovpl NNM
QUESTION: Enter the name of HA resource group:  ? jp1ha1

A primary node configuration has been discovered.

QUESTION: Enter a valid virtual host name:  ? lhost1
Information: Use of network interface information:

Network interface: bond0
Network subnet mask: 255.255.255.0

Available value:
1: disk
2: none
QUESTION: Enter the type of shared file system (disk, none):  ? 1

Available value:
1: vxfs
2: ext2
3: ext3
QUESTION: Enter the name of disk type:  ? 1
QUESTION: Enter the name of disk group:  ? shdg3
The disk group was not found. Import will be attempted.
QUESTION: Enter the name of volume group:  ? shvol3
QUESTION: Enter the directory to mount disk:  ? /shdsk1
Creating a resource group.
VCS NOTICE V-16-1-10136 Group added; populating SystemList and setting the Paralle
l attribute recommended before adding resources
Configuring the HA value /var/opt/OV/shared/nnm/conf/ov.conf.
Deleting the boot script.
Note: Updating NNMi FQDN to match the specified virtual host name. Configuring fqd
n to lhost1.

Configuring the domain to xxx.xxx.

Generating a new SSL certificate.

lhost1.xxx.xxx.selfsigned.
[Completed successfully]

Exporting the generated certificate to the trust store.

The certificate has been saved in temporary.cert.
The certificate has been added to the key store.
#
```

2. On the primary cluster node, disable the service automatic start feature.

   Use the following commands to disable the service automatic start feature:

   `systemctl disable netmgt.service`

   `systemctl disable nettrap.service`

```
systemctl stop netmgt.service
systemctl stop nettrap.service
```

3. In VCS or SCS, enable the created resources (set `Enabled` to `1`).

   Example:

   ```
   hares -modify resource-group-app Enabled 1
   hares -modify resource-group-dg Enabled 1
   hares -modify resource-group-ip Enabled 1
   hares -modify resource-group-mount Enabled 1
   hares -modify resource-group-volume Enabled 1
   ```

   Next, set the VCS or SCS settings to read-only, and then output the VCS or SCS configuration file `main.cf`:

   ```
   haconf -dump -makero
   ```

   The resources for monitoring network interfaces by VCS or SCS (such as NIC, MultiNICA, and MultiNICB of VCS or SCS) are not configured. If necessary, add configurations.

   Important

   If you use HTTPS communications to access the NNMi server, you must configure the cluster to use an appropriate certificate. For details, see 10.3.6 Working with Certificates in High-Availability Environments.

(d) Verifying the startup

Lastly, verify the startup.

1. Start the NNMi HA resource group.

   ```
   /opt/OV/misc/nnm/ha/nnmhastartrg.ovpl NNM resource-group
   ```

   This command returns the prompt with waiting for the start of the HA resource group. Use the command of HA cluster software to verify that the resource group has started.

   If NNMi does not start successfully, see 19.8 Troubleshooting the HA Configuration.

NNMi is now running under HA.

Important

Do not use the `ovstart` and `ovstop` commands for normal NNMi operation in the HA configuration. Use these commands only when instructed to do so for HA maintenance purposes. To start and stop NNMi in the HA configuration, start or stop the HA resource group by using the cluster software.

(2) Configuring NNMi on the secondary cluster node

(a) Preparations

Start with the preparations:

1. If you have not already done so, complete the procedure described in 19.2 Verifying the prerequisites to configuring NNMi for HA.

2. If you have not already done so, install NNMi, and then verify that NNMi is working correctly.
3. Restore the backup data.

   Restore onto the secondary cluster node the backup data obtained in step 3 in subsection (a) in (1) Configuring NNMi on the primary cluster node.

   ```
   /opt/OV/bin/nnmrestore.ovpl -force -partial -source backup-data
   ```

   For details about this command, see 20. NNMi Backup and Restore Tools.

(b) Configuring NNMi for HA

Next, run NNMi's HA configuration.

1. Create the mount point for the shared disk.

   You must use for this mount point the same name as used for the mount point created in step 1 in subsection (b) in (1) Configuring NNMi on the primary cluster node.
2. Stop NNMi.

   ```
   /opt/OV/bin/ovstop -c
   /opt/OV/bin/nettrap stop
   ```
3. Configure the NNMi HA resource group:

   ```
   /opt/OV/misc/nnm/ha/nnmhaconfigure.ovpl NNM
   ```

   Specify the HA resource group name when prompted by the command.

   Execution example

   ```
   # /opt/OV/misc/nnm/ha/nnmhaconfigure.ovpl NNM

   QUESTION: Enter the name of HA resource group:  ? jp1ha1
   A secondary node configuration has been discovered.
   Completed the cluster update
   Deleting the boot script.
   Note: Updating NNMi FQDN to match the specified virtual host name. Configuring fqd
   n to lhost1.xxx.xxx.

   Setting the domain to .xxx.xxx.

   Generating a new SSL certificate.

   #
   ```
4. On the secondary cluster node, disable the service automatic start feature.

   Use the following commands to disable the service automatic start feature:

   ```
   systemctl disable netmgt.service
   systemctl disable nettrap.service
   systemctl stop netmgt.service
   systemctl stop nettrap.service
   ```
5. In VCS or SCS, apply configuration changes to the HA cluster:

   ```
   haconf -dump -makero
   ```
6. Verify that configuration was successful:

   ```
   /opt/OV/misc/nnm/ha/nnmhaclusterinfo.ovpl -group resource-group -nodes
   ```

This command outputs a list of all nodes that are in the specified HA resource group.

7. Optionally, test the configuration by taking the HA resource group on the primary node offline and then bringing the HA resource group on the secondary node online.

19.5 Shared NNMi Data

Because NNMi running in an HA environment shares files among NNMi nodes in the HA cluster, you must use a shared disk that is accessible from all NNMi nodes and that is controlled by the HA product.

Important

A configuration that uses NFS or CIFS connection for shared disk is not supported.

19.5.1 Data on the NNMi shared disk

This subsection lists the NNMi data files that are maintained on the shared disk when NNMi is running under HA.

The locations are mapped to the shared disk location as follows:

- In Windows
  - `%NnmDataDir%` maps to `%HA_MOUNT_POINT%\NNM\dataDir`
- In Linux
  - `$NnmDataDir` maps to `$HA_MOUNT_POINT/NNM/dataDir`

The following are the main directories that are moved to the shared disk:

- In Windows
  - `%NnmDataDir%shared\nnm\databases\Postgres`

  Embedded database
  - `NnmDataDir%log\nnm`

  NNMi logging directory
  - `%NnmDataDir%shared\nnm\databases\custompoller`

  Custom poller collections export directory
  - `%NnmDataDir%nmsas\NNM\log`

  NNMi audit log directory
  - `%NnmDataDir%nmsas\NNM\conf`

  NNMi directory for configuring audit log files
  - `%NnmDataDir%nmsas\NNM\data`

  Transaction store used by `ovjboss`
- In Linux
  - `$NnmDataDir/shared/nnm/databases/Postgres`

  Embedded database
  - `$NnmDataDir/log/nnm`

  NNMi logging directory
  - `$NnmDataDir/shared/nnm/databases/custompoller`

  Custom poller collections export directory
  - `$NnmDataDir/nmsas/NNM/log`

  NNMi audit log directory

- `$NnmDataDir/nmsas/NNM/conf`

  NNMi directory for configuring audit log files

- `$NnmDataDir/nmsas/NNM/data`

  Transaction store used by `ovjboss`

The `nnmhadisk.ovpl` command copies these files between local disk and shared disk. Run this command as the instructions in this chapter indicate. For a summary of the command syntax, see the *nnm-ha* manpage.

19.5.2 Replication of configuration files

NNMi running in an HA environment uses file replication to maintain copies of the NNMi configuration files on all NNMi nodes in the HA cluster. By default, the NNMi command `nnmdatareplicator.ovpl` manages file replication. This command monitors the updating of configuration files located on the local disk. When a configuration file is updated, the command copies it to the shared disk. In the event of a failover, the command copies the most recent configuration files from the shared disk to the target node. After that, NNMi is started.

The above update verification and copying of the configuration files are a part of the NNMi monitoring process that is run periodically from the HA cluster. Therefore, if node switchover occurs after configuration files have been changed but before they were copied, the changes are not applied. In such a case, you must change the configuration again.

In the `nnmdatareplicator.conf` file, specify the NNMi folders and files to be included in data replication.

For details about the data replication process, see the *nnm-ha* manpage.

19.6 Maintaining the HA Configuration

19.6.1 Placing NNMi in maintenance mode

The *maintenance mode* is a function for temporarily disabling failover during NNMi maintenance.

NNMi running in an HA environment is monitored by the HA product. If NNMi stops, the HA product determines that a failure has occurred and fails over from the primary node to the secondary node. This means that failover also occurs when NNMi is stopped for maintenance purposes.

The maintenance mode disables failover processing by suppressing the monitoring of NNMi. This means that you can perform maintenance work by executing `ovstop` and `ovstart` on the active cluster node. Make sure that you do not execute `ovstop` and `ovstart` on the passive cluster node.

> **Important**
>
> If a product that requires NNMi is running, placing only NNMi in the maintenance mode will still trigger failover if the related product fails. In such a case, first stop the related product or place it in the mode equivalent to the maintenance mode, and then place NNMi in the maintenance mode.

(1) Placing NNMi in maintenance mode

When NNMi is placed in the maintenance mode, NNMi's monitoring process is disabled. While NNMi is in the maintenance mode, stopping or starting NNMi for that HA resource group does not trigger failover.

To place NNMi in the maintenance mode, create the following file (which can be empty) on the active cluster node:

- Windows
  `%NnmDataDir%hacluster\`*resource-group*`\maintenance`
- Linux
  `$NnmDataDir/hacluster/`*resource-group*`/maintenance`

(2) Removing NNMi from maintenance mode

Taking NNMi out of maintenance mode re-enables NNMi monitoring. If NNMi is stopped, the HA resource group will fail over to the passive cluster node.

To remove an HA resource group from maintenance mode:

1. Verify that NNMi is running correctly:

   ```
   ovstatus -c
   ```

   All NNMi services must show the state `RUNNING`.
2. Delete the maintenance file from the node that was the active cluster node before maintenance was initiated.
   For details about the maintenance file, see (1) Placing NNMi in maintenance mode.

19.6.2 Maintaining NNMi in an HA cluster

> **Note**
>
> For HA Monitor, some of the procedures might differ. For the actual procedures, see the *Release Notes*.

(1) Starting and stopping NNMi

While NNMi is running under HA, do not use the `ovstart` and `ovstop` commands unless instructed to do so for HA maintenance purposes. For normal operation, use the NNMi-provided HA commands (`nnmhastartrg.ovpl` and `nnmhastoprg.ovpl`) or the appropriate HA product commands for starting and stopping HA resource groups.

(2) Changing NNMi host names and IP addresses in a cluster environment

(a) Renaming virtual hosts

NNMi's virtual hosts cannot be renamed after NNMi has been configured for HA. To rename a virtual host, unconfigure NNMi for HA and then re-configure NNMi for HA under the new virtual host name.

(b) Changing virtual IP addresses

To change the virtual IP address of the NNMi HA resource group, perform the following steps on the active cluster node:

1. Stop the NNMi HA resource group:
   - Windows

     `%NnmInstallDir%misc\nnm\ha\nnmhastoprg.ovpl NNM` *resource-group*

     `net stop NnmTrapReceiver`
   - Linux

     `/opt/OV/misc/nnm/ha/nnmhastoprg.ovpl NNM` *resource-group*

     `/opt/OV/bin/nettrap stop`
2. Change the cluster configuration to use the new IP address:
   - Windows

     In the cluster's management console, change the IP address resource configuration. Open the resource group, double-click *resource-group*`-ip`, select parameters, and then enter the new IP address.
   - Linux

     `/opt/OV/misc/nnm/ha/nnmhargconfigure.ovpl NNM` *resource-group* `-set_value` *resource-group*`-ip Address` *new-IP-address*

     Run `haconf -dump -makero` to apply the configuration change to the HA cluster.
3. Start the NNMi HA resource group:
   - Windows

     `%NnmInstallDir%misc\nnm\ha\nnmhastartrg.ovpl NNM` *resource-group*
   - Linux

     `/opt/OV/misc/nnm/ha/nnmhastartrg.ovpl NNM` *resource-group*
4. Verify that NNMi started correctly:

- Windows

  ```
  %NnmInstallDir%bin\ovstatus -c
  ```

- Linux

  ```
  /opt/OV/bin/ovstatus -c
  ```

(c) Renaming physical hosts

If you need to rename a physical host in the system in a cluster environment, do so after stopping NNMi. No NNMi settings are required. After the physical host has been renamed, start NNMi.

Note that physical host names (computer names) cannot be changed in Windows cluster environments.

(d) Changing physical IP addresses

For details about the procedure for changing a physical IP address, see 22.4 Changing the IP address of a stand-alone NNMi management server.

(3) Stopping NNMi without causing failover

To perform NNMi maintenance, you can stop NNMi on the active cluster node without causing failover to a currently passive cluster node. Follow these steps on the active cluster node:

1. If there are related products that require NNMi, stop those products or place them into a mode equivalent to maintenance mode.
2. Put the HA resource group in maintenance mode as described in (1) Placing NNMi in maintenance mode.
3. Stop NNMi:

   ```
   ovstop -c
   ```

(4) Restarting NNMi after maintenance

If you have stopped NNMi in the manner that prevents failover, follow these steps to restart NNMi and HA monitoring:

1. Start NNMi:

   ```
   ovstart -c
   ```

2. Verify that NNMi started correctly:

   ```
   ovstatus -c
   ```

   All NNMi services must show the state `RUNNING`.

3. Take the HA resource group out of maintenance mode as described in (2) Removing NNMi from maintenance mode.
4. If you have stopped or placed NNMi-related products into maintenance mode, restore them to their initial state.

(5) Backing up NNMi configured for HA

(a) Online backup

If you use online backups, verify that the shared disk is accessible from the active cluster node, and then perform the normal backup procedure.

(b) Offline backup

To make an offline backup of NNMi configured for HA, perform the procedure described below. For details about the maintenance mode indicated in the procedure, see 19.6.1 Placing NNMi in maintenance mode.

1. Determine which cluster node in the HA cluster is active:
   - Windows

   `%NnmInstallDir%misc\nnm\ha\nnmhaclusterinfo.ovpl -group` *resource-group* `-activeNode`
   - Linux

   `/opt/OV/misc/nnm/ha/nnmhaclusterinfo.ovpl -group` *resource-group* `-activeNode`
2. Place the active cluster node in the maintenance mode.
3. Stop NNMi:

   ```
   ovstop -c
   ```
4. Verify that the shared disk is online by using an HA product operation. If the shared disk is offline, place it online.
5. Verify that the shared disk is accessible, and then execute the `nnmbackup.ovpl` command to perform an offline backup and obtain backup data.
6. Start NNMi:

   ```
   ovstart -c
   ```

   Wait until NNMi completes its startup.
7. After NNMi services have started, release maintenance mode.

(6) Restoring NNMi configured for HA

To restore backup data, perform the procedure described below. For details about the maintenance mode indicated in the procedure, see 19.6.1 Placing NNMi in maintenance mode.

> **Important**
>
> Do not restore backup data obtained from an NNMi with a single configuration to an NNMi with a cluster configuration.

1. Restore NNMi to a status in which NNMi runs successfully as a cluster and is configured for HA.

   For example, if part or all of the system has failed due to a hardware failure, restore the system so that NNMi runs with the HA configuration.
2. Set the node used to perform restore processing as the active cluster node.
3. Place the active cluster node in the maintenance mode.
4. Perform restore processing.
   - For backup data obtained by using the `nnmbackup.ovpl` command

     Use the `nnmrestore.ovpl` command to restore the backup data.
   - For backup data obtained by using the `nnmbackupembdb.ovpl` command

     Use the `nnmrestoreembdb.ovpl` command to restore the backup data.

> **Important**
>
> If you use the `nnmrestore.ovpl` command to restore backup data obtained on another node, do not specify the `lic` option so that that node's license is not applied.

5. Start NNMi:

```
ovstart -c
```

6. Release maintenance mode.
7. Perform steps 2 through 6 on the remaining node.

   These steps are necessary in order to synchronize the configuration files on all nodes' local disks. Make sure that you restore the same backup data.

   If you use the `nnmrestoreembdb.ovpl` command, restore the backup data only on one node because this command restores a database on the shared disk.

(7) Initializing the database

1. Determine which cluster node in the HA cluster is active:
   - Windows

   `%NnmInstallDir%misc\nnm\ha\nnmhaclusterinfo.ovpl -group` *resource-group* `-activeNode`

   - Linux

   `/opt/OV/misc/nnm/ha/nnmhaclusterinfo.ovpl -group` *resource-group* `-activeNode`
2. Place the active cluster node in the maintenance mode.
3. Verify that the shared disk is accessible.
4. Initialize the database by executing the `nnmresetembdb.ovpl` command with no argument specified:
   - Windows
     `%NnmInstallDir%bin\nnmresetembdb.ovpl`
   - Linux
     `/opt/OV/bin/nnmresetembdb.ovpl`
5. Execute `ovstatus -c` to verify that the NNMi services are running.
6. Release the maintenance mode.

19.7 Unconfiguring NNMi from an HA cluster

The process of removing an NNMi node from an HA cluster involves undoing the HA configuration for that instance of NNMi. You can then run that instance of NNMi as a stand-alone management server, or you can uninstall NNMi from that node.

To completely unconfigure NNMi from an HA cluster, follow the steps described below.

- 19.7.1 Determining the active cluster node
- 19.7.2 Unconfiguring NNMi on the passive cluster node
- 19.7.3 Unconfiguring NNMi on the active cluster node

To unconfigure NNMi on the active cluster node, the procedure for deleting the NNMi data is described as well as the procedure for using the NNMi data on the single server after NNMi has been unconfigured from the HA cluster.

> **Note**
>
> For HA Monitor, unconfigure NNMi without using `nnmhaunconfigure.ovpl`. For details about the procedure, see the *Release Notes*.

19.7.1 Determining the active cluster node

1. Determine which cluster node in the HA cluster is active:
   - Windows

   `%NnmInstallDir%misc\nnm\ha\nnmhaclusterinfo.ovpl -group` *resource-group* `-activeNode`
   - Linux

   `/opt/OV/misc/nnm/ha/nnmhaclusterinfo.ovpl -group` *resource-group* `-activeNode`

19.7.2 Unconfiguring NNMi on the passive cluster node

1. On the passive cluster node, unconfigure NNMi from the HA cluster:
   - Windows

     `net stop NnmTrapReceiver`

     `%NnmInstallDir%misc\nnm\ha\nnmhaunconfigure.ovpl NNM` *resource-group*
   - Linux

     `/opt/OV/bin/nettrap stop`

     `/opt/OV/misc/nnm/ha/nnmhaunconfigure.ovpl NNM` *resource-group*

   This command removes the corresponding node from the list of nodes in the HA resource group. It does not change the settings for running NNMi configured for HA or data on the shared disk of any other node.

   The following message might be displayed, but this is not a problem:
   - Windows

     `Warning: There is no value in the public entry PUBLIC.HA_MOUNT_POINT in the resource group` *xxxxx* `in the cluster registry.`

> **Important**
>
> In a VCS or SCS environment where NNMi is in an HA configuration and the physical host name has been changed, before the HA configuration is canceled, the physical host name must be reverted to the name that was used when HA was configured. To continue using the new host name even after switching to a single server configuration, cancel the HA configuration, and then configure the required settings as described in 22.5 Changing the host name or domain name of an NNMi management server.

2. In VCS or SCS, apply the changes to the HA cluster.

   `haconf -dump -makero`

3. Change the FQDN setting for the NNMi node to the physical host name.

   a. Edit the `nms-local.properties` file.

   File path

   - Windows: `%NnmDataDir%conf\nnm\props\nms-local.properties`
   - Linux: `/var/opt/OV/conf/nnm/props/nms-local.properties`

   What to edit

   `com.hp.ov.nms.fqdn` = *virtual-host-name*

   Specify a virtual host name, not a physical host name.

   b. Execute the `nmsetofficialfqdn.ovpl` command.

   For *FQDN*, specify the FQDN of the physical host name (host name displayed by the `hostname` command).

   - Windows

     `%NnmInstallDir%bin\nnmsetofficialfqdn.ovpl -force` *FQDN*

   - Linux

     `/opt/OV/bin/nnmsetofficialfqdn.ovpl -force` *FQDN*

   This command changes the FQDN setting that was changed to the virtual host name during HA configuration to the FQDN of the physical host name.

   The following messages might be displayed during command execution:

   - `For single sign-on to function normally, you must generate a new certificate manfully`

     Ignore this message because single sign-on is not supported.

   As a result, a self-signed certificate is used. If you want to use a different self-signed certificate or a Certificate Authority (CA)-signed certificate for NNMi communications, you must do some additional work. For details about the certificates, see 10. Working with Certificates for NNMi.

4. Move the NNMi HA resource group-specific files to a separate location for safekeeping.

   If you do not plan to reconfigure the NNMi HA resource group, you do not need to save a copy of these files, and you can delete them at this time.

   - Windows

     In Explorer, delete the `%NnmDataDir%hacluster\`*resource-group*`\` folder.

   - Linux

     `cd /var/opt/OV/hacluster/`

     `rm -r` *resource-group*

5. Delete the following file:

File path

- Windows

In Explorer, delete `%NnmDataDir%shared\nnm\databases\nnmdatareplicator\DataReplicator.db`.

- Linux

```
rm /var/opt/OV/shared/nnm/databases/nnmdatareplicator/DataReplicator.db
```

6. Enable the service automatic start feature.

- Windows

From the **Start** menu, select **Administrative Tools** > **Services**, and select **NNM Trap Receiver** and **NNM Trap Receiver Manager**, and then set **Startup type** to `Automatic`.

- Linux

```
systemctl enable netmgt.service
systemctl enable nettrap.service
systemctl start netmgt.service
systemctl start nettrap.service
```

The NNMi services are started when the `systemctl start` command is executed.

The procedure is complete.

If you want to remove NNMi completely from the HA cluster, unconfigure NNMi on the passive cluster nodes, and then unconfigure NNMi on the active cluster node.

19.7.3 Unconfiguring NNMi on the active cluster node

1. On the active cluster node, stop the NNMi HA resource group and `NnmTrapReceiver`.

- Windows

```
%NnmInstallDir%misc\nnm\ha\nnmhastoprg.ovpl NNM resource-group
net stop NnmTrapReceiver
```

- Linux

```
$NnmInstallDir/misc/nnm/ha/nnmhastoprg.ovpl NNM resource-group
/opt/OV/bin/nettrap stop
```

> **Important**
>
> In a VCS or SCS environment where NNMi is in an HA configuration and the physical host name has been changed, before a resource group is stopped, the physical host name must be reverted to the name that was used when HA was configured. To continue using the new host name even after switching to a single server configuration, cancel the HA configuration, and then configure the required settings as described in 22.5 Changing the host name or domain name of an NNMi management server.

2. On the active cluster node, unconfigure NNMi from the HA cluster:

- Windows

```
%NnmInstallDir%misc\nnm\ha\nnmhaunconfigure.ovpl NNM resource-group
```

- Linux

```
$NnmInstallDir/misc/nnm/ha/nnmhaunconfigure.ovpl NNM resource-group
```

This command removes the corresponding node from the list of failover targets in the HA resource group.

This command removes access to the shared disk but does not unconfigure the disk group or the volume group.

The following message might be displayed, but this is not a problem:

- WSFC

  `Warning: There is no value in the public entry PUBLIC.HA_MOUNT_POINT in the resource group` *xxxxx* `in the cluster registry.`

- VCS or SCS

  `VCS WARNING V-16-1-10133 Group does not exist:` *resource-group*

3. Change the FQDN setting for the NNMi node to the physical host name.

   a. Edit the `nms-local.properties` file.

   File path

   - Windows: `%NnmDataDir%conf\nnm\props\nms-local.properties`

   - Linux: `/var/opt/OV/conf/nnm/props/nms-local.properties`

   What to edit

   `com.hp.ov.nms.fqdn =` *virtual-host-name*

   Specify a virtual host name, not a physical host name.

   b. Execute the `nnmsetofficialfqdn.ovpl` command.

   For *FQDN*, specify the FQDN of the physical host name (host name displayed by the `hostname` command).

   - Windows

     `%NnmInstallDir%bin\nnmsetofficialfqdn.ovpl -force` *FQDN*

   - Linux

     `/opt/OV/bin/nnmsetofficialfqdn.ovpl -force` *FQDN*

   This command changes the FQDN setting that was changed to the virtual host name during HA configuration to the FQDN of the physical host name.

   The following messages might be displayed during command execution:

   - `For single sign-on to function normally, you must generate a new certificate manfully`

     Ignore this message because single sign-on is not supported.

   As a result, a self-signed certificate is used. If you want to use a different self-signed certificate or a Certificate Authority (CA)-signed certificate for NNMi communications, you must do some additional work.

   For details about the certificates, see 10. Working with Certificates for NNMi.

4. On the active cluster node, move the files that are specific to the NNMi HA resource group to a separate location for safekeeping.

   If you do not plan to reconfigure the NNMi HA resource group, you do not need to save a copy of these files, and you can delete them at this time.

   - Windows

     In Explorer, delete the `%NnmDataDir%hacluster\`*resource-group*`\` folder.

   - Linux

     `cd /var/opt/OV/hacluster`

     `rm -r` *resource-group*

5. Delete the following file:

File path

- Windows

In Explorer, delete `%NnmDataDir%shared\nnm\databases\nnmdatareplicator\DataReplicator.db`.

- Linux

```
rm /var/opt/OV/shared/nnm/databases/nnmdatareplicator/DataReplicator.db
```

6. Mount the shared disk.

   Use an OS or cluster operation to make the shared disk accessible.

   Example:

   In the **Server Manager**, please open the management screen of **Storage** Services > Disks, right-click on the disk where the shared disk has mounted and select **Onine**.

7. Copy the NNMi files from the shared disk to the previous active cluster node.

   Perform this procedure if either of the following is applicable:

   - You will be running NNMi with a database migrated from an HA configuration to a single-server configuration.
   - You used `nnmchangeembdbpw.ovpl` in the HA configuration to change the database password.

   Use the following command to copy the NNMi files from the shared disk to the local disk on the previous active cluster node:

   - Windows

     `%NnmInstallDir%misc\nnm\ha\nnmhadisk.ovpl NNM -from` *HA-mount-point*

   - Linux

     `/opt/OV/misc/nnm/ha/nnmhadisk.ovpl NNM -from` *HA-mount-point*

8. Delete the `NNM` folder or the `NNM` directory from the shared disk.

9. Unmount the shared disk.

   Example:

   In the **Server Manager**, please open the management screen of **Storage** Services > Disks, right-click on the disk where the shared disk is mounted and select **Offine**.

10. Enable the service automatic start feature.

    - Windows

      From the **Start** menu, select **Administrative Tools** > **Services**, and select **NNM Trap Receiver** and **NNM Trap Receiver Manager**, and then set **Startup type** to `Automatic`.

    - Linux

      ```
      systemctl enable netmgt.service
      systemctl enable nettrap.service
      systemctl start netmgt.service
      systemctl start nettrap.service
      ```

      The NNMi services are started when the `systemctl start` command is executed.

> **Note**
>
> If you will be running NNMi on the previous active cluster node, the preparations are now complete.
>
> Execute `ovstart` to start NNMi.
>
> The information provided below applies if either of the following is applicable:

- You will be running NNMi on the previous passive cluster node using a database migrated from an HA configuration to a single-server configuration.
- You used `nnmchangeembdbpw.ovpl` in the HA configuration to change the database password.

11. Use the command shown below to back up the NNMi configuration on the previous active cluster node.

    This provides a backup containing the data that was copied from the shared disk to a local disk in step 7.

    - Windows

      `%NnmInstallDir%bin\nnmbackup.ovpl -type offline -scope all -target` *directory*
    - Linux

      `/opt/OV/bin/nnmbackup.ovpl -type offline -scope all -target` *directory*

12. Restore the active cluster node backup data obtained in step 11 to the previous passive cluster node on which you want to run NNMi using the data that was used with the HA configuration.

    - Windows

      `%NnmInstallDir%bin\nnmrestore.ovpl -force -source` *backup_data*
    - Linux

      `/opt/OV/bin/nnmrestore.ovpl -force -source` *backup_data*

    For details about this command, see 20. NNMi Backup and Restore Tools.

19.8 Troubleshooting the HA Configuration

19.8.1 Common configuration mistakes

Some common HA configuration mistakes are listed here:

- Disk configuration is not valid.
  - VCS or SCS: If a resource cannot be probed, there is something wrong with the configuration. If a disk cannot be probed, the disk might no longer be accessible by the operating system.
  - Test the disk configuration manually and confirm against HA products documentation that the configuration is appropriate.
- The disk is in use and cannot be started for the HA resource group.

  Always check that the disk is not activated before starting the HA resource group.
- WSFC network configuration is not valid.

  If network traffic is flowing across multiple NIC cards, RDP sessions fail when activating programs that consume a large amount of network bandwidth, such as the NNMi `ovjboss` process.
- Some HA products do not restart automatically at startup.

  Review the HA product documentation for details about how to configure automatic restart at startup.
- NFS or other access is added directly to the OS.

  The resource group configuration must manage this behavior.
- Being in the shared disk mount point during a failover or when the HA resource group is being placed offline.

  HA kills any processes that prevent the shared disk from being unmounted. Move to a different directory when a failover occurs or when the resource group becomes offline.
- Reusing the HA cluster virtual IP address as the HA resource virtual IP address.

  This works on one system and not the other. Configure different IP addresses to each system.
- Timeouts are too frequent.

  If the products are misbehaving, the HA product might timeout the HA resource and cause a failover.

  In WSFC, check the value of the **Time to wait for resource to start** setting. NNMi sets this value to 15 minutes, but you can increase it.
- Maintenance mode is not being used.

  Maintenance mode was created for debugging HA failures. If you attempt to bring a resource group online on a system and it fails over shortly thereafter, use the maintenance mode to keep the resource group online to see what is failing.
- Cluster logs are not being used.

  Cluster logs can show many common mistakes.

19.8.2 HA resource testing

This subsection describes the general approach to testing the resources that you will place into the NNMi HA resource group.

This testing identifies hardware configuration problems. We recommend that you perform this testing before configuring NNMi to run under HA. Keep a record of the configuration values that generate positive results, and use these value when you perform full configuration of the NNMi HA resource group.

For specific details regarding any of the commands listed here, see the most recent documentation for your HA product.

To test HA resources:

1. Start the HA cluster.
2. (Windows only) Verify that the following virtual IP addresses have been defined for the HA cluster:
   - Virtual IP address for the HA cluster
   - Virtual IP address for each HA resource group

   None of these IP addresses can be in use elsewhere.
3. Add an HA resource group to the HA cluster.
   Use a non-production name, such as `test`, for this HA resource group.
4. Test the connection to the HA resource group:
   - Add the virtual IP address and corresponding virtual host name for the resource group as a resource to the HA resource group.
     Use the values that you will later associate with the NNMi HA resource group.
   - Trigger failover from the active cluster node to the passive cluster node to verify that the HA cluster fails over correctly.
   - Trigger failover from the new active cluster node to the new passive cluster node to verify failback.
   - If the resource group does not fail over correctly, log on to the active node and verify that the IP address is properly configured and accessible. Also verify that no firewall is blocking the IP address.
   - Trigger failover from the active cluster node to the passive cluster node to verify that the HA cluster fails over correctly.
   - Trigger failover from the new active cluster node to the new passive cluster node to verify failback.
   - If the resource group does not fail over correctly, log on to the active cluster node, and verify that the disk is mounted and accessible.
5. Keep a record of the commands and inputs that you used to configure the shared disk.
   You might need this information when configuring the NNMi HA resource group.
6. Remove the resource group from each node.
   - Remove the IP address entry.
   - Offline the resource group, and then remove the resource group from the node

   At this point, you can use the NNMi-provided tools to configure NNMi to run under HA.

19.8.3 General HA troubleshooting

(1) Resource hosting subsystem process stops unexpectedly

Starting an HA cluster resource on a computer running the Windows Server 2016 operating system stops the resource hosting subsystem (`rhs.exe`) process unexpectedly.

For details about this known problem, see the Microsoft Support Website article:

```
http://support.microsoft.com/kb/978527
```

Important

Always run the NNMi resource in a separate resource monitor (`rhs.exe`) specific to the resource group.

(2) Product monitoring times out

The system log contains a message similar to the following example:

```
VCS ERROR V-16-2-13027 Thread(...) Resource(<resource group>-app) - monitor procedure
 did not complete within the expected time.
```

This message indicates that the product could not monitor the resources within the time set in Veritas Cluster Server or Symantec Cluster Server.

A timeout value of 60 seconds is set as the default for Veritas Cluster Server or Symantec Cluster Server.

To change the timeout value set in Veritas Cluster Server or Symantec Cluster Server, run the following commands (in the order shown here):

```
/opt/VRTSvcs/bin/haconf -makerw
/opt/VRTSvcs/bin/hares -override resource-group-app MonitorTimeout
/opt/VRTSvcs/bin/hares -modify resource-group-app MonitorTimeout <value in seconds>
/opt/VRTSvcs/bin/haconf -dump -makero
```

(3) Log files on the active cluster node are not updating

This situation is normal. It occurs because the log files have been redirected to the shared disk.

For NNMi, review the log files in the location specified by `HA_NNM_LOG_DIR` in the `ov.conf` file.

(4) Cannot start the NNMi HA resource group on a particular cluster node

If the `nnmhargconfigure.ovpl` or `nnmhastartrg.ovpl` command does not correctly start, stop, or switch the NNMi HA resource group, review the following information:

- WSFC
  - Review in Failover Cluster Management the state of the resource group and underlying resources.
  - Review the Event Viewer log for any errors.
- VCS or SCS
  - Run `/opt/VRTSvcs/bin/hares -state` to review the resource state.
  - For failed resources, review the `/var/VRTSvcs/log/`*resource*`.log` file for the resource that is failing. Resources are referenced by the agent type (for example, `IP*.log`, `Mount*.log`, and `Volume*.log`).

If you cannot locate the source of the problem, you can start the NNMi HA resource group manually by using HA product commands:

1. Mount the shared disk.

2. Assign the virtual host to the network interface:
   - WSFC
     - Start Failover Cluster Management.
     - Expand the resource group.
     - Right-click *resource-group*`-ip`, and then click **Bring Online**.
   - VCS or SCS
     `/opt/VRTSvcs/bin/hares -online` *resource-group*`-ip -sys` *local-host-name*
3. Start the HA resource group.
   Example:
   - Windows
     `%NnmInstallDir%misc\nnm\ha\nnmhastartrg.ovpl NNM -start` *resource-group*
   - Linux
     `$NnmInstallDir/misc/nnm/ha/nnmhastartrg.ovpl NNM -start` *resource-group*

   Return code `0` indicates that NNMi started successfully.
   Return code `1` indicates that NNMi did not start correctly.

(5) The message System error XXXX occurred is displayed (in Windows)

A system (OS or cluster software) error might have occurred. For details, see the OS or cluster software documentation.

Error examples: Examples of errors in WSFC are described below.

- Example: `System error 5054 occurred (0x000013be). The cluster network is invalid.`
  If an IP address of the internal network for heartbeat is specified as an IP address for NNMi, this error occurs in the `cluster.exe` command that was executed to create IP address resources.
- Example: `System error 5057 occurred (0x000013c1). That cluster IP address is already in use.`
  If an IP address already in use is specified as an IP address for NNMi, this error occurs in the `cluster.exe` command that was executed to create IP address resources.

Action: Check the nature of the system error and take appropriate action. When a specified IP address is not valid for NNMi, as is the case in these examples, check the IP address that is to be used.

19.8.4 NNMi-specific HA troubleshooting

The topics in this subsection apply to HA configuration for NNMi only.

(1) NNMi does not start correctly under HA

When NNMi does not start correctly, you must determine whether the issue is a hardware issue with the virtual IP address or the disk, or whether the issue is some form of application failure. During this determination process, put the system in maintenance mode.

To fix this problem:

1. On the active cluster node in the HA cluster, disable HA resource group monitoring by creating the following maintenance file:

   Windows: `%NnmDataDir%hacluster\`*resource-group*`\maintenance`

   Linux: `$NnmDataDir/hacluster/`*resource-group*`/maintenance`

2. Start NNMi:

   ```
   ovstart
   ```

3. Verify that NNMi started correctly:

   ```
   ovstatus -c
   ```

   All NNMi services must show the state `RUNNING`. If this is not the case, troubleshoot the process that does not start correctly.

4. After completing your troubleshooting, delete the maintenance file:

   Windows: `%NnmDataDir%hacluster\`*resource-group*`\maintenance`

   Linux: `$NnmDataDir/hacluster/`*resource-group*`/maintenance`

(2) Changes to NNMi data are not seen after failover

The NNMi configuration points to a different system than the one NNMi is running. To fix this problem, verify that the `ov.conf` file has appropriate entries for the following items:

- `NNM_INTERFACE=`*virtual-host-name*
- `HA_RESOURCE_GROUP=`*resource-group*
- `HA_MOUNT_POINT=`*HA-mount-point*
- `NNM_HA_CONFIGURED=YES`
- `HA_POSTGRES_DIR=`*HA-mount-point*`/NNM/dataDir/shared/nnm/databases/Postgres`
- `HA_CUSTOMPOLLER_DIR=`*HA-mount-point*`/NNM/dataDir/shared/nnm/databases/custompoller`
- `HA_NNM_LOG_DIR=`*HA-mount-point*`/NNM/dataDir/log/nnm`
- `HA_JBOSS_DATA_DIR=`*HA-mount-point*`/NNM/dataDir/nmsas/NNM/data`
- `HA_LOCALE=`*locale* (Linux only)
- `HA_PERFSPI_ADAPTER_DIR=`*HA-mount-point*`/NNM/dataDir/shared/perfSpi/datafiles`

For the location of the `ov.conf` file, see 19.9.1 NNMi HA configuration files.

(3) nmsdbmgr does not start after HA configuration

This situation usually occurs as a result of starting NNMi after running the `nnmhaconfigure.ovpl` command but without having run the `nnmhadisk.ovpl` command with the `-to` option specified. In this case, the `HA_POSTGRES_DIR` entry in the `ov.conf` file specifies the location on the shared disk, but this location is not available to NNMi.

To fix this problem:

1. On the active cluster node in the HA cluster, disable HA resource group monitoring by creating the following maintenance file:

- Windows: `%NnmDataDir%hacluster\`*resource-group*`\maintenance`
- Linux: `$NnmDataDir/hacluster/`*resource-group*`/maintenance`

2. Copy the NNMi database to the shared disk:
   - Windows: `%NnmInstallDir%misc\nnm\ha\nnmhadisk.ovpl NNM -to` *HA-mount-point*
   - Linux: `$NnmInstallDir/misc/nnm/ha/nnmhadisk.ovpl NNM -to` *HA-mount-point*
3. Start the NNMi HA resource group:
   - Windows: `%NnmInstallDir%misc\nnm\ha\nnmhastartrg.ovpl NNM` *resource-group*
   - Linux: `$NnmInstallDir/misc/nnm/ha/nnmhastartrg.ovpl NNM` *resource-group*
4. Start NNMi:

   ```
   ovstart
   ```

5. Verify that NNMi started correctly:

   ```
   ovstatus -c
   ```

   All NNMi services must show the state `RUNNING`.
6. After completing your troubleshooting, delete the maintenance file:
   - Windows: `%NnmDataDir%hacluster\`*resource-group*`\maintenance`
   - Linux: `$NnmDataDir/hacluster/`*resource-group*`/maintenance`

(4) NNMi runs correctly on only one HA cluster node (Windows)

The Windows operating system requires two different virtual IP addresses, one for the HA cluster and one for the HA resource group. If the virtual IP address of the HA cluster is the same as that of the NNMi HA resource group, NNMi runs correctly only on the node associated with the HA cluster IP address.

To correct this problem, change the virtual IP address of the HA cluster to a unique value within the network.

(5) Disk failover does not occur

This situation can arise when the operating system does not support the shared disk. Review the HA product, operating system, and disk manufacturer documentation to determine whether these products can work together.

When a disk failure occurs, NNMi does not start on failover. Most likely, `nmsdbmgr` fails because the `HA_POSTGRES_DIR` directory does not exist. Verify that the shared disk is mounted and that the appropriate files are accessible.

(6) Shared disk is not accessible (Windows)

If nothing is displayed even after the command `nnmhaclusterinfo.ovpl -config NNM -get HA_MOUNT_POINT` is run, this indicates that the shared disk cannot be accessed because the specified mount point is incorrect.

The drive of the shared disk mount point must be fully specified during HA configuration.

Example: `Y:`

To correct this problem, run the `nnmhaconfigure.ovpl` command on each node in the HA cluster. Fully specify the drive of the shared disk mount point.

(7) Shared disk files are not found on the secondary cluster node after failover

The most common cause of this situation is that the `nnmhadisk.ovpl` command was run with the `-to` option specified while the shared disk was not mounted. In this case, the data files are copied to the local disk, so the files are not available on the shared disk.

To fix this problem:

1. On the active cluster node in the HA cluster, disable HA resource group monitoring by creating the following maintenance file:

   Windows: `%NnmDataDir%hacluster\`*resource-group*`\maintenance`

   Linux: `$NnmDataDir/hacluster/`*resource-group*`/maintenance`
2. Log on to the active cluster node and verify that the disk is mounted and available.
3. Stop NNMi:

   ```
   ovstop
   ```

   Windows: `net stop NnmTrapReceiver`

   Linux: `/opt/OV/bin/nettrap stop`
4. Copy the NNMi database to the shared disk:

   Windows: `%NnmInstallDir%misc\nnm\ha\nnmhadisk.ovpl NNM -to` *HA-mount-point*

   Linux: `$NnmInstallDir/misc/nnm/ha/nnmhadisk.ovpl NNM -to` *HA-mount-point*
5. Start the NNMi HA resource group:

   Windows: `%NnmInstallDir%misc\nnm\ha\nnmhastartrg.ovpl NNM` *resource-group*

   Linux: `$NnmInstallDir/misc/nnm/ha/nnmhastartrg.ovpl NNM` *resource-group*
6. Start NNMi:

   ```
   ovstart
   ```
7. Verify that NNMi started correctly:

   ```
   ovstatus -c
   ```

   All NNMi services must show the state `RUNNING`.
8. After completing your troubleshooting, delete the maintenance file:

   Windows: `%NnmDataDir%hacluster\`*resource-group*`\maintenance`

   Linux: `$NnmDataDir/hacluster/`*resource-group*`/maintenance`

19.9 HA configuration reference

This section explains the NNMi HA configuration files, scripts, and log files.

19.9.1 NNMi HA configuration files

The table below lists the NNMi HA configuration files. These files apply to NNMi and are installed at the following location:

- Windows
  `%NnmDataDir%shared\nnm\conf`
- Linux
  `$NnmDataDir/shared/nnm/conf`

Table 19-11: NNMi HA configuration files

File name	Description
`ov.conf`	This file describes the NNMi HA implementation and is updated by the `nnmhaclusterinfo.ovpl` command. NNMi processes read this file to determine the HA configuration.
`nnmdatareplicator.conf`	This file is used by the `nnmdatareplicator.ovpl` command to determine the NNMi folders and files that have been included in data replication from the active cluster node to the passive cluster nodes. If you implement a different method of replicating the NNMi configuration, see this file for a list of the data to include. For details, see the comments in this file.

19.9.2 NNMi-provided HA configuration scripts

The tables below list the HA configuration scripts that are included with NNMi. The NNMi-provided scripts are convenience scripts that can be used to configure HA for any product that has a customer Perl module. If you prefer, you can use commands provided by the HA product to configure HA for NNMi.

On the NNMi management server, the NNMi-provided HA configuration scripts are installed at the following location:

- Windows
  `%NnmInstallDir%misc\nnm\ha`
- Linux
  `$NnmInstallDir/misc/nnm/ha`

Table 19-12: NNMi HA configuration scripts

Script name	Description
`nnmhaconfigure.ovpl`	Configures NNMi for an HA cluster. Run this script on all nodes in the HA cluster.
`nnmhaunconfigure.ovpl`	Unconfigures NNMi from an HA cluster. Run this script on one or more nodes in the HA cluster, as needed.
`nnmhaclusterinfo.ovpl`	Retrieves cluster information regarding NNMi. Run this script as needed on any node in the HA cluster.

Script name	Description
nnmhadisk.ovpl	Copies NNMi data files to and from the shared disk. During HA configuration, run this script on the primary cluster node. At other times, run this script per the instructions in this chapter.
nnmhastartrg.ovpl	Starts the NNMi HA resource group in an HA cluster. During HA configuration, run this script on the primary cluster node.
nnmhastoprg.ovpl	Stops the NNMi HA resource group in an HA cluster. During HA unconfiguration, run this script on the active cluster node.

The NNMi-provided scripts listed in Table 19-13 are used by the scripts listed in Table 19-12. Do not run the scripts listed in Table 19-13 directly.

Table 19-13: NNMi HA support scripts

Script name	Description
nnmdatareplicator.ovpl	Checks the nnmdatareplicator.conf configuration file for changes and copies files to remote systems.
nnmharg.ovpl	Starts, stops, and monitors NNMi in an HA cluster. For VCS or SCS configurations, this script is used by the VCS or SCS start, stop, and monitor scripts (nnmhargconfigure.ovpl configures this usage). This script is also used by nnmhastartrg.ovpl to enable and disable tracing.
nnmhargconfigure.ovpl	Configures HA resources and resource groups. This script is used by nnmhaconfigure.ovpl and nnmhaunconfigure.ovpl.
nnmhastart.ovpl	Starts NNMi in an HA cluster. This script is used by nnmharg.ovpl.
nnmhastop.ovpl	Stops NNMi in an HA cluster. This script is used by nnmharg.ovpl.
nnmhamonitor.ovpl	Monitors NNMi processes in an HA cluster. This script is used by nnmharg.ovpl.
nnmhamscs.vbs	This is a template for creating a script to start, stop, and monitor NNMi processes in a WSFC HA cluster. The generated script is used by WSFC and is stored at the following location: %NnmDataDir%hacluster*resource-group*\hamscs.vbs

19.9.3 NNMi HA configuration log files

The following log files are applicable to an HA configuration for NNMi:

- Windows configuration
  - NnmDataDir%tmp\HA_nnmhaserver.log
  - NnmDataDir%log\haconfigure.log
- Linux
  - $NnmDataDir/tmp/HA_nnmhaserver.log
  - $NnmDataDir/log/haconfigure.log
- Windows runtime
  - Event Viewer log
  - %HA_MOUNT_POINT%\NNM\dataDir\log\nnm\ovspmd.log
  - %HA_MOUNT_POINT%\NNM\dataDir\log\nnm\postgres.log

- %HA_MOUNT_POINT%\NNM\dataDir\log\nnm\nmsdbmgr.log
- %SystemRoot%\Cluster\cluster.log

This is the log file for cluster runtime issues, including adding and removing resources and resource groups, other configuration issues, and starting and stopping issues.

- Linux for VCS or SCS

Resource	Log file
resource-group-app	• /var/VRTSvcs/log/Application_A.log • $HA_MOUNT_POINT/NNM/dataDir/log/nnm/ovspmd.log • $HA_MOUNT_POINT/NNM/dataDir/log/nnm/public/postgres.log • $HA_MOUNT_POINT/NNM/dataDir/log/nnm/public/nmsdbmgr.log • Linux: /var/log/messages* • Solaris: /var/adm/messages*
resource-group-dg *resource-group*-volume *resource-group*-mount	• /var/VRTSvcs/log/DiskGroup_A.log • /var/VRTSvcs/log/Volume_A.log • /var/VRTSvcs/log/Mount_A.log • Linux: /var/log/messages* • Solaris: /var/adm/messages*
resource-group-ip	• /var/VRTSvcs/log/IP_A.log • Linux: /var/log/messages* • Solaris: /var/adm/messages*

Note: For operating system-specific issues related to the HA resources, review the /var/adm/messages* or /var/log/messages* files. For *resource-group*-app, look for messages regarding unable to start a process.

20 NNMi Backup and Restore Tools

Good backup and restore strategies are key to ensuring the uninterrupted functioning of any business. Because NNMi is an important asset for network operations, it must be backed up regularly. The two types of critical data related to an NNMi installation are as files in the file system and data in the relational database. This chapter explains the tools NNMi provides for backing up and restoring important NNMi files and data.

20.1 Backup and restore commands

NNMi provides the following scripts for backing up and restoring NNMi data:

- `nnmbackup.ovpl`

  Backs up all necessary file system data (including configuration information) and any data stored in the NNMi database.
- `nnmrestore.ovpl`

  Restores a backup that was created with the `nnmbackup.ovpl` script.
- `nnmbackupembdb.ovpl`

  Creates a complete backup of the NNMi database (but not the file system data) while NNMi is running.
- `nnmrestoreembdb.ovpl`

  Restores a backup that was created with the `nnmbackupembdb.ovpl` script.
- `nnmresetembdb.ovpl`

  Drops the NNMi database tables. Run the `ovstart` command to re-create the tables.

For each command's syntax, see the appropriate reference page.

20.2 Backing up NNMi data

The NNMi backup command (`nnmbackup.ovpl`) copies key NNMi file system data and some or all of the tables in the NNMi Postgres database to a specified target directory. Each backup operation stores files in a parent directory called `nnm-bak-`*timestamp* inside the target directory. You can specify the `-noTimeStamp` option to save disk space, in which case the parent directory is named simply `nnm-bak`. When a backup is performed after a previous backup with the `-noTimeStamp` option in effect, the previous backup is renamed `nnm-bak.previous`, thereby creating a rolling backup. This renaming occurs after the second backup has been completed to protect against any loss of backup data.

The NNMi backup command can create a tar archive of the backup data. You can use any tool of your choice to compress backup files. You can also use any appropriate tool to save a copy of a backup. For details, see the *nnmbackup.ovpl Reference Page*.

20.2.1 Backup type

The NNMi backup command supports two types of backups:

- Online backups occur while NNMi is running. NNMi ensures that the database tables are synchronized in the backed up data. Operators can be actively using the NNMi console and other processes can be interacting with the NNMi database during an online backup. With an online backup, you can back up all NNMi data or only some of the data according to function, as described in 20.2.2 Backup scope. For the NNMi database, the `nmsdbmgr` service must be running.
- Offline backups occur while NNMi is completely stopped. With an offline backup, the backup scope applies to the file system files only. An offline backup always includes the complete NNMi database regardless of the backup scope. For the NNMi database, the backup copies the Postgres database files.

20.2.2 Backup scope

The NNMi backup command provides several scopes that define how much of NNMi is backed up.

Configuration scope

The configuration scope (`-scope config`) loosely aligns to the information in the **Configuration** workspace on the NNMi console.

The configuration scope includes the following data:

- For online backups, only those database tables that store NNMi configuration information.
- For offline backups, the entire database.
- For all backups, the NNMi configuration information in the file system, as listed in Table 20-1: Configuration scope files and directories.

Topology scope

The topology scope (`-scope topology`) loosely aligns to the information in the **Inventory** workspace on the NNMi console. Because the network topology is dependent on the configuration that was used for discovering that topology, the topology scope includes the configuration scope.

The topology scope includes the following data:

- For online backups, only those database tables that store NNMi configuration and network topology information.
- For offline backups, the entire database.

- For all backups, the NNMi configuration information in the file system, as listed in Table 20-1: Configuration scope files and directories. Currently, there are no file system files associated with the topology scope.

Event scope

The event scope (`-scope event`) loosely aligns to the information in the **Incident Browsing** workspace on the NNMi console. Because events are dependent on the network topology related to those events, the event scope includes the configuration and topology scopes.

The event scope includes the following data:

- For online backups, only those database tables that store NNMi configuration, network topology, and event information.
- For offline backups, the entire database.
- For all backups, the NNMi configuration information in the file system, as listed in Table 20-1: Configuration scope files and directories, and the NNMi event information, as listed in Table 20-2: Event scope files and directories.

All scope

The complete backup (`-scope all`) includes all important NNMi files and the complete database.

Table 20-1: Configuration scope files and directories

Directory or file name	Description
`%NnmInstallDir%conf` (Windows only)	Configuration information
`%NnmInstallDir%misc\nms\lic` `$NnmInstallDir/misc/nms/lic`	Miscellaneous license information
`%NnmDataDir%nmsas\NNM\conf` `$NnmDataDir/nmsas/NNM/conf`	JBoss configuration
`%NnmDataDir%conf` `$NnmDataDir/conf`	Configuration information
`%NnmDataDir%conf\nnm\props` `$NnmDataDir/conf/nnm/props`	Local NNMi configuration properties files
`%NnmDataDir%shared\nnm\conf\licensing\LicFile.txt` `$NnmDataDir/shared/nnm/conf/licensing/LicFile.txt`	License information
`%NnmDataDir%NNMVersionInfo` `$NnmDataDir/NNMVersionInfo`	NNMi version information file
`%NnmDataDir%shared\nnm\user-snmp-mibs` `$NnmDataDir/shared/nnm/user-snmp-mibs`	Shared user-added SNMP MIB information
`%NnmDataDir%shared\nnm\actions` `$NnmDataDir/shared/nnm/actions`	Shared lifecycle transition actions
`%NnmDataDir%shared\nnm\certificates` `$NnmDataDir/shared/nnm/certificates`	Shared NNMi SSL certificates
`%NnmDataDir%shared\nnm\conf` `$NnmDataDir/shared/nnm/conf`	Shared NNMi configuration information
`%NnmDataDir%shared\nnm\conf\licensing` `$NnmDataDir/shared/nnm/conf/licensing`	Shared NNMi license configuration information
`%NnmDataDir%shared\nnm\lrf` `$NnmDataDir/shared/nnm/lrf`	Shared NNMi component registration files

Directory or file name	Description
%NnmDataDir%shared\nnm\conf\props $NnmDataDir/shared/nnm/conf/props	Shared NNMi configuration properties files
%NnmDataDir%shared\nnm\www\htdocs\images $NnmDataDir/shared/nnm/www/htdocs/images	Shared background images for NNMi node group map

In this context, files in the shared directories are those shared with another NNMi management server in an NNMi application failover or high availability environment.

Table 20-2: Event scope files and directories

Directory or file name	Description
%NnmDataDir%log\nnm\signin.log $NnmDataDir/log/nnm/signin.log	NNMi console sign-in log

20.3 Restoring NNMi data

The NNMi restore script (`nnmrestore.ovpl`) places backup data on the NNMi management server. The type and scope of the backup determines what NNMi can restore.

> **Note**
>
> If you use the `nnmrestore.ovpl` script to place database records on a second NNMi management server, both NNMi management servers must have the same type of operating system and the same NNMi version and patch level.

> **Important**
>
> Do not restore backup data acquired from an NNMi with a cluster configuration to an NNMi with a single configuration.

When you are using the global network management function, placing the backup data from one NNMi management server onto a second NNMi management server means that both servers have the same database UUID. After you restore NNMi on the second NNMi management server, you must uninstall NNMi from the original NNMi management server.

- In restoring an online backup, NNMi copies the file system data to the correct locations and overwrites the contents of the database tables that were included in the backup. Objects that were deleted after the backup was made are restored, and objects that have been created since the backup was made disappear. Additionally, any objects that were changed after the backup was made revert to their state at the time of the backup. For the NNMi database, the `nmsdbmgr` service must be running.
- In restoring an offline backup, NNMi overwrites the Postgres files in the file system, completely replacing the database files with the contents of the backup.

With the `-force` option, the `nnmrestore.ovpl` command stops all NNMi processes, starts the `nmsdbmgr` service (if restoring from an online backup of the NNMi database), restores the data, and then restarts all NNMi processes.

If the provided source is a tar file, the NNMi restore command extracts the tar file to a temporary folder in the current working directory. In this case, either ensure that the current working directory has adequate storage capacity to support the temporary folder, or extract the archive before running the restore command.

> **Note**
>
> Because the database schema might change from one version of NNMi to the next, data backups cannot be shared across versions of NNMi.

20.3.1 Same-system restore

When you use the backup and restore commands on the same system (single-system backup and restore), the following items must not have changed between the time of the backup and the time of the restore:

- NNMi version (including any patches)
- Operating system type

- Character set (language)
- Host name
- Domain

20.3.2 Different-system restore

You can also use the backup and restore commands to transfer data from one NNMi management server to another. The intended uses of different-system restoration include recovering from a system failure and transferring NNMi to a different system during an operating system upgrade.

Tip

You must note the following if you are using the global network management function: Because the NNMi UUID is copied to the target system during the database restore, both the source system and the target system will appear to be running the same instance of NNMi. To resolve this anomaly, you must uninstall NNMi from the source system.

Note

To create multiple functional NNMi management servers with similar configurations, such as while deploying global network management, use the `nnmconfigexport.ovpl` and `nnmconfigimport.ovpl` commands.

For a different-system restore, the following items must be identical on both systems:

- NNMi version (including any patches)
- Operating system type
- Character set (language)

The following items can differ between the two systems:

- Host name
- Domain

In a different-system restore, the `nnmrestore.ovpl` command does not copy license information to the new system. You must obtain and apply a new license for the new NNMi management server. For details, see the license manual.

20.4 Backup and restore strategies

20.4.1 Back up all data periodically

Make sure that your disaster recovery plan includes a regularly scheduled complete backup of all NNMi data. You do not need to shut down NNMi to create this backup. If you incorporate the backup into a script, you can use the `-force` option to ensure that NNMi is in the correct state before the backup begins.

Example:

```
nnmbackup.ovpl -force -type online -scope all -archive -target nnmi_backups\periodic
```

To recover your NNMi data after a hardware failure, follow these steps:

1. Repair or replace the failed hardware.
2. Install NNMi to the same version and patch level as were in place at the time of the backup.
3. Restore the NNMi data.
   - If the recovery NNMi management server satisfies the requirements listed in 20.3.1 Same-system restore, run a command similar to the following example:

   ```
   nnmrestore.ovpl -force -lic -source nnmi_backups\periodic\newest_backup
   ```

   - If the recovery NNMi management server does not qualify for a same-system restore but satisfies the requirements listed in 20.3.2 Different-system restore, run a command similar to the following example:

   ```
   nnmrestore.ovpl -force -source nnmi_backups\periodic\newest_backup
   ```

   Update the licensing as needed.

20.4.2 Back up data before changing the configuration

Perform a scoped backup (as described in 20.2.2 Backup scope) as needed before beginning configuration changes. In this way, if your configuration changes do not have the expected effect, you will be able to revert to a known operational configuration.

Example:

```
nnmbackup.ovpl -type online -scope config -target nnmi_backups\config
```

To restore this backup to the same NNMi management server, stop all NNMi processes, and then run a command similar to the following example:

```
nnmrestore.ovpl -force -source nnmi_backups\config\newest_backup
```

20.4.3 Back up data before upgrading NNMi or the operating system

Before making major system changes (including upgrading NNMi or the operating system), perform a complete backup of all NNMi data. To ensure that no changes are made to the NNMi database after the backup is made, stop all NNMi processes and create an offline backup.

Example:

```
nnmbackup.ovpl -type offline -scope all -target nnmi_backups\offline
```

If NNMi does not run correctly after the system change, roll back the change or set up a different NNMi management server and ensure that the requirements listed in 20.3.2 Different-system restore are satisfied, and then run a command similar to the following example:

Example:

```
nnmrestore.ovpl -source nnmi_backups\offline\newest_backup
```

Update the licensing as needed.

20.4.4 Restore file system files only

To overwrite NNMi files without affecting the database tables, run a command similar to the following example:

Example:

```
nnmrestore.ovpl -partial -source nnmi_backups\offline\newest_backup
```

20.5 Backing up and restoring the database

NNMi provides the `nnmbackupembdb.ovpl` and `nnmrestoreembdb.ovpl` commands to back up and restore the NNMi database only. This functionality is useful for creating a snapshot of the data as you experiment with NNMi configuration settings.

The `nnmbackupembdb.ovpl` command performs online backups only. At a minimum, the `nmsdbmgr` service must be running.

Each backup operation stores files in a parent directory called `nnm-bak-<TIMESTAMP>` in the target directory. You can specify the `-noTimeStamp` option to save disk space. When you use the `-noTimeStamp` option, the parent directory is simply named `nnm-bak`. When a backup is performed after a previous backup was made using the `-noTimeStamp` option, the previous backup is renamed `nnm-bak.previous`, thereby creating rolling backups. This renaming is performed after the second backup has been made to protect against any loss of backup data.

Tip

Run the `nnmresetembdb.ovpl` command before restoring data to the database. This command ensures that the database does not contain any errors, thus eliminating the possibility of encountering database constraint violations. For details about running this database reset command, see the *nnmresetembdb.ovpl Reference Page*.

21 Maintaining NNMi

Once the NNMi management servers begin working, you can perform maintenance tasks in order to optimize several NNMi features.

21.1 Administering access control lists for NNMi folders

You might encounter a situation that would cause you to modify the user name that runs the NNM Action Server. However, if you change the user name that runs the action server without modifying the user name permissions, the NNM Action Server might not start, and NNMi might not log messages when running incident actions. This section discusses the actions to take to prevent this from happening.

NNMi supports changing the permissions for the following directories:

- `/var/opt/OV/log/nnm/public`
- `/var/opt/OV/shared/perfSpi`

Although the default permissions for the `/var/opt/OV/log/nnm/public` folder are `755`, NNMi uses ACLs to adjust access permissions for the database user (`nmsdbmgr`) and the `nnmaction` user (`bin`). During NNMi post-installation (part of the installation or upgrade script), the installation script changes the `/var/opt/OV/log/nnm/public` folder permissions and adds the ACLs.

If the installation script is unable to set the ACLs in the `/var/opt/OV/log/nnm/public` folder due to some unexpected error, the script will leave the `/var/opt/OV/log/nnm/public` folder world-writable (by other users), even though the NNMi installation completes successfully. Following a successful NNMi installation, if you want to restrict world-write permissions on the `/var/opt/OV/log/nnm/public` folder, see the system administrator's documentation to determine how to set up ACLs for the NNMi management server's operating system.

For the `/var/opt/OV/log/nnm/public` folder, use Linux ACLs (access control lists) to adjust user access. Configuring ACLs is a useful method for extending the `owner/group/other` permissions. ACLs are supported in Linux.

For example, after running the command listed below, the user depicted by the *user* variable obtains write access to the folder `/var/opt/OV/log/nnm/public`. Without running the following command, the permissions for the `/var/opt/OV/log/nnm/public` folder are `755`, and files within the directory are not writable by anyone other than `root`.

`setfacl -m user:`*user*`:rwx /var/opt/OV/log/nnm/public`

For details about how to use the `setfacl` command, see the appropriate reference pages.

21.2 Configuring node groups

NNMi provides a command line tool to help you automate the configuration of node groups. The `nnmnodegroup.ovpl` command enables you to create, list, modify, and delete node groups.

For details, see the *nnmnodegroup.ovpl Reference Page*.

21.3 Configuring node group map settings

In addition to using the NNMi console to configure node group map settings, you can use the `nnmnodegroupmapsettings.ovpl` command line tool to configure node group map settings. This tool lets you create, modify, and delete node group map settings. It also lets you list current node group map settings in TXT, XML, or CSV format.

> **Note**
>
> You can refresh the Web browser in which NNMi is currently running to see immediately the effects of the changes made to your node group map settings.

For details, see the *nnmnodegroupmapsettings.ovpl Reference Page*.

21.4 Configuring communication settings

You can use the `nnmcommunication.ovpl` command line tool to configure NNMi communication settings. This tool lets you create, list, modify, and delete communication settings. It can generate lists in text tables, as text lists, or in XML format.

An administrator can also use the `nnmcommunication.ovpl` tool to lock and directly manage SNMP agent settings for such fields as management addresses and community strings, bypassing the normal configuration.

The `nnmcommunication.ovpl` tool supports creating, updating, or deleting SNMP proxy ports and SNMP proxy addresses for Default, Node-specific, Region-specific, and SNMP Agent-specific settings using the Command Line Interface (CLI).

For details, see the *nnmcommunication.ovpl Reference Page*.

21.5 Administering a Custom Poller collection export

The Custom Poller feature enables you to take a proactive approach to network management by using SNMP MIB expressions to specify additional information that NNMi needs to poll. A Custom Poller collection defines the information you want to gather (poll) as well as how NNMi is to react to the gathered data. For details, see *Create a Custom Poller Collection* and Create Custom Polling Configurations in NNMi Help.

The Custom Poller feature relies on you to remove files from the export directory as you process them. Do not use the exported files for long-term storage; if they consume more than the configured maximum disk space, NNMi will remove the older files as it creates new ones. Unless you process these files and store them in a different location, you will lose them.

21.5.1 Changing the Custom Poller collections export directory

NNMi writes the data from the collections you export into the following directory:

- Windows: `%NNM_DATA%\shared\nnm\databases\custompoller\export`
- Linux: `$NNM_DATA/shared/nnm/databases/custompoller/export`

To change the directory into which NNMi writes its Custom Poller files, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-custompoller.properties`
   - Linux: `$NNM_PROPS/nms-custompoller.properties`
2. Look for the `exportdir` entry.
   This entry is similar to the following line:

   ```
   #!com.hp.nnm.custompoller.exportdir=base-directory-to-export-custom-poller-metrics
   ```

   To configure NNMi to write Custom Poller collection information into the `C:\CustomPoller` directory, change the line as follows:

   ```
   com.hp.nnm.custompoller.exportdir=C:/CustomPoller
   ```

   Make sure that the characters `#!` at the beginning of the line are deleted.

   Important

   For the directory delimiter character, use a forward slash (`/`), not a backslash (`\`), in Windows as well.
3. Save your changes.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.5.2 Changing the maximum amount of disk space for Custom Poller collections export

To change the maximum amount of disk space that NNMi uses when exporting data to `collection_name.csv` files, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-custompoller.properties`
   - Linux: `$NNM_PROPS/nms-custompoller.properties`
2. Look for the `maxdiskspace` entry.

   This entry is similar to the following line:

   ```
   #!com.hp.nnm.custompoller.maxdiskspace=1000
   ```

   To configure NNMi to reserve up to 2,000 megabytes (2 gigabytes) of storage space for each `collection_name.csv` file, change the line as follows:

   ```
   com.hp.nnm.custompoller.maxdiskspace=2000
   ```
3. Save your changes.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.5.3 Changing the Custom Poller metric accumulation interval

NNMi sets the period of time (in minutes) during which it accumulates Custom Poller Collection metrics before it writes data into a file. To change the Custom Poller metric accumulation interval, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-custompoller.properties`
   - Linux: `$NNM_PROPS/nms-custompoller.properties`
2. Look for a line that resembles the following:

   ```
   #!com.hp.nnm.custompoller.accumulationinterval=5
   ```

   To configure NNMi to collect metrics for 10 minutes instead of the default value of 5 minutes, change the line as follows:

   ```
   com.hp.nnm.custompoller.accumulationinterval=10
   ```
3. Save your changes.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.6 Administering incident actions

You can configure actions to run automatically at any point in the incident lifecycle. For example, you might want to configure an action to occur when an incident of the type you are configuring is generated. For details, see *Configure an Action for an Incident* in NNMi Help.

To adjust action parameters, follow the steps shown in the following subsections.

21.6.1 Setting the number of simultaneous actions

To modify the number of simultaneous actions that NNMi can run, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nnmaction.properties`
   - Linux: `$NNM_PROPS/nnmaction.properties`
2. Look for a line that resembles the following:

   ```
   #!com.hp.ov.nms.events.action.numProcess=10
   ```

   To configure NNMi to enable 20 simultaneous actions instead of the default value, change the line as follows:

   ```
   com.hp.ov.nms.events.action.numProcess=20
   ```

   Make sure you remove the `#!` characters at the beginning of the line.
3. Save your changes.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.6.2 Setting the number of threads for Jython actions

To modify the number of threads the action server uses to run `jython` scripts, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nnmaction.properties`
   - Linux: `$NNM_PROPS/nnmaction.properties`
2. Look for a line that resembles the following:

   ```
   #!com.hp.ov.nms.events.action.numJythonThreads=10
   ```

   To configure NNMi to enable 20 threads for running `jython` scripts instead of the default value, change the line as follows:

   ```
   com.hp.ov.nms.events.action.numJythonThreads=20
   ```

   Make sure you remove the `#!` characters at the beginning of the line.
3. Save your changes.

4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.6.3 Setting the action server name parameter

To modify the user name that runs the action server on a Windows NNMi management server, change the `LogOn` property of the NNM Action Server service. Specify a user name that has administrator permissions.

To modify the user name that runs the action server from an NNMi management server running on Linux operating system, complete the following steps:

1. Edit the following file:

   ```
   $NNM_PROPS/nnmaction.properties
   ```

2. Look for a line that resembles the following:

   ```
   #!com.hp.ov.nms.events.action.userName=bin
   ```

   To configure NNMi to have `system` run the action server instead of the default value, change the line as follows:

   ```
   com.hp.ov.nms.events.action.userName=system
   ```

   Make sure you remove the `#!` characters at the beginning of the line.

3. Save your changes.
4. Restart the action server by running the following commands:
   a. `ovstop nnmaction`
   b. `ovstart nnmaction`

21.6.4 Changing the action server queue size

If a command that does not terminate for a long time is defined as an incident action for a large number of incidents that occur over a short period of time, the action server might use up a lot of memory. To provide better action server performance, Hitachi places limits on the memory size that the action server can use.

To modify these limits, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nnmaction.properties`
   - Linux: `$NNM_PROPS/nnmaction.properties`
2. Look for two lines that resemble the following:

   ```
   com.hp.ov.nms.events.action.jvmargs.minMemsize=-Xms6m
   com.hp.ov.nms.events.action.jvmargs.maxMemsize=-Xmx30m
   ```

3. These parameters show that the minimum and maximum memory size are set to 6 megabytes and 30 megabytes, respectively. Adjust these parameters to meet your needs.
4. Save your changes.

5. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.6.5 Incident actions log

When an action runs, output is logged to the associated incident actions log file. To view the contents of the log for a selected incident, choose **Tools** and then the **Incident Actions Log** menu option. The following table describes the items contained in the log:

Table 21-1: Incident actions log items

Item	Description
`Command`	Command to run when the lifecycle state in which the incident is configured is reached
`Incident Name`	Name of incident
`Incident UUID`	UUID of the incident (displayed under the **Registration** tab)
`Command Type`	Type of command (`Jython` or `ScriptOrExecutable`)
`Lifecycle`	Lifecycle state of the incident (`Registered`, `In Process`, `Completed`, or `Closed`)
`Exit Code`	Command's return code
`Standard Output`	Standard output of the action
`Standard Error`	Standard error output
`Execution Status`	Determined status of the action

21.7 Overriding settings in the server.properties file

A system might have two `server.properties` files.

The following file, which is created by the product installer, contains properties that customize the application server for application instances. This file is not modifiable by users and is replaced during code maintenance (upgrades and patches).

- Windows: `%NnmInstallDir%NNM\server\server.properties`
- Linux: `$NnmInstallDir/NNM/server/server.properties`

The following file is used by users to configure applications for their environment and will not be modified by the product during upgrades or patches. This file overrides values configured in other files. All customizing is implemented in this file.

- Windows: `%NnmDataDir%nmsas\NNM\server.properties`
- Linux: `$NnmDataDir/nmsas/NNM/server.properties`

21.7.1 Override the browser locale setting

You can use the following `server.properties` file to force a specified locale value for all NNMi clients regardless of their browsers' locale value:

- Windows: `%NnmDataDir%nmsas\NNM\server.properties`
- Linux: `$NnmDataDir/nmsas/NNM/server.properties`

When this value is set in the `server.properties` file, a browser's locale value is ignored.

To override browser locale settings:

1. Open the `server.properties` file.
   - Windows: `%NnmDataDir%nmsas\NNM\server.properties`
   - Linux: `$NnmDataDir/nmsas/NNM/server.properties`
2. Navigate to `nmsas.server.forceClientLocale`.
3. Set `nmsas.server.forceClientLocale` to either of the following:
   - `nmsas.server.forceClientLocale` = *two-letter-ISO-language-code*

   For example, enter the following to use only the ISO language code to set the locale to English:

   Example:

   `nmsas.server.forceClientLocale = en`
   - `nmsas.server.forceClientLocale` = *two-letter-ISO-language-code_two-letter-ISO-country-code*

   For example, enter the following to use the ISO language and country codes to set the locale to English:

   Example:

   `nmsas.server.forceClientLocale = en_US`
4. Restart the NNMi `ovjboss` service by running the following commands on the NNMi management server:

```
ovstop ovjboss
ovstart
```

Changes to the `server.properties` file are read only at the time of `ovjboss` startup.

For details, see the comments in the `server.properties` file.

21.7.2 Configuring SNMP Set object access privileges

You can use the following file to configure the object access privileges required for using the SNMP Set feature on the nodes to which users have access:

- Windows: `%NnmDataDir%nmsas\NNM\server.properties`
- Linux: `$NnmDataDir/nmsas/NNM/server.properties`

For details about the SNMP Set feature, see NNMi Help. For details about object access privileges, see NNMi Help for Administer.

To configure object access privileges for the SNMP Set feature:

1. Open the `server.properties` file.
   - Windows: `%NnmDataDir%nmsas\NNM\server.properties`
   - Linux: `$NnmDataDir/nmsas/NNM/server.properties`
2. Add the following line:

   ```
   permission.override.com.hp.nnm.SNMP_SET=object-access-role
   ```

   The following are the valid values for *object-access-role*:

   ```
   com.hp.nnm.ADMIN
   com.hp.nnm.LEVEL2
   com.hp.nnm.LEVEL1
   com.hp.nnm.GUEST
   ```

   For example, to enable the **Object Administrator** and **Object Operator Level 2** object access privileges to use the SNMP Set feature, enter the following.

   Example:

   ```
   permission.override.com.hp.nnm.SNMP_SET=com.hp.nnm.ADMIN,com.hp.nnm.LEVEL
   2
   ```
3. Include all the object access privileges for which you want to enable access.
4. Restart the NNMi `ovjboss` service by running the following commands on the NNMi management server:

   ```
   ovstop ovjboss
   ovstart
   ```

Changes to the `server.properties` file are read only at the time of `ovjboss` startup.

21.8 Administering SNMP traps

This section describes how to perform tasks.

21.8.1 Configuring NNMi to authenticate SNMPv3 traps for nodes that are either managed by using SNMPv2 or SNMPv1 or that are not discovered

Follow the steps in this section if NNMi is receiving SNMPv3 traps from nodes that meet either of the following criteria:

- The device is managed using SNMPv2 or SNMPv1.
- The device is not discovered by NNMi.

You can configure NNMi to add SNMPv3 engine IDs for these devices into the SNMPv3 cache.

By configuring NNMi this way, NNMi can authenticate and store these SNMPv3 traps.

To configure NNMi to receive and store SNMPv3 traps for nodes that are managed using SNMPv2 or SNMPv1 or that are not discovered:

1. In the NNMi console, navigate to **Configuration** > **Communication Settings**.
   Configure the default, regions, or specific node settings level such that each inbound trap will have a corresponding configuration to use to authenticate the trap. For details, see *Configure Default SNMPv3 Settings* in NNMi Help.

   > **Note**
   >
   > It is a good practice to use a region with included address ranges for your SNMPv3 nodes or configure a **Specific Node Setting** for each.

2. On the NNMi console, navigate to **Configuration** > **Incidents** > **Incident Configuration**.
3. Deselect **Discard Unresolved SNMP Traps and Syslog Messages**.
   Once you have deselected **Discard Unresolved SNMP Traps and Syslog Messages**, NNMi will retain traps sent from nodes that it has not discovered.
4. Run the `ovstop` command on the NNMi management server.
5. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-communication.properties`
   - Linux: `$NNM_PROPS/nms-communication.properties`
6. Add the following line to the end of the file:

   ```
   com.hp.nnm.snmp.engineid.file=file-pathfile.txt
   ```

   The *file-path*`file.txt` entry is the full path and file name of the file that contains the devices.
   With these configuration changes, NNMi will read the entries from this file into the SNMPv3 cache each time you restart the NNMi processes.

Important

On a Linux NNMi management server, the file path will be in the usual format, such as `/var/opt/OV/etc`.

On Windows NNMi management servers, use forward slashes for separators. For example, specify a file such as `C:/temp/file.txt`.

7. Save your changes.
8. Edit the *file-path*`file.txt` file.

   a. Add IP addresses for the device, port, and engine ID, separating them with the comma.

   b. Make the entry for each device on a separate line.

   An engine ID is a series of hexadecimal bytes. NNMi ignores the character case but recognizes spaces.

   Use the following examples as templates for creating your entries:

```
16.1.2.3,161,80 00 00 09 30 00 00 1f e9 a3 33 01
16.1.2.4,161,80 00 00 11 03 00 00 2d 51 99 30 00
1050:0000:0000:0000:0005:0600:300c:326b, 161, 800000090300001f9ea33000
ff06::c3,161,80 00 00 09 03 00 00 1f 9A A3 30 00
```

   a. Run the `ovstart` command on the NNMi management server to start NNMi and read the *file-path*`file.txt` file.

   b. Check the `Boot.log` file to verify that NNMi read the file.

   Verify that the file contains log messages similar to the following indicating that the file was read:

```
2012-10-17 14:44:44.876 INFO [NnmTrapService]Start: Populate engineIDs from file
2012-10-17 14:45:08.017 INFO [SnmpV3EngineIdCachePopulator]Successfully loaded 3 V
3
Engine IDs from file /temp/patch2/v3hosts.txt
```

   If there was a failure mapping a node to a valid configuration, you will see a message similar to the following:

```
2012-10-17 14:45:03.485 WARNING [SnmpV3EngineIdCachePopulator]V3
Engine IDs: Could not resolve SNMPv3 configuration for 16.1.2.6
```

   If you see a message similar to this, adjust the **Configuration** > **Communication Configuration** settings for the affected node.

Note

If you need to remove an entry from the cache as well as from the *file-path*`file.txt` file, it is best to remove the entry from the *file-path*`file.txt`, and then restart NNMi by running the following commands:

```
ovstop

ovstart
```

21.8.2 Block SNMPv1 or SNMPv2c Traps

Despite configuring device discovery to use only SNMPv3, some managed nodes may still try to send SNMPv1 or SNMPv2c traps to the NNMi management server. To prevent any SNMPv1 or SNMPv2c traps from reaching the NNMi

management server, it is recommended that you configure NNMi to accept only SNMPv3 traps and block all SNMPv1 and SNMPv2c traps.

Note: Before completing this configuration procedure, make sure that NNMi is configured to discover your network with the SNMPv3 protocol.

1. Log on to the NNMi management server.
2. Run the following command:
   - Windows:
     ```
     %NnmInstallDir%bin\nnmtrapconfig.ovpl -setProp disallowV1V2 -persist
     ```
   - Linux:
     ```
     /opt/OV/bin/nnmtrapconfig.ovpl -setProp disallowV1V2 -persist
     ```
3. Do one of the following:
   - Windows: Restart the NNM TrapReceiver service from the **Services** window.
   - Linux: Run the following commands:
     ```
     /opt/OV/bin/nettrap stop
     /opt/OV/bin/nettrap start
     ```

21.8.3 Configuring timeframes within which the Causal Engine stops accepting traps

When large areas of a network are unavailable at regular and predictable times, NNMi enables you to moderate the Causal Engine analysis load by inhibiting delivery of traps to the Causal Engine. To inhibit delivery of traps, you configure as an NNMi administrator the timeframes within which the NNMi Causal Engine is to stop accepting traps from the event system.

> **Important**
>
> This feature does not interfere with traps delivered to the NNMi console.

Traps that are delivered to the Causal Engine are used to trigger the State Poller to poll a node sooner than the schedule set by the State Poller polling policy. When you inhibit delivery of traps, NNMi must wait until the scheduled polling interval before obtaining updated information from the State Poller. In all cases, the NNMi Causal Engine reaches the same conclusion with or without traps by using status flows from the NNMi State Poller.

To configure times during which the Causal Engine is to stop accepting traps:

1. Create the following file:
   - Windows: `%NNM_PROPS%\nms-apa.properties`
   - Linux: `$NNM_PROPS/nms-apa.properties`
2. Add the following content to the created file:
   ```
   PROPERTY NAME: com.hp.ov.nms.apa.trapGateSchedule
   ```
   Use the following examples as guidelines:

In the following example, traps flow at midnight, are inhibited at 8:30 a.m., resume flowing at 10:00 a.m., and then are inhibited again at 4:30 p.m.:

```
com.hp.ov.nms.apa.trapGateSchedule = ENABLE_APA_TRAPS 08:30 10:00 16:30
```

In the following example, traps are inhibited at midnight, begin flowing at 8:30 a.m., are inhibited at 10:00 a.m., and then flow again at 4:30 p.m.:

```
com.hp.ov.nms.apa.trapGateSchedule = DISABLE_APA_TRAPS 08:30 10:00 16:30
```

3. Save your changes.
4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.9 Blocking incidents using the trapFilter.conf file

Note the following if the number of incidents flowing through your NNMi management server reaches a rate that causes NNMi to block newly arriving incidents:

- NNMi will generate a `TrapStorm` incident, indicating that incidents are being blocked.
- NNMi might also generate a major health message indicating that the incident rate is high and incidents are being blocked.

Use either of the following methods to reduce the number of incidents:

- Use the `nnmtrapd.conf` file to block incidents from entering NNMi by reducing the volume of incident traffic.

  Important

  When you use the `nnmtrapd.conf` file approach, NNMi still uses these incidents to calculate the trap rate and to write to the trap binary store. By using the `nnmtrapd.conf` file approach, you only stop incidents from being created or stored in the database.

  For details, see the *nnmtrapd.conf Reference Page*.
- Use `trapFilter.conf` to block incidents earlier in the NNMi event pipeline, preventing the blocked incidents from being analyzed for trap rate calculations and from being stored in the NNMi trap binary store.

  Note

  Adding device IP addresses or OIDs to the `trapFilter.conf` file enables you to block high-volume incidents and avoid problems caused by a high volume of incidents.

  For details, see the *trapFilter.conf Reference Page* and the *nnmtrapconfig.ovpl Reference Page*.

21.10 Configuring character set encoding settings for NNMi

Depending on the locale configured for your NNMi management server, you might need to configure the source encoding NNMi will use to interpret SNMP OCTETSTRING data. To do this, edit the nms-jboss.properties file as follows:

1. Edit the following file:
   - Windows: %NNM_PROPS%\nms-jboss.properties
   - Linux: $NNM_PROPS/nms-jboss.properties
2. Search for the text block containing the following line:

```
#!com.hp.nnm.sourceEncoding=UTF-8
```

3. Uncomment this line to read as follows:

```
com.hp.nnm.sourceEncoding=UTF-8
```

4. Modify the property value (UTF-8) shown in step 3 using the examples of comment statements shown in the nms-jboss.properties file.
5. Save the nms-jboss.properties file.
6. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.11 Modifying MIB Browser Parameters

If you use the NNMi MIB browser (Action > MIB Information > Browse MIB menu) to obtain information about a node, and provide an optional SNMP community string for that node, the NNMi MIB browser uses MIB browser parameters located in the nms-ui.properties file for MIB Browser SNMP communication.

> **Important**
>
> If you do not provide a community string when using the MIB Browser, NNMi uses the Communication Configuration settings established for the node (if any). These settings are configured in the NNMi console using the Communications Settings view in the Configuration workspace. See Configuring Communication Protocol in the NNMi help for more information.

To modify the MIB Browser parameters in the nms-ui.properties file, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Locate the text block containing the following line:

   ```
   # MIB Browser Parameters
   ```

3. Locate the MIB browser parameters located below `# MIB Browser Parameters` by searching for lines containing the following text:

   ```
   mibbrowser
   ```

4. Modify the MIB browser parameters by following instructions within the nms-ui.properties file.
5. Save your changes.
6. Restart NNMi:

   ```
   ovstop
   ovstart
   ```

21.12 Configuring NNMi to allow level 2 operators to delete nodes and incidents

By default, NNMi permits NNMi administrators to create, edit, or delete nodes or incidents in NNMi. You can configure accounts assigned to the NNMi Operator Level 2 (L2) User Group to have the ability to delete nodes or incidents. You can achieve this by using one of the following methods:

- (Recommended) Elevate the privileges of the required L2 users to delete the required nodes or incidents. This can be done using the NNMi web console. For more information, see the NNMi Admin help.
- Configure NNMi to globally enable L2 users to delete nodes or incidents. This can be done by overriding the default privileges by modifying certain NNMi property files.

> **Important**
>
> Use the override method only for global enablement. Once enabled, you cannot control L2 user access privileges in the NNMi web console.

To enable L2 users to edit or delete nodes, their associated incidents, or both, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-topology.properties`
   - Linux: `$NNM_PROPS/nms-topology.properties`
2. Append the following lines as required:
   - To enable L2 users to delete nodes, append the following line:

     ```
     permission.override.com.hp.nnm.DELETE_OBJECT=com.hp.nnm.ADMIN,com.hp.nnm.LEVEL2
     ```

   - To enable L2 users to delete incidents, append the following line:

     ```
     permission.override.com.hp.nnm.incident.DELETE=com.hp.nnm.ADMIN,com.hp.nnm.LEVEL
     2
     ```

3. Save the file.
4. Restart NNMi.

   ```
   ovstop
   ovstart
   ```

When making file changes under HA, you must make the changes on both nodes in the cluster. For an NNMi that uses an HA configuration, if the change requires you to stop and restart the NNMi management server, you must place the nodes in maintenance mode before running the `ovstop` and `ovstart` commands.

21.13 Configuring NNMi to allow level 2 operators to edit maps

By default, NNMi permits only NNMi administrators to edit maps by creating, modifying, and deleting node groups. You can configure NNMi so that user accounts assigned to the NNMi Operator Level 2 user group also have this ability.

Following is the procedure for changing NNMi to permit user accounts assigned to the NNMi Operator Level 2 user group to create, modify, and delete node groups on nodes to which they have access:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Search for the following text block and uncomment it:

   ```
   #!com.hp.nnm.ui.level2MapEditing = true
   ```
3. Save your change.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

When making file changes under HA, you must make the changes on both nodes in the cluster. For an NNMi that uses an HA configuration, if the change requires you to stop and restart the NNMi management server, you must place the nodes in maintenance mode before running the `ovstop` and `ovstart` commands.

After completing step 1 through step 5, the NNMi console changes as follows:

- The **Inventory** > **Node Group** menu shows **Create** and **Delete** toolbar icons for the NNMi Operator Level 2.
- The toolbar on the **Node Group** form contains the **Save and New** and **Delete Node Group** buttons.
- The **All Node Groups** folder appears in the **Topology Maps** workspace. For details, see *About Workspaces* in NNMi online Help.
- For node group maps, the NNMi console contains the **Save Map** toolbar button and **File** > **Save Map** menu items.
- The behavior of the **Save Layout** action depends on the existence of a node group map setting for the node group map. If no node group map setting exists for a node group map, you must create one.

You can configure NNMi so that NNMi Operator Level 2 users have permission to create node group map settings:

1. From the NNMi console, open **Topology Maps** > **Node Group Overview**.
2. Double-click the **Node Group** icon of interest.
   NNMi opens the node group map associated with the selected node group.
3. Open the node group map settings you want to modify:
   Select **File** > **Open Node Group Map Settings**.
4. Set the **Minimum NNMi Role to Save Layout** to **Operator Level 2**.
5. Save your changes.

The NNMi operator level 2 user group can now create, edit, and delete node group map settings from a node group map view.

21.14 Configuring NNMi to allow level 1 operators to run status polls and configuration polls

NNMi permits user accounts assigned to the NNMi Operator Level 2 user group to run status polls and configuration polls on nodes to which they have access. You must change the **Menu Item** configuration in the NNMi console as well as the object access privilege levels in the `nms-topology.properties` file for each poll.

If you need to change NNMi to permit user accounts assigned to the NNMi Operator Level 1 user group to run status polls and configuration polls, do the following:

1. Open the **Configuration** > **User Interface** > **Menu Item**s > **Status Poll** form.
2. From the **Menu Item Contexts** tab, open the entry for each **Required NNMi Role/Object Type** item you need to change.
3. Change the value of the **Required NNMi Role** to **Operator Level 1** for each object type for which you want a level 1 operator to be able to run status polls.

   This step enables the user accounts assigned to the NNMi Operator Level 1 user group to view the status poll action for the object type specified.

To change NNMi to permit user accounts assigned to the NNMi Operator Level 1 user group to view the **Configuration Poll** menu item, do the following:

1. Open the **Configuration** > **User Interface** > **Menu Items** > **Configuration Poll** form.
2. From the **Menu Item Contexts** tab, open the entry for each **Required NNMi Role/Object Type** item you need to change.
3. Change the value of the **Required NNMi Role** to **Operator Level 1** for each object type for which you want a level 1 operator to be able to run configuration polls.

   This step enables the user accounts assigned to the NNMi Operator Level 1 user group to view the configuration poll action for the object type specified.

   Editing the `nms-topology.properties` file, as shown in steps 7 through 10, permits user accounts assigned to the NNMi Operator Level 1 user group to run both status poll and configuration poll commands from the NNMi console. If you do not complete these steps, NNMi will display the status poll and configuration poll options in the **Actions** menu, but the user will see an error message when an attempt is made to run the status poll or configuration poll commands.
4. To change the level of access required for status polls and configuration polls (the required object access privilege levels), edit the following file:
   - Windows: `%NNM_PROPS%\nms-topology.properties`
   - Linux: `$NNM_PROPS/nms-topology.properties`
5. Scroll to the end of the file and add the following line for the status poll change:

```
permission.override.com.hp.nnm.STATUS_POLL=com.hp.nnm.ADMIN,com.hp.nnm.LEVEL2,com.
hp.nnm.LEVEL1
```

6. Add the following line for the configuration poll change:

```
permission.override.com.hp.nnm.CONFIG_POLL=com.hp.nnm.ADMIN,com.hp.nnm.LEVEL2,com.
hp.nnm.LEVEL1
```

7. Save your changes.
8. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

When making file changes under HA, you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configuration, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands.

21.15 Determining the original trap address from traps sent by a proxy SNMP gateway

Traps sent by a proxy SNMP gateway might not show the original trap address when NNMi is used in the default configuration. An administrator can configure NNMi to determine the original trap address.

Note the following:

- NNMi contains the `cia.originaladdress` custom incident attribute. NNMi determines the meaning of the `cia.originaladdress` attribute in conjunction with the `com.hp.nnm.trapd.useUdpHeaderIpAddress` property.
- The value of the `com.hp.nnm.trapd.useUdpHeaderIpAddress` parameter is false by default, so NNMi normally ignores the `cia.originaladdress` attribute.
- Once you have set the `com.hp.nnm.trapd.useUdpHeaderIpAddress` value to true, the `cia.originaladdress` attribute will provide the value of the SNMP agent address.

Setting the `com.hp.nnm.trapd.useUdpHeaderIpAddress` value to true is useful when you want to use the UDP header address as the source in NNMi but you still require access to the actual SNMP address of the managed device.

Important

When the `com.hp.nnm.trapd.useUdpHeaderIpAddress` attribute is false (the default setting), the `cia.originaladdress` and `cia.address` attributes both contain the same value.

To configure NNMi to determine the original trap address using the value of `cia.originaladdress`:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Search for the text block containing the following line:

   ```
   #!com.hp.nnm.trapd.useUdpHeaderIpAddress=false
   ```

3. Uncomment and edit this line to read as follows:

   ```
   com.hp.nnm.trapd.useUdpHeaderIpAddress=true
   ```

4. Save your changes.
5. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

   Important

   When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of using NNMi in an HA configurations, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before

running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

NNMi uses the value of `cia.originaladdress` to determine the original trap address.

21.15.1 Trap address ordering

NNMi analyzes source addresses as follows:

- `SNMPv1` and `SNMPv2c` traps in which the `com.hp.nnm.trapd.useUdpHeaderIpAddress` property is set to `true` use the following address order:

```
rfc3584TrapAddress (.1.3.6.1.6.3.18.1.3.0)
nnmTrapForwardingAddress (.1.3.6.1.4.1.11.2.17.2.19.1.1.3.0)
securityPackNotificationAddress (.1.3.6.1.4.1.99.12.45.2.1.0)
proxyOid (.1.3.6.1.4.1.11.2.17.5.1.0)
Source address in IP header
```

- `SNMPv1` traps in which the `com.hp.nnm.trapd.useUdpHeaderIpAddress` property is set to false use the following address order:

```
rfc3584TrapAddress (.1.3.6.1.6.3.18.1.3.0)
nnmTrapForwardingAddress (.1.3.6.1.4.1.11.2.17.2.19.1.1.3.0)
securityPackNotificationAddress (.1.3.6.1.4.1.99.12.45.2.1.0)
proxyOid (.1.3.6.1.4.1.11.2.17.5.1.0)
agent-addr field in v1 trap
Source address in IP header
```

21.16 NNMi NmsTrapReceiver process

NNMi provides a standalone `NmsTrapReceiver` process for minimizing the loss of SNMP traps during a failover. `NmsTrapReceiver` runs on both the active and standby nodes.

21.16.1 Configuring the NmsTrapReceiver

NNMi provides the following user-configurable setting:

- `trapReceiverJmsTTL`

  The `trapReceiverJmsTTL` option sets the maximum time that the `TrapReceiver` will cache traps. The default setting is 5 minutes. Data is lost if JBoss is down for longer than the amount of time that is set in `trapReceiverJmsTTL`.

  Note

  Before you configure this setting, time a failover to determine a benchmark, and then set the `trapReceiverJmsTTL` to be double that amount of time.

For details about how to modify this setting, see the *nnmtrapconfig.ovpl Reference Page*.

Important

For proper operation, it is critical that the clocks are synchronized between the active and standby nodes. Otherwise, you might experience a large duplication or loss of traps.

For details, see the *nnmtrapconfig.ovpl Reference Page*.

21.16.2 Starting and stopping the NmsTrapReceiver process

The `NmsTrapReceiver` process is started automatically by the operating system (Linux: `nettrap.service` on `systemd` ; Windows: `HP NNM NmsTrapReceiver` Service). The `NmsTrapReceiver` process is also started by `ovstart` if `ovstart` detects that the `NmsTrapReceiver` process is not running.

If you need to start or stop the `NmsTrapReceiver` manually, use the operating system service.

Important

The `ovstart` and `ovstop` commands only start and stop the JBoss pipeline for the processing of traps, not the remote trap server.

21.17 Configuring HTTPS-only communication with the NNMi console

The most effective method of preventing HTTP access to the NNMi console is to place the NNMi management server behind a firewall that permits only HTTPS access to the protected systems.

Using a firewall configuration to prevent HTTP access can cause problems for integrations that use Web services that support only HTTP to communicate with NNMi. See the documentation for the integrating product to determine whether it supports HTTPS.

For a less secure approach, redirect NNMi console access requests from the HTTP port to the HTTPS port by completing the following steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Search for the string `https` to locate the text block containing the following line:

   ```
   #! com.hp.ov.nms.ui.https.only=false
   ```

3. Uncomment and edit this line to read as follows:

   ```
   com.hp.ov.nms.ui.https.only=true
   ```

4. Save your changes.
5. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

   Note

   Setting this property to redirect HTTP requests to HTTPS for the NNMi console can cause problems with some applications that cross-launch back to NNMi. If you experience such problems, disable this HTTPS redirect.

21.18 Configuring NNMi to require encryption for remote access

The HTTP mode of communication can still be used even after installing and configuring NNMi to use HTTPS communication. To be able to restrict remote access to NNMi via HTTP, completely disable NNMi's HTTP mode of communication by the following instructions.

Before configuring NNMi to permit only encrypted remote access, make sure the global network management and other integrations support SSL. Configure them for SSL before configuring NNMi to permit only encrypted remote access.

Do not perform this task if you want to and are yet to configure the application failover cluster. After setting up the NNMi application failover cluster, you can complete these steps to disable HTTP and other unencrypted access.

To disable HTTP access from the network to NNMi, edit the `server.properties` file as follows:

1. Edit the following file (you will need to create it if it does not exist):
   - Windows: `%NnmDataDir%nmsas\NNM\server.properties`
   - Linux: `$NnmDataDir/nmsas/NNM/server.properties`
2. Add the following four lines to the `server.properties` file:

```
nmsas.server.net.bind.address = 127.0.0.1
nmsas.server.net.bind.address.ssl = 0.0.0.0
nmsas.server.net.hostname = localhost
nmsas.server.net.hostname.ssl = ${com.hp.ov.nms.fqdn}
```

3. Save your changes.
4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.19 Configuring NNMi to preserve a previously supported varbind order

All SNMPv2 traps contain the sysUptime.0 and snmpTrapOID.0 OIDs as the first and second varbinds.

> **Important**
>
> When an SNMPv2 trap definition contains either or both of sysUptime.0 and snmpOID.0 as trap parameters, they might appear in NNMi as additional varbinds in positions other than first and second in the varbind list.

Prior to NNMi 10-10, NNMi removed all instances of the sysUpTime.0 and snmpTrapOID.0 OIDs from the varbind list. Starting with NNMi 10-10, NNMi retains these OIDs when they are part of the trap definition, but they might appear in positions other than first and second in the varbind list of received trap. This change in positioning might alter the varbind order for those traps that have either sysUpTime.0 or snmpTrapOID.0 as trap parameters.

In the following example, the first boldface varbind contains the value for snmpTrapOID.0 and the second boldface varbind contains the value for sysUpTime.0. As shown in this example, these varbinds appear as additional varbinds in positions other than first and second in the varbind list:

```
//0: SNMP MESSAGE (0x30): 115 bytes
//2: INTEGER VERSION (0x2) 1 bytes: 1 (SNMPv2C)
//5: OCTET-STR COMMUNITY (0x4) 6 bytes: "public"
//13: V2-TRAP-PDU (0xa7): 102 bytes
//15: INTEGER REQUEST-ID (0x2) 2 bytes: 18079
//19: INTEGER ERROR-STATUS (0x2) 1 bytes: noError(0)
//22: INTEGER ERROR-INDEX (0x2) 1 bytes: 0
//25: SEQUENCE VARBIND-LIST (0x30): 90 bytes
//27: SEQUENCE VARBIND (0x30): 13 bytes
//29: OBJ-ID (0x6) 8 bytes: .1.3.6.1.2.1.1.3.0
//39: TIMETICKS (0x43) 1 bytes: 9
//42: SEQUENCE VARBIND (0x30): 32 bytes
//44: OBJ-ID (0x6) 10 bytes: .1.3.6.1.6.3.1.1.4.1.0
//56: OBJ-ID (0x6) 18 bytes: .1.3.6.1.6.3.1.1.5.3.1.3.6.1.4.1.9.1.14
//76: SEQUENCE VARBIND (0x30): 14 bytes
//78: OBJ-ID (0x6) 9 bytes: .1.3.6.1.2.1.2.2.1.1
//89: INTEGER (0x2) 1 bytes: 92
//92: SEQUENCE VARBIND (0x30): 23 bytes
//94: OBJ-ID (0x6) 10 bytes: .1.3.6.1.6.3.1.1.4.3.0
//106: OBJ-ID (0x6) 9 bytes: .1.3.6.1.4.1.11.2.3.14
```

> **Note**
>
> Set the com.hp.nnm.events.preserveOldVarbindListOrder property to true only if you want NNMi to remove all instances of the sysUpTime.0 and snmpTrapOID.0 OIDs from the varbind list.

To retain the NNMi behavior that existed prior to NNMi 10-10, do the following:

1. Edit the following file:
   - Windows: %NNM_PROPS%\nms-jboss.properties
   - Linux: $NNM_PROPS/nms-jboss.properties

2. Add the following line:

```
com.hp.nnm.events.preserveOldvarbindListOrder=true
```

3. Save your changes.
4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.20 Configuring the auto-trim oldest SNMP trap incidents feature

To keep NNMi performing at a high level, NNMi drops incoming SNMP traps (including `syslog` messages) after storing a specific number of SNMP traps in its database. You can use the auto-trim oldest SNMP trap incidents feature to control the number of SNMP traps stored in the NNMi database and to retain important incoming SNMP traps.

Important

Until NNMi 12-00, NNMi did not trim root causes, and only trimmed SNMP trap incidents.

In NNMi 12-10 or later, either "all incidents" or "only SNMP trap incidents" can now be set. The default is "all incidents".

In NNMi 12-10 or later, the automatic trim function for SNMP trap incidents is enabled when a new installation is performed, and NNMi deletes old incidents from the database. (By default, an archive is not created.) In the case of a version upgrade, the previous setting is inherited.

`com.hp.nnm.events.snmpTrapAutoTrimSetting`

Refer to the following concrete example, and configure settings such as the settings to enable or disable the automatic trim function and to switch between "only SNMP traps" and "all incidents" as the trimming target.

Note

To trim SNMP trap incidents manually from the NNMi database, use the `nnmtrimincidents.ovpl` command. For details, see the *nnmtrimincidents.ovpl Reference Page*.

21.20.1 Enabling the auto-trim oldest incidents feature (no incident archive)

If the number of incidents (including all types of incidents except SNMP traps and including `syslog` messages) in the database exceeds 50,000, perform the following procedure to use the automatic trim function for incidents to delete 10,000 incidents. Incidents are deleted in order starting from the oldest incident. Note that this procedure does not create an archive for incidents.

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Look for the following line:

   ```
   #!com.hp.nnm.events.snmpTrapAutoTrimStartPercentage=50
   ```
3. Uncomment and edit this line to read as follows:

   ```
   com.hp.nnm.events.snmpTrapAutoTrimStartPercentage=50
   ```
4. Look for the following line:

   ```
   #!com.hp.nnm.events.snmpTrapAutoTrimPercentageToDelete=25
   ```

5. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapAutoTrimPercentageToDelete=20
```

6. Look for the following line:

```
#!com.hp.nnm.events.snmpTrapAutoTrimSetting=Disabled
```

7. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapAutoTrimSetting=TrimOnly
```

   If an archive is necessary, specify TrimAndArchive.

8. Find the row that includes the following character string.

```
com.hp.nnm.events.allowAutoTrimAllIncidents
```

9. Delete the comment symbol, and make the following correction.

```
com.hp.nnm.events.allowAutoTrimAllIncidents=true
```

10. Save your changes.
11. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

The default value of `com.hp.nnm.events.snmpTrapMaxStoreLimit` (which sets the upper limit on the number of incidents) is 100,000. In this case, if the number of incidents in the database exceeds 50,000 (50% of the upper limit), 10,000 incidents are deleted in order, started from the oldest incident, and based on the following formula.

```
(com.hp.nnm.events.snmpTrapAutoTrimStartPercentage / 100) X com.hp.nnm.events.snmpTra
pMaxStoreLimit X (com.hp.nnm.events.snmpTrapAutoTrimPercentageToDelete / 100)
* "X" means multiplication.
```

21.20.2 Enabling the auto-trim oldest SNMP trap incidents feature (incident archive enabled)

Suppose you want to enable the auto-trim oldest SNMP trap incidents feature to trim 10,000 SNMP trap incidents (including `syslog` messages) once the number of SNMP trap incidents in the NNMi database exceeds 50,000. For this example, you want NNMi to archive the SNMP trap incidents before trimming them. Complete the following steps: SNMP trap incidents are deleted in order, starting from the oldest incident. Note that this procedure creates an archive for SNMP trap incidents.

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Look for the line includes the following character string:

```
com.hp.nnm.events.snmpTrapAutoTrimStartPercentage
```

3. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapAutoTrimStartPercentage=50
```

4. Look for the line includes the following character string:

```
com.hp.nnm.events.snmpTrapAutoTrimPercentageToDelete
```

5. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapAutoTrimPercentageToDelete=20
```

6. Look for the line includes the following character string:

```
#!com.hp.nnm.events.snmpTrapAutoTrimSetting=Disabled
```

7. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapAutoTrimSetting=TrimAndArchive
```

8. Look for the line includes the following character string:

```
com.hp.nnm.events.allowAutoTrimAllIncidents
```

9. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.allowAutoTrimAllIncidents=false
```

10. Save your changes.
11. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

The default value of `com.hp.nnm.events.snmpTrapMaxStoreLimit` (which sets the upper limit on the number of incidents) is 100,000. In this case, if the number of SNMP trap incidents (including `syslog` messages) in the database exceeds 50,000 (50% of the upper limit), 10,000 SNMP trap incidents are deleted in order, started from the oldest incident, and based on the following formula.

```
(com.hp.nnm.events.snmpTrapAutoTrimStartPercentage / 100) X com.hp.nnm.events.snmpTra
pMaxStoreLimit X (com.hp.nnm.events.snmpTrapAutoTrimPercentageToDelete / 100)
* "X" means multiplication.
```

The deleted incidents are archived in the following file:

- Windows: `%NNM_TMP%\incidentArchive."`*date*`".csv.gz`
- Linux: `$NNM_TMP/incidentArchive."`*date*`".csv.gz`

The archive file name is fixed until the NNMi service is restarted and incidents are added to the same file.

21.20.3 Rotate archive files

In default setting, there is not upper limit of the file size of the archive file created by the auto-trim feature. You can rotate the archive file in specific file size and save disk usage. Suppose you want to rotate the archive files 3 times when the size reaches 10MB. Complete the following steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`

2. Locate the text block containing the following line:

```
#!com.hp.nnm.events.autoTrimArchiveRotationEnabled=false
```

3. Uncomment and edit the line to read as follows:

```
com.hp.nnm.events.autoTrimArchiveRotationEnabled=true
```

4. Locate the text block containing the following line:

```
#!com.hp.nnm.events.autoTrimArchiveRotationArchiveSize=128
```

5. Uncomment and edit the line to read as follows:

```
com.hp.nnm.events.autoTrimArchiveRotationArchiveSize=10
```

6. Locate the text block containing the following line:

```
#!com.hp.nnm.events.autoTrimArchiveRotationRotateNumber=5
```

7. Uncomment and edit the line to read as follows:

```
com.hp.nnm.events.autoTrimArchiveRotationRotateNumber=3
```

8. Restart the NNMi management server:
   a. Run the `ovstop` command on the NNMi management server.
   b. Run the `ovstart` command on the NNMi management server.

> **Important**
>
> When making file changes under High Availability (HA), you need to make the changes on both nodes in the cluster. For NNMi using HA configurations, if the change requires you to stop and restart the NNMi management server, you must put the nodes in maintenance mode before running the `ovstop` and `ovstart` commands.

With this settings, trimmed incidents are archived into the following file. Note that the file name doesn't contain the time stamp.

- Windows: `%NNM_TMP\incidentArchive.csv.gz`
- Linux: `$NNM_TMP/incidentArchive.csv.gz`

When the file size of the archive file reached the specified value in MB (10 in this example), the archive file is renamed to "incidentArchive.csv.gz.1". The new incidents are archived into the new incidentArchive.csv.gz. "incidentArchive.csv.gz.<n>" is renamed to "incidentArchive.csv.gz.<n+1>" by the rotation. If the value of "n" in the archive file name is the same as the specified value (3 in this example), the file is removed by the rotation, instead of being renamed.

21.20.4 Changing the maximum number of SNMP trap incidents to be saved

Depending on whether you need to keep SNMP trap incidents for a long period of time, you can change the maximum number of SNMP trap incidents to be saved in the database.

Important

By default, NNMi begins dropping SNMP traps (including `syslog` messages) after the number of SNMP trap incidents in its database reaches 100,000. Setting this limit to a higher value is not recommended, as doing so can cause NNMi performance degradation. Carefully evaluate the situation before changing the maximum number.

(1) Changing the maximum number to less than 100,000

To change the maximum number to 50,000:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Look for the following line:

   ```
   #!com.hp.nnm.events.snmpTrapMaxStoreLimit=100000
   ```

3. Uncomment and edit this line to read as follows:

   ```
   com.hp.nnm.events.snmpTrapMaxStoreLimit=50000
   ```

4. Save your changes.
5. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

(2) Changing the maximum number to more than 100,000

To change the maximum number to 200,000:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Look for the following line:

   ```
   #!com.hp.nnm.events.snmpTrapEnforce100KLimit=true
   ```

3. Uncomment and edit this line to read as follows, and save the file:

   ```
   com.hp.nnm.events.snmpTrapEnforce100KLimit=false
   ```

4. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
5. Look for the following line:

   ```
   #!com.hp.nnm.events.snmpTrapMaxStoreLimit=100000
   ```

6. Uncomment and edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapMaxStoreLimit=200000
```

7. Save your changes.
8. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

The default value of `com.hp.nnm.events.snmpTrapMaxStoreLimit` (which sets the upper limit on the number of incidents) is 100,000. In this case, if the number of incidents in the database exceeds 50,000 (50% of the upper limit), 10,000 incidents are deleted in order, started from the oldest incident, and based on the following formula.

21.20.5 Monitoring the auto-trim oldest SNMP trap incidents feature

From the NNMi console, click **Help**, choose **System Information**, and then **Health** to check whether messages have been output regarding the health of the auto-trim oldest SNMP trap incidents feature. NNMi also generates the following alarms related to the auto-trim oldest SNMP trap incidents feature:

- NNMi generates `SnmpTrapLimitCritical` when the number of SNMP trap incidents stored in the database (including syslog messages) reaches 100% of the `com.hp.nnm.events.snmpTrapMaxStoreLimit` value.
- NNMi generates `SnmpTrapLimitMajor` when the number of SNMP trap incidents stored in the database (including syslog messages) reaches 95% of the `com.hp.nnm.events.snmpTrapMaxStoreLimit` value.
- NNMi generates `SnmpTrapLimitWarning` when the number of SNMP trap incidents stored in the database (including `syslog` messages) reaches 90% of the `com.hp.nnm.events.snmpTrapMaxStoreLimit` value.

> **Important**
>
> When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configuration, if the change requires that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

21.20.6 Disabling the auto-trim oldest SNMP trap incidents feature

To disable the auto-trim oldest SNMP trap incidents feature, complete the following steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Locate the line containing the following property:

```
com.hp.nnm.events.snmpTrapAutoTrimSetting
```

3. Edit this line to read as follows:

```
com.hp.nnm.events.snmpTrapAutoTrimSetting=Disabled
```

4. Save your changes.

5. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

21.21 Modifying NNMi normalization properties

NNMi stores both host names and node names in case-sensitive form. This means that all searches, sorts, and filters that the NNMi console provides return case-sensitive results. If the DNS servers you use return a variety of case-preserving node names and host names, including all-uppercase, all-lowercase, and a mixture of uppercase and lowercase, this can cause less-than-optimal results.

You can change several NNMi normalization properties to meet your specific needs. A good practice is to make these changes before seeding NNMi for its initial discovery.

We recommend that you adjust the settings in this section during deployment, but before running the initial discovery.

If you run an initial discovery, and then decide to change the normalization properties later, you can run the `nnmnoderediscover.ovpl -all` script to initiate a full discovery. For details, see the *nnmnoderediscover.ovpl Reference Page*.

You can change the following properties:

- Normalize discovered node names to `UPPERCASE`, `LOWERCASE`, or `OFF`.
- Normalize discovered host names to `UPPERCASE`, `LOWERCASE`, or `OFF`.

To change normalization properties follow these steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-topology.properties`
   - Linux: `$NNM_PROPS/nms-topology.properties`
2. To configure NNMi to normalize discovered names, look for a line that resembles the following:

   ```
   #!com.hp.ov.nms.topo.NAME_NORMALIZATION=OFF
   ```

   a. Uncomment the property (to uncomment a property, remove the `#!` characters from the beginning of the line):

   ```
   com.hp.ov.nms.topo.NAME_NORMALIZATION=OFF
   ```

   b. Change `OFF` to `LOWERCASE` or `UPPERCASE`.

   c. Save your changes.
3. To configure NNMi to normalize discovered host names, look for a line that resembles the following:

   ```
   #!com.hp.ov.nms.topo.HOSTNAME_NORMALIZATION=OFF
   ```

   a. Uncomment the property:

   ```
   com.hp.ov.nms.topo.HOSTNAME_NORMALIZATION=OFF
   ```

   To uncomment a property, remove the `#!` characters from the beginning of the line.

   b. Change `OFF` to `LOWERCASE` or `UPPERCASE`.

   c. Save your changes.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.21.1 Changing normalization properties following an initial discovery

Changing normalization properties following an initial discovery causes NNMi to be inconsistent with the property changes until the next discovery. To remedy this, run the `nnmnoderediscover.ovpl -all` script to initiate a full discovery after changing NNMi normalization properties.

21.22 Modifying the database port

You might want to configure NNMi to use a different port for the database. To do so, follow these steps:

1. Edit the following file:
   - Windows: `%NNM_CONF%\nnm\props\nms-local.properties`
   - Linux: `$NNM_CONF/nnm/props/nms-local.properties`
2. Search for a line that resembles the following:

   ```
   #!com.hp.ov.nms.postgres.port=5432
   ```

3. Uncomment this property:

   ```
   com.hp.ov.nms.postgres.port=5432
   ```

   To uncomment a property, remove the characters `#!` from the beginning of its line.
4. Change the existing value to the new port number.
5. Save your changes.
6. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.23 NNMi self monitoring

21.23.1 Suppressing NNMi status message

NNMi performs self-monitoring checks, including checks of memory, CPU, and disk resources. NNMi generates an incident when the NNMi management server becomes low on a resource or detects a serious condition.

To view NNMi health information, use one of the following methods:

- From the NNMi console, click **Help**, choose **System Information**, and then click the **Health** tab.
- Run the `nnmhealth.ovpl` script.

NNMi opens a status message at the bottom of the NNMi console and at the top of forms when it detects a self-monitoring health exception. You can disable this warning message by completing the following steps:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-ui.properties`
   - Linux: `$NNM_PROPS/nms-ui.properties`
2. Search for the text block containing the following line:

   ```
   #!com.hp.nms.ui.health.disablewarning=false
   ```
3. Uncomment and edit this line to read as follows:

   ```
   com.hp.nms.ui.health.disablewarning=true
   ```
4. Change the existing value to the new port number.
5. Save your changes.
6. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.23.2 Suppressing NNMi health incidents

NNMi generates an incident after the NNMi management server detects unusual conclusions of self-monitoring. To suppress health incidents for specific conclusions, run the following command. The `<conclusions>` is a list of comma separated conclusion names:

- Windows:

  ```
  %InstallDir%\bin\nnmhealth.ovpl -suppress <conclusions>
  ```
- Linux:

  ```
  $InstallDir/bin/nnmhealth.ovpl -suppress <conclusions>
  ```

The modifications by `nnmhealth.ovpl` continue until the administrator restarts NNMi. If you want to persist the settings after restarting NNMi, do the following steps:

1. Open the following file:
   - Windows: `%NNM_PROPS\nms-topology.properties`
   - Linux: `$NNM_PROPS/nms-topology.properties`
2. Locate the text block containing the following line:

   ```
   #com.hp.ov.nms.health.SUPPRESSED_CONCLUSIONS=
   ```

3. Uncomment and edit the following line:

   ```
   com.hp.ov.nms.health.SUPPRESSED_CONCLUSIONS=<conclusions>
   ```

   The `<conclusions>` is a list of comma separated conclusion names.
4. Save your changes.
5. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

For the detail of how to know the names of conclusions, see the *nnmhealth.ovpl Reference Page*.

Important

When making file changes under High Availability (HA), you need to make the changes on both nodes in the cluster. For NNMi using HA configurations, if the change requires you to stop and restart the NNMi management server, you must put the nodes in maintenance mode before running the `ovstop` and `ovstart` commands.

21.24 Suppressing the use of discovery protocols for specific nodes

NNMi uses several protocols to discover Layer 2 connectivity between and among network devices. There are many defined discovery protocols; for example, *Link Layer Discovery Protocol* (LLDP) is an industry standard protocol. There are also many vendor-specific protocols, such as *Cisco Discovery Protocol* (CDP) for Cisco devices.

You can configure NNMi to suppress discovery protocol collections for devices you specify. There are special circumstances, such as those described below, which might be remedied by suppressing discovery protocol collections.

Enterasys devices:

Using SNMP to collect information from the *Enterasys Discovery Protocol* (EnDP) and LLDP tables on some Enterasys devices might cause issues with NNMi running out of memory. You can prevent this by configuring NNMi to skip EnDP and LLDP processing on these devices. To do this, add the management addresses of the devices to the `disco.SkipXdpProcessing` file. For details, see 21.24.1 Suppressing the use of discovery protocol collections.

New operating system versions on some Enterasys devices support the `set snmp timefilter break` command. On such Enterasys devices, run the `set snmp timefilter break` command. When you use this command to configure such a device, you do not need to list the device in the `disco.SkipXdpProcessing` file.

Nortel devices:

Many Nortel devices use the *SynOptics Network Management Protocol* (SONMP) to discover Layer 2 layout and connectivity. Some of these devices use the same MAC address on multiple interfaces, which does not work well with this protocol. You might experience this problem if two interconnected Nortel devices show a Layer 2 connection between the wrong set of interfaces and the connection shows a connection source of SONMP.

For this example, it is best to configure NNMi to not use the SONMP protocol to derive Layer 2 connections for the devices shown as participating in the wrong connection. To do this, add the management address of the two devices to the `disco.SkipXdpProcessing` file. For details, see 21.24.1 Suppressing the use of discovery protocol collections.

21.24.1 Suppressing the use of discovery protocol collections

To suppress the use of discovery protocol collections, follow these steps:

1. Create the following file:
   - Windows: `%NnmDataDir%shared\nnm\conf\disco\disco.SkipXdpProcessing`
   - Linux: `$NnmDataDir/shared/nnm/conf/disco/disco.SkipXdpProcessing`

     The `disco.SkipXdpProcessing` file is case-sensitive.
2. Add to the `disco.SkipXdpProcessing` file the management address for each device for which protocol collection is to be suppressed.

   For details, see the *disco.SkipXdpProcessing Reference Page*.
3. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

Important

Suppressing discovery protocol processing of a node or nodes might cause some inaccuracies in the Layer 2 layout of the managed network.

The `ovjboss` service reads the `disco.SkipXdpProcessing` file at startup. If you make any changes after starting NNMi, restart NNMi as shown in this step.

If you ran the `set snmp timefilter break` command on any Enterasys devices, remove their device addresses from the `disco.SkipXdpProcessing` file, and then restart NNMi as shown in this step. NNMi opens more accurate Layer 2 maps when it uses discovery protocols.

For details, see the *disco.SkipXdpProcessing Reference Page*.

21.25 Configuring actions for secondary root cause management events

By default, NNMi does not run actions on secondary root cause management events.

This helps prevent unnecessary generation of actions. For example, if NNMi detects an `InterfaceDown` incident, and soon after it determines that the corresponding card is down, then, if dampening is used, the `CardDown` incident becomes the root cause and the `InterfaceDown` incident is downgraded to secondary.

In this case, an action on the `InterfaceDown` incident is not desired because such an action will be now applied to the new root cause (`CardDown`).

To enable actions for secondary root cause management events, do the following:

1. Edit the following file:
   - Windows: `%NNM_PROPS%\nms-jboss.properties`
   - Linux: `$NNM_PROPS/nms-jboss.properties`
2. Search for the text block containing the following line:

   ```
   #!com.hp.nnm.events.action.runActionOnSecRootCauseMgmtEvent=false
   ```
3. Uncomment and edit this line to read as follows:

   ```
   com.hp.nnm.events.action.runActionOnSecRootCauseMgmtEvent=true
   ```
4. Save the `nms-jboss.properties` file.
5. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

21.26 Scheduling outages

NNMi enables you to use the `nnmscheduledoutage.ovpl` command to schedule outages for any set of nodes. For example, you might want to schedule an outage for weekly maintenance on a set of routers, or perhaps to replace the power supply for an individual node.

For details, see the *nnmscheduledoutage.ovpl Reference Page*.

> **Note**
>
> For details about using NNMi to schedule outages, see NNMi Help.

21.27 Configuring sensor status

NNMi includes the following physical sensors and node sensors, which can be monitored as an aid in determining status.

Table 21-2: Physical sensors and node sensors

Physical sensor	Propagates status to physical component by default?	Node sensor	Propagates status to node by default?
FAN	Yes	CPU	No
POWER_SUPPLY	Yes	MEMORY	Yes
TEMPERATURE	No	BUFFERS	No
VOLTAGE	No	DISK_SPACE	No
BACK_PLANE	Yes		

Important

By default, FAN, POWER_SUPPLY, BACK_PLANE, and MEMORY propagate their status to the physical component level. For example, if a fan has a red status indicator, its corresponding physical component (chassis) receives a status indicator of yellow. A user viewing the status of a chassis in this case would be alerted to the fact that a component of that chassis has experienced some sort of failure.

21.27.1 Configuring physical sensor status

You can configure whether a physical sensor propagates its status to the physical component level (for example, the chassis) by following the steps in the following subsections.

(1) Propagating physical sensor status to a physical component

1. If not already present, create a new properties file with the name nnm-apa.properties in the following directory:
   - Windows: %NnmDataDir%shared\nnm\conf\props
   - Linux: $NnmDataDir/shared/nnm/conf/props
2. Use a text editor to set the following text in this properties file:

   ```
   com.hp.ov.nms.apa.PhysSensorPropagateToPhysicalComponentStatus_type=true
   ```

   type is the physical sensor. For details, see 21.27 Configuring sensor status.
3. Save the properties file.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

Important

When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configurations, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

(2) Configuring physical sensor status to not propagate to the physical component

1. If not already present, create a new properties file with the name `nnm-apa.properties` in the following directory:
   - Windows: `%NnmDataDir%shared\nnm\conf\props`
   - Linux: `$NnmDataDir/shared/nnm/conf/props`
2. Use a text editor to include the following text in this properties file:

```
com.hp.ov.nms.apa.PhysSensorNoPropagateToPhysicalComponentStatus_type=true
```

   type is the physical sensor. For details, see 21.27 Configuring sensor status.
3. Save the properties file.
4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

Important

When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configuration, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

(3) Overriding physical sensor status values

By default, the three sensor status values `None`, `Warning`, and `Unavailable` are mapped to the `Normal` status by the Causal Engine. You can override these default status mappings so that `None`, `Warning`, and `Unavailable` map to `Critical`.

To override physical sensor status values:

1. If not already present, create a new properties file with the name `nnm-apa.properties` in the following directory:
   - Windows: `%NnmDataDir%shared\nnm\conf\props`
   - Linux: `$NnmDataDir/shared/nnm/conf/props`
2. Use a text editor to include one, two, or all three of the following lines, as applicable, in this properties file:

```
com.hp.ov.nms.apa.PhysSensorValueReMappedToDown_NONE=true
com.hp.ov.nms.apa.PhysSensorValueReMappedToDown_Warning=true
com.hp.ov.nms.apa.PhysSensorValueReMappedToDown_Unavailable=true
```

3. Save the properties file.
4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

Important

- You can map the `Unavailable` status to `Unpolled` status (because `Unavailable` means that the measurement facility is not available). Often, this situation might occur because the sensor has become nonfunctional, rather than because the component has become nonfunctional. To map `Unavailable` to `Unpolled`, use the same procedure as described above, except use the following text in step 2:
  `com.hp.ov.nms.apa.PhysicalSensorValueReMappedToUnpolled_Unavailable=true`
- When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configuration, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

21.27.2 Configuring node sensor status

You can configure whether a node sensor propagates its status to the node level by following the steps in the following subsections.

(1) Propagating node sensor status to a node

1. If not already present, create a new properties file with the name `nnm-apa.properties` in the following directory:
   - Windows: `%NnmDataDir%shared\nnm\conf\props`
   - Linux: `$NnmDataDir/shared/nnm/conf/props`
2. Use a text editor to include the following text in this properties file:

   ```
   com.hp.ov.nms.apa.NodeSensorPropagateToNodeStatus_type=true
   ```

   type is the physical sensor. For details, see 21.27 Configuring sensor status.
3. Save the properties file.
4. Restart NNMi by running the following commands:

```
ovstop
ovstart
```

Important

When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configuration, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

(2) Configuring a node sensor's status to not propagate to the node

1. If not already present, create a new properties file with the name `nnm-apa.properties` in the following directory:
   - Windows: `%NnmDataDir%shared\nnm\conf\props`
   - Linux: `$NnmDataDir/shared/nnm/conf/props`
2. Use a text editor to include the following text in this properties file:

   ```
   com.hp.ov.nms.apa.NodeSensorNoPropagateToNodeStatus_type=true
   ```

   type is the physical sensor. For details, see 21.27 Configuring sensor status.
3. Save the properties file.
4. Restart NNMi by running the following commands:

   ```
   ovstop
   ovstart
   ```

   Important

   When making file changes under High Availability (HA), you must make the changes on both nodes in the cluster. In the case of NNMi in an HA configuration, if the changes require that you stop and restart the NNMi management server, you must put the nodes in the maintenance mode before running the `ovstop` and `ovstart` commands. For details, see 19.6.1 Placing NNMi in maintenance mode.

22 Changing the NNMi Management Server

You can duplicate the NNMi configuration on another system, such as to move from a test environment to a production environment or to change the hardware of the NNMi management server. You can change the IP address of the NNMi management server without affecting the NNMi configuration.

22.1 Best practices for preparing the NNMi configuration to be moved

The following best practices are effective for moving the NNMi configuration to a different system:

- If the node group configuration uses host names to identify managed nodes, the production and test NNMi management servers must use the same DNS servers. In the case where the production and test systems use different DNS servers, changes in the resolved name for a managed node might result in different polling settings between the two NNMi management servers.
- You can limit the configuration export to a single author. Create a new author value that is unique to your group or company. Specify this author value when you create or modify any of the following items:
  - Device profile
  - Incident configuration
  - Menu
  - Menu item
  - Custom correlation configuration
  - Icon
  - MIB expression
  - Trap log configuration

22.2 Moving the NNMi configuration and database

To move the NNMi configuration and the database, such as from a test system to a production system, make a complete backup of all NNMi data on the source (test) system, and then restore the backup to the target (production) system. To ensure that no changes are made to the NNMi database after the backup is made, stop all NNMi processes and create an offline backup.

Example:

```
nnmbackup.ovpl -type offline -scope all -target nnmi_backups\offline
```

Verify that the items listed in 20.3.2 Different-system restore are the same in both systems, and then execute a command similar to the following example.

Example:

```
nnmrestore.ovpl -source nnmi_backups\offline\newest_backup
```

Important

NNMi uses the same SSL certificate for accessing the database and for supporting HTTPS access to the NNMi console. The certificate for accessing the database was created when the NNMi processes first started on the source system. This certificate is included in the backup and restore data. Without this certificate, NNMi cannot access the database from the target system.

However, for HTTPS access to the NNMi console, the SSL certificate must be generated on the target system. Because the current implementation of JBoss does not support certificate merging, NNMi does not support HTTPS access to the NNMi console on a system that was set up by restoring data from a different system. If the target system must support HTTPS access to the NNMi console, use the procedure described in 22.3 Moving the NNMi configuration, and then begin data collection anew on the target system.

22.3 Moving the NNMi configuration

Use the `nnmconfigexport.ovpl` command to output the NNMi configuration to an XML file. Then use the `nnmconfigimport.ovpl` command to pull this configuration from the XML file into NNMi on the new system.

Important

Do not edit a file exported with the `nnmconfigexport.ovpl` script before using the `nnmconfigimport.ovpl` script to import the file.

For details about these commands, see the appropriate reference pages.

Note

- The `nnmconfigexport.ovpl` command does not retain SNMPv3 credentials. For details, see the *nnmconfigexport.ovpl Reference Page*.
- You can move only the NNMi configuration. Hitachi does not support moving topology or incident data from one NNMi management server to another NNMi management server.

22.4 Changing the IP address of a stand-alone NNMi management server

If you need to change the IP address of an NNMi management server, do so after stopping NNMi. After the address change, apply the license key that corresponds to the changed address and then start NNMi.

22.5 Changing the host name or domain name of an NNMi management server

Important

If the NNMi management server participates in NNMi application failover or participates global network management feature or contact your support representative for assistance.

If you have configured the NNMi management server to connect to the directory service via SSL, you will need to add the certificate of directory server to the NNMi truststore, again. After following the steps in this section, please follow the steps in 10.3.8 Configuring an SSL connection to the Directory service.

To change the NNMi management server's host name, domain name, or both, set NNMi to use the NNMi management server's new fully qualified domain name (FQDN).

Example:

```
nnmsetofficialfqdn.ovpl -force newnnmi.servers.example.com
```

After executing `nnmsetofficialfqdn.ovpl`, restart NNMi to apply the configuration.

For details, see the *nnmsetofficialfqdn.ovpl Reference Page*.

Important

The FQDN is a host name combined with a domain name. If you change either of these, you are changing the NNMi management server's FQDN. SSL certificates are always linked to the FQDN. The common name (CN) field in the certificate must match the server FQDN. Therefore, if you change the FQDN, you must obtain a new SSL certificate with a matching CN. The `nnmsetofficialfqdn.ovpl` command updates the NNMi management server's FQDN and it also creates a new self-signed certificate, which matches the new FQDN. However, if you are using CA certificates, you must generate the new CA certificate. For details, see 10.3.2 Generating a CA-Signed Certificate.

If you change the IP address of the NNMi management server (regardless of whether the FQDN changes), you must obtain a new license. For details, see 22.4 Changing the IP address of a stand-alone NNMi management server.

23 NNMi Security

This chapter explains security issues.

23.1 Providing a password for embedded database tools

NNMi requires a password to run embedded database tools (such as `psql`). Initially, NNMi provides a default password, which the user must change by running the `nnmchangeembdbpw.ovpl` script. You must be logged in as an administrator on a Windows system or as root on a Linux system to run the `nnmchangeembdbpw.ovpl` script. For details, see the *nnmchangeembdbpw.ovpl Reference Page*.

In an HA environment, you run the `nnmchangeembdbpw.ovpl` script on the primary cluster node only. The application automatically copies the password to the secondary cluster node; no additional action is required.

23.2 Configure TLS Protocols

By default, NNMi supports the TLSv1.2 protocol for HTTPS communication.

It is recommended that NNMi use only TLSv1.2 unless older, less secure, protocols are necessary for supporting legacy clients.

To configure NNMi to use protocols other than TLSv1.2, follow these steps:

1. Log on to the NNMi management server.
2. Open the following file with a text editor:
   - Windows: `%NnmDataDir%nmsas\NNM\server.properties`
   - Linux: `/var/opt/OV/nmsas/NNM/server.properties`
3. Adding or updating the `com.hp.ov.nms.ssl.PROTOCOLS` property with a comma-separated list of the protocols that you want to use.
   For example, if you want to use the TLSv1, TLSv1.1, and TLSv1.2 protocols, make sure the following line exists in the `server.properties` file:

   ```
   com.hp.ov.nms.ssl.PROTOCOLS=TLSv1.2,TLSv1.1,TLSv1
   ```

4. Restart the NNMi processes by running the following commands:
   - Windows:

     ```
     %NnmInstallDir%bin\ovstop -c
     %NnmInstallDir%bin\ovstart -c
     ```

   - Linux:

     ```
     /opt/OV/bin/ovstop -c
     /opt/OV/bin/ovstart -c
     ```

23.3 NNMi data encryption

NNMi incorporates data encryption in many areas of the product.

Example:

NNMi stores passwords for user accounts in the NNMi database in encrypted form.

23.3.1 Encryption and user account passwords

Important

This information does not apply to the Lightweight Directory Access Protocol (LDAP) or to Common Access Card (CAC) accounts.

NNMi user accounts created from the NNMi console are stored in the NNMi database. The passwords for these users are hashed and also stored in the database.

When a user signs into the NNMi console, or uses a command line interface (CLI) tool, the password the user provides is hashed and compared to the hashed value stored in the database. If the user provides the correct password, these two hashed strings will match, authenticating the user.

Earlier versions of NNMi (10-50 or earlier) used encryption algorithms for hashing user passwords; these algorithms are now considered outdated. NNMi 11-00 uses a stronger algorithm for user account passwords. However, because hashing constitutes one-way encryption, it is not possible to decrypt and then re-encrypt user passwords during an upgrade from NNMi 10-50 to 11-00.

During an upgrade, all existing users still have their passwords stored in the database using the legacy encryption algorithm. However, when a user whose password has been hashed using the legacy algorithm logs on successfully, the password the user has provided is re-encrypted automatically using the new hash algorithm specified in the crypto configuration file.

This means all passwords are updated to the new algorithm slowly over time, as each user logs in for the first time after the upgrade. The same will be true if the crypto configuration is changed in the future. Each user's password will be upgraded to the new hash algorithm at the time of the user's next successful logon.

Important

- Upgrading user passwords depends on the presence of the earlier legacy algorithm (for example, MD5) listed in the `<allowed>` block. For this reason, you must keep the earlier legacy algorithm listed in the `<allowed>` block until all passwords have been migrated.
- If the earlier legacy algorithm is not kept in the `<allowed>` block, it will not be possible to re-hash the existing passwords that exist in hashed form in the database. In such a case, those users will not be able to log on, and NNMi will not be able to use the new algorithm to re-encrypt their passwords.
- Once the earlier legacy algorithm has been removed from the `<allowed>` block, the administrator either must delete and re-create the affected users or must reset the passwords for the users whose passwords were encrypted with the earlier legacy algorithm.

Use the following command to determine if a user's password can be used with an algorithm listed in the crypto configuration file or is still encrypted with an earlier legacy algorithm that is no longer specified in the crypto configuration file:

```
nnmsecurity.ovpl -listUserAccounts legacy
```

For details, see the *nnmsecurity.ovpl Reference Page*.

24 Upgrading from NNMi Version 9, 10, 11, or 12

This chapter explains several possible version upgrade scenarios.

If you plan to upgrade an NNMi management server of version 9, 10, 11, or 12 that is running in an NNMi application failover configuration, the supported upgrade procedure requires you to unconfigure application failover temporarily, upgrade each of the NNMi management servers, and then reconfigure application failover.

To upgrade NNMi version 9, 10, 11, or 12 that is running in a high-availability (HA) cluster, see the *Release Notes*.

24.1 Upgrading NNMi management servers

24.1.1 Upgrading NNMi management servers from version 12-60

This subsection describes how to upgrade an NNMi management server that is running NNMi version 12-60.

> **Note**
>
> Before upgrading an NNMi management server, see 1. Preinstallation Checklists.

1. Run the `nnmbackup.ovpl` script to back up the NNMi management server.

   You perform this step only as a precaution, because you would use this backup only in the unlikely event of a failed migration. For details, see the *nnmbackup.ovpl Reference Page*.

2. Follow the procedure described in 2. Installing and Uninstalling NNMi to install a version 13-00 NNMi management server.

3. Verify that the information from the NNMi management server migrated successfully.

24.1.2 Upgrading NNMi management servers from version 9, 10, 11, or 12

This subsection describes how to upgrade NNMi management servers running NNMi version 9, 10, 11, or 12.

1. Follow the procedure described in the setup guide, # and the Release Notes for NNMi 12-60 to upgrade an NNMi management server to an NNMi management server running NNMi 12-60.

   #: The setup guide refers to the following manual:

   JP1/Network Node Manager i Setup Guide (3021-3-E02-30(E))

2. See 24.1.1 Upgrading NNMi management servers from version 12-60 to upgrade an NNMi management server running version 12-60.

24.2 Upgrading to a different NNMi management server

This section describes the process for upgrading to NNMi 13-00 on a new system while maintaining the configuration of the existing (source) NNMi management server.

> **Note**
>
> Before upgrading an NNMi management server, see 1. Preinstallation Checklists.

The steps below explain how to copy data from the source NNMi management server to a target NNMi management server. These steps assume you have NNMi 12-60 running on the source NNMi management server.

1. Back up the source NNMi management server by running the `nnmbackup.ovpl` script. Label the backup file.

   You would use this backup only in the unlikely event of a failed migration. For details, see the *nnmbackup.ovpl Reference Page*.
2. By following the procedure described in 2. Installing and Uninstalling NNMi, install NNMi 13-00 on the source NNMi management server.
3. Verify that NNMi 13-00 is running correctly on the source NNMi management server.
4. Back up NNMi 13-00 on the source NNMi management server by running the `nnmbackup.ovpl` script. Label this backup file.

   You will need this file for copying data to the target NNMi management server. For details, see the *nnmbackup.ovpl Reference Page*.
5. By following the procedure described in 2. Installing and Uninstalling NNMi, install NNMi 13-00 on the target NNMi management server.

   To migrate the data from step 4, the target NNMi management server must be running the same operating system version. NNMi does not support data migration to an NNMi management server running on a different operating system.
6. Run the `nnmrestore.ovpl` script to copy NNMi database information to the target server.

   For details, see the *nnmrestore.ovpl Reference Page*.
7. Obtain and install a new license on the target NNMi management server.
8. Verify that the information from the target NNMi management server migrated successfully from the existing NNMi management server.

24.3 Upgrading global and regional managers from NNMi 12-60

24.3.1 NNMi versions supported by global network management

A regional manager running NNMi 12-60 or earlier that is connected to a global manager running NNMi 13-00 is not supported. The global manager and regional managers must be running the same NNMi version.

24.3.2 Global network management upgrade steps

During upgrading of NNMi management servers configured in a global network management environment to NNMi 13-00, the connections between the global network manager and the regional managers will be dropped until both the global managers and the regional managers have been upgraded to NNMi 13-00. For this reason, we recommend that you upgrade all of the servers at approximately the same time to minimize the total downtime.

For example, you might upgrade the NNMi management servers using the following steps:

1. Upgrade the regional managers to NNMi 13-00 and verify that they are operating correctly.

   After upgrading has been completed, follow the procedure in the *Release Notes* to apply the new license.

   If the certificate repository is not already migrated to the PKCS#12 repository, after upgrade installation, please migrate to the PKCS #12 repository on the regional managers by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

   The global manager will remain disconnected while the process of upgrading the regional managers is underway.
2. Upgrade the global manager to NNMi 13-00.

   After upgrading has been completed, follow the procedure in the *Release Notes* to apply the new license.

   If the certificate repository is not already migrated to the PKCS#12 repository, after upgrade installation, please migrate to the PKCS #12 repository on the global manager by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

Important

Note the following:

- After upgrading has been completed, the updating of statuses and incidents might be delayed.

24.4 Upgrading to NNMi 13-00 configured for application failover

24.4.1 Upgrading from NNMi 12-60 configured for application failover

To upgrade from NNMi 12-60 while running in an NNMi application failover configuration, follow the steps provided below.

(1) Upgrading to NNMi 13-00 configured for application failover

To upgrade NNMi management servers configured for application failover, follow these steps:

1. As a precaution, run the `nnmconfigexport.ovpl` script on both the active and the standby NNMi management servers before proceeding.

   For details, see 4.2 Best practice: Save the existing configuration.

2. As a precaution, back up your NNMi data on both the active and standby NNMi management servers before proceeding.

   For details, see 20.2.2 Backup scope.

3. Complete the steps provided below on the active NNMi management server.

   Note that NNMi must be running for the following `nnmcluster` steps to work. Completing these steps will reduce the time needed for startup of the standby NNMi management server shown in step 7.

   a. Run the `nnmcluster` command.

   b. When NNMi prompts you, type `dbsync`, then press **Enter**. Review the displayed information to make sure it includes the following messages:

   - `ACTIVE_DB_BACKUP`: Reports that the active NNMi management server is performing a new backup.
   - `ACTIVE_NNM_RUNNING`: Reports that the active NNMi management server has completed the backup reported in the previous message.
   - `STANDBY_RECV_DBZIP`: Reports that the standby NNMi management server is receiving a new backup from the active NNMi management server.
   - `STANDBY_READY`: Reports that the standby NNMi management server is ready to perform in the event of a failure of the active NNMi management server.

   c. Run `exit` or `quit` to stop the interactive `nnmcluster` process you started in step a.

4. Run the `nnmcluster -shutdown` command on the standby NNMi management server.

   This stops all `nnmcluster` processes on the standby NNMi management server.

5. To verify there are no `nnmcluster` nodes running on the standby NNMi management server, complete the following steps on the standby NNMi management server:

   a. Run the `nnmcluster` command.

   b. Verify that there are no local `nnmcluster` nodes present except the one marked `(SELF)`. There might be one or more remote nodes present.

   c. Run `exit` or `quit` to stop the interactive `nnmcluster` process you started in step a.

6. Complete the following steps on the standby NNMi management server to temporarily disable application failover:

   a. Edit the following file:

   - Windows: `%NNM_SHARED_CONF%\props\nms-cluster.properties`
   - Linux: `$NNM_SHARED_CONF/props/nms-cluster.properties`

b. Comment out the `com.hp.ov.nms.cluster.name` parameter.

c. Save your change.

d. Edit the following file:

- Windows: `%NNM_DB%\Postgres\postgresql.conf`
- Linux: `$NNM_DB/Postgres/postgresql.conf`

e. Delete the following application failover settings:

- Line beginning with `# The following lines were added by the NNM cluster.`
- Line beginning with `archive_command =`
- Line beginning with `archive_timeout =`
- Line beginning with `max_wal_senders =`
- Line beginning with `archive_mode =`
- Line beginning with `wal_level =`
- Line beginning with `hot_standby =`
- Line beginning with `wal_keep_segments =`
- Line beginning with `listen_addresses =`

f. Save your changes.

g. Create the following null file:

- Windows: `%NNM_TMP%\postgresTriggerFile`
- Linux: `$NNM_TMP/postgresTriggerFile`

7. Start and then stop processes on the standby NNMi management server.

   a. Run the `ovstart` command on the standby NNMi management server. Running the `ovstart` command causes the standby NNMi management server to import the transaction logs from the active NNMi management server.

   b. When the `ovstart` command has finished, run the `ovstatus -v` command. All NNMi services normally show the state `RUNNING`.

   c. Run the `ovstop` command on the standby NNMi management server.

8. Upgrade the standby NNMi management server to NNMi 13-00 by following the instructions in 2. Installing and Uninstalling NNMi and the *Release Notes*.

   After upgrading has been completed, follow the procedure in the *Release Notes* to apply the new license.

   If the certificate repository is not already migrated to the PKCS#12 repository, after upgrade installation, please migrate to the PKCS #12 repository on the former standby NNMi management server by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

   You now have the former active NNMi management server running NNMi 12-60 or earlier and the former standby NNMi management server running NNMi 13-00. These NNMi management servers are now running independently with no database synchronization. This means that both NNMi management servers are monitoring the network in parallel.

   To complete the upgrade and remedy this situation, select a time to upgrade the former active node to NNMi 13-00. Have the operators temporarily use the former standby node to monitor the network while you complete the upgrade.

   The remainder of this procedure assumes you plan to retain the database information from the former active node and discard the database information from the former standby node.

9. Run the `nnmcluster -halt` command on the former active NNMi management server.

10. To verify that there are no `nnmcluster` nodes running on the former active NNMi management server, complete the following steps on the former active NNMi management server:

a. Run the `nnmcluster` command.

b. Verify that there are no local `nnmcluster` nodes present except the one marked `(SELF)`. There might be one or more remote nodes present.

c. Run `exit` or `quit` to stop the interactive `nnmcluster` process you started in step a.

11. Complete the following steps on the former active NNMi management server to disable application failover temporarily:

    a. Edit the following file:

    - Windows: `%NNM_SHARED_CONF%\props\nms-cluster.properties`
    - Linux: `$NNM_SHARED_CONF/props/nms-cluster.properties`

    b. Comment out the `com.hp.ov.nms.cluster.name` parameter.

    c. Save your changes.

12. Upgrade the former active NNMi management server to NNMi 13-00 by following the instructions in 2. Installing and Uninstalling NNMi.

    After upgrading has been completed, follow the procedure in the *Release Notes* to apply the new license.

    If the certificate repository is not already migrated to the PKCS#12 repository, after upgrade installation, please migrate to the PKCS #12 repository on the former active NNMi management server by using the steps in 10.2 Configuring an Upgraded NNMi Environment to Use the New Keystore.

    Now you have two servers running NNMi 13-00, but they are still independent because the databases are not synchronized.

13. Complete the following steps on the former active NNMi management server:

    a. Run the `ovstop` command.

    b. Edit the following file:

    - Windows: `%NNM_SHARED_CONF%\props\nms-cluster.properties`
    - Linux: `$NNM_SHARED_CONF/props/nms-cluster.properties`

    c. If you have upgraded from version 12-60, type in the value of the `com.hp.ov.nms.cluster.name` parameter.

    If you have upgraded from version 12-60, the commented-out properties are not preserved, so you must retype the cluster name.

    d. Uncomment the `com.hp.ov.nms.cluster.name` parameter.

    e. Save your changes.

14. Run either the `ovstart` command or the `nnmcluster -daemon` command on the former active NNMi management server. It is now the active cluster node.

15. Instruct the operators to begin using the active cluster node to monitor the network.

    The former standby NNMi management server discards all database activity that occurred during the maintenance process, from step 9 through step 13.

16. Complete the following steps on the former standby NNMi management server:

    a. Run the `ovstop` command.

    b. Edit the following file:

    Windows: `%NNM_SHARED_CONF%\props\nms-cluster.properties`

    Linux: `$NNM_SHARED_CONF/props/nms-cluster.properties`

    c. If you have upgraded from version 12-60, type in the value of the `com.hp.ov.nms.cluster.name` parameter.

    d. Comment out the `com.hp.ov.nms.cluster.name` parameter.

e. Save your changes.

17. Run either the `ovstart` command or the `nnmcluster -daemon` command on the former standby NNMi management server.

    This NNMi management server becomes the standby node and receives a copy of the database from the active cluster node.

(2) Applying patches to NNMi 13-00 configured for application failover

Both NNMi management servers must be running the same NNMi version and patch level. To apply patches to the active and standby NNMi management servers, use either of the following procedures:

- Apply patches for application failover, shutting down both the active and standby servers

  Use this procedure when there is no problem with interrupting network monitoring.
- Apply patches for application failover, keeping one NNMi management server active

  Use this procedure when you must not interrupt network monitoring.

(a) Applying patches for application failover, shutting down both the active and standby servers

This procedure results in both NNMi management servers being inactive for some period of time during the patch installation process. To apply patches on the NNMi management servers configured for application failover, follow these steps:

1. As a precaution, run the `nnmconfigexport.ovpl` script on both the active and the standby NNMi management servers before proceeding.

   For details, see 4.2 Best practice: Save the existing configuration.
2. As a precaution, back up your NNMi data on both the active and the standby NNMi management servers before proceeding.

   For details, see 20.2.2 Backup scope.
3. As a precaution, run the following procedure on the active NNMi management server:

   a. Run the `nnmcluster` command.

   b. When NNMi prompts you, type `dbsync`, then press **Enter**. Review the displayed information to make sure it includes the following messages:

   - `ACTIVE_DB_BACKUP`: Reports that the active NNMi management server is performing a new backup.
   - `ACTIVE_NNM_RUNNING`: Reports that the active NNMi management server has completed the backup reported in the previous message.
   - `STANDBY_READY`: Reports the previous status of the standby NNMi management server.
   - `STANDBY_RECV_DBZIP`: Reports that the standby NNMi management server is receiving a new backup from the active NNMi management server.
   - `STANDBY_READY`: Reports that the standby NNMi management server is ready to perform in the event of a failure of the active NNMi management server.

   c. Run `exit` or `quit` to stop the interactive `nnmcluster` process you started in step a.
4. Run the `nnmcluster -halt` command on the active NNMi management server.

   This stops all `nnmcluster` processes on both the active and standby NNMi management servers.
5. To verify there are no `nnmcluster` nodes running on both servers, complete the following steps on both the active and the standby NNMi management servers:

a. Run the `nnmcluster` command.

b. Verify that there are no `nnmcluster` nodes present except the one marked `(SELF)`.

c. Run `exit` or `quit` to stop the interactive `nnmcluster` process you started in step a.

6. On the active NNMi management server, comment out the `com.hp.ov.nms.cluster.name` parameter in the `nms-cluster.properties` file:

   a. Edit the following file:

   - Windows: `%NNM_SHARED_CONF%\props\nms-cluster.properties`
   - Linux: `$NNM_SHARED_CONF/props/nms-cluster.properties`

   b. Comment out the `com.hp.ov.nms.cluster.name` parameter.

   c. Save your change.

7. Apply the NNMi patches on the active NNMi management server using the instructions in `RELEASE.TXT` provided with the patches.
8. On the active NNMi management server, uncomment the `com.hp.ov.nms.cluster.name` parameter in the `nms-cluster.properties` file:

   a. Edit the following file:

   - Windows: `%NNM_SHARED_CONF%\props\nms-cluster.properties`
   - Linux: `$NNM_SHARED_CONF/props/nms-cluster.properties`

   b. Uncomment the `com.hp.ov.nms.cluster.name` parameter.

   c. Save your change.

9. Run the `ovstart` command on the active NNMi management server.
10. Verify that the patches have been installed correctly on the active NNMi management server by viewing information on the **Product** tab of the **Help** > **System Information** window in the NNMi console.
11. Run the `nnmcluster -dbsync` command to make a new backup.
12. On the standby NNMi management server, comment out the `com.hp.ov.nms.cluster.name` parameter in the `nms-cluster.properties` file, as shown in a through c in step 6.
13. Apply the NNMi patches on the standby NNMi management server.
14. On the standby NNMi management server, uncomment the `com.hp.ov.nms.cluster.name` parameter in the `nms-cluster.properties` file, as shown in a through c in step 8.
15. Run the `ovstart` command on the standby NNMi management server.

(b) Applying patches for application failover, keeping one NNMi management server active

This procedure results in one NNMi management server always being active during the patch installation process.

Although this method preserves continuous monitoring of the network, NNMi loses the transaction logs that are generated during this patch installation process.

To apply NNMi patches on the NNMi management servers configured for application failover, follow these steps:

1. As a precaution, run the `nnmconfigexport.ovpl` script on both the active and the standby NNMi management servers before proceeding.

   For details, see 4.2 Best practice: Save the existing configuration.

2. As a precaution, back up your NNMi data on both the active and the standby NNMi management servers before proceeding.

   For details, see 20.2.2 Backup scope.

3. Run the `nnmcluster` command on one of the nodes.
4. Enter `dbsync` on the NNMi management server used in the previous step to synchronize the two databases.

   The `dbsync` option works on an NNMi management server using an embedded database.

5. Wait until the active NNMi management server reverts to `ACTIVE_NNM_RUNNING` and the standby NNMi management server reverts to `STANDBY_READY` before continuing.
6. Exit from or quit the `nnmcluster` command.
7. Stop the cluster on the standby NNMi management server by running the following command on the standby NNMi management server:

   ```
   nnmcluster -shutdown
   ```

8. Make sure the following processes and services have terminated before continuing:

   ```
   - postgres
   - ovjboss
   ```

9. Make sure the `nnmcluster` process has terminated before continuing.

   If the `nnmcluster` process will not terminate, manually kill the `nnmcluster` process only as a last resort.

10. Edit the following file on the standby NNMi management server:
    - Windows: `%nnmDataDir%shared\nnm\conf\props\nms-cluster.properties`
    - Linux: `$nnmDataDir/shared/nnm/conf/props/nms-cluster.properties`
11. Comment out the cluster name property by placing a hash mark (#) at the beginning of the line, then save your change:

    ```
    #com.hp.ov.nms.cluster.name = NNMicluster
    ```

12. Apply the NNMi patches on the standby NNMi management server.
13. At this point, the standby NNMi management server has been patched but is stopped, and the active NNMi management server has not been patched and is running.

    Stop the active NNMi management server and immediately bring the standby NNMi management server online to monitor your network.

14. Shut down the cluster on the active NNMi management server by running the following command on the active NNMi management server:

    ```
    nnmcluster -halt
    ```

15. Make sure the `nnmcluster` process has terminated.

    If it does not terminate within a few minutes, manually kill the `nnmcluster` process.

16. On the standby NNMi management server, uncomment the cluster name from the `nms-cluster.properties` file.
17. Start the cluster on the standby NNMi management server by running the following command on the standby NNMi management server:

    ```
    nnmcluster -daemon
    ```

18. Install the NNMi patches on the active NNMi management server.

19. At this point, the previous active NNMi management server has been patched but is offline.
    Bring it back into the cluster (as the standby NNMi management server) by performing the following:
    a. Uncomment the entry in the `nms-cluster.properties` file on the active NNMi management server.
    b. Start the active NNMi management server with the following command:
    `nnmcluster -daemon`
20. To monitor the progress, run the following command on both the active and the standby NNMi management servers:

    ```
    nnmcluster
    ```

    Wait until the previous active NNMi management server finishes retrieving the database from the previous standby NNMi management server.
21. After the previous active NNMi management server displays `STANDBY_READY`, run the following command on the previous active NNMi management server:

    ```
    nnmcluster -acquire
    ```

25 NNMi Northbound Interface

Job Management Partner 1/Consolidated Management 2/Network Node Manager i (NNMi) provides the NNMi Northbound interface for forwarding NNMi incidents to any application that can receive SNMPv2c traps. For each NNMi management server, you can implement the NNMi Northbound interface to multiple Northbound applications, each configured separately. This chapter explains how to configure NNMi to forward NNMi incidents to desired Northbound applications. For details about a specific Northbound application, see the application documentation. The chapter also discusses integration with different Northbound applications.

25.1 Overview of the NNMi Northbound interface

The following provides an overview of the NNMi Northbound interface:

- The NNMi Northbound interface forwards NNMi management events as SNMPv2c traps to a Northbound application.

  The Northbound application might filter, act on, and show the NNMi traps. The Northbound application might also provide tools for accessing the NNMi console in the context of an NNMi trap.
- The NNMi Northbound interface can send incident lifecycle state change notifications, incident correlation notifications, and incident deletion notifications to the Northbound application.

  In this way, the Northbound application can replicate the results of NNMi causal analysis.
- The NNMi Northbound interface can also forward to the Northbound application the SNMP traps that NNMi receives.
- The NNMi Northbound interface enables event consolidation in a third-party or custom event consolidator.
- The NNMi Northbound interface enriches events with information that can be used to integrate other applications with NNMi.

This chapter uses the following terms:

- Northbound application: Any application that can receive and process SNMPv2c traps.
- Trap-receiving component: The portion of a Northbound application that receives SNMP traps.

  Some applications include a separately installable component that receives SNMP traps and forwards them to another component for processing.

  For any Northbound application that does not include such a component, *trap-receiving component* is synonymous with *Northbound application*.
- NNMi Northbound interface: The NNMi functionality that forwards NNMi incidents as SNMPv2c traps to a Northbound application.
- Northbound destination: A configuration of the NNMi Northbound interface that defines the connection to the trap-receiving component of a Northbound application and specifies the types of traps that NNMi will send to that Northbound application.

25.2 Enabling the NNMi Northbound interface

NNMi does not limit the amount of information sent in an SNMP trap using UDP. If any network hardware in the transmission path cannot handle the size of the trap data, or if network traffic is heavy, the trap might be lost. For this reason, we recommend that you install the trap-receiving component of the Northbound application on the NNMi management server. The Northbound application is responsible for ensuring reliable information transfer.

To enable the NNMi Northbound interface:

1. If necessary, configure the Northbound application to understand the NNMi trap definitions.
2. On the NNMi management server, configure NNMi incident forwarding:

   a. In the NNMi console, open the **NNMi Northbound Interface Destinations** form (**Integration Module Configuration** > **Northbound Interface**), and then click **New**.

   If you have selected an available destination, click **Reset** to make the **New** button available.

   b. Select the **Enabled** check box to make the remaining fields on the form available.

   c. Enter the information for connecting to the Northbound application.

   For details about these fields, see 25.8.1 NNMi Northbound application connection parameters.

   d. Specify the sending options and incident filter for the content to send to the Northbound application.

   For details about these fields, see 25.8.2 NNMi Northbound interface integration content.

   e. Click **Submit** at the bottom of the form.

   A new window opens that displays a status message. If the message indicates a problem with the settings, click **Return** and adjust the values as suggested in the error message text.
3. (Optional) Create contextual interaction with NNMi by creating URLs that provide access to NNMi views from the Northbound application.

   NNMi does not limit the amount of information sent in an SNMP trap using UDP. If any network hardware in the transmission path cannot handle the size of the trap data, or if network traffic is heavy, the trap might be lost. For this reason, we recommend that you install the trap-receiving component of the Northbound application on the NNMi management server. The Northbound application is responsible for ensuring reliable information transfer.

   For details, in the NNMi console, click **Help** > **NNMi Documentation Library** > **Integrate NNMi Elsewhere with URLs**.

25.3 Using the NNMi Northbound interface

When the NNMi Northbound interface is enabled, the Northbound destination determines the information that NNMi sends to a Northbound application. Configure the Northbound application to show and interpret the forwarded traps, as appropriate in your network environment. For details about the contents and format of the traps that NNMi sends to a Northbound application, see the `hp-nnmi-nbi.mib` and `hp-nnmi-registrations.mib` files.

NNMi sends only one copy of each management event, SNMP trap, or notification trap to a Northbound destination. NNMi does not queue traps. If the trap-receiving component of a Northbound application is unavailable when NNMi forwards a trap, the trap is lost.

This section describes the types of traps the integration can send. For details about setting the content configuration, see 25.8.2 NNMi Northbound interface integration content.

25.3.1 Incident forwarding

(1) Management events

When the Northbound destination includes management events, NNMi forwards each management event incident to the Northbound application when that incident changes to the **Registered** lifecycle state.

The `OID` of the forwarded management event is the SNMP object ID on the **Management Event Configuration** form in the NNMi console. NNMi forwards all custom management events with the `OID` `1.3.6.1.4.1.11.2.17.19.2.0.9999`.

(2) Third-party SNMP traps

When the Northbound destination includes third-party SNMP traps, NNMi forwards each incoming SNMPv1, v2c, or v3 format trap to the Northbound application when the associated incident changes to the **Registered** lifecycle state. NNMi preserves the original trap varbinds in order (as defined in the MIB) and appends the NNMi-specific varbinds to the message payload. If the original trap does not contain all the defined varbinds, NNMi pads `NULL` values for the missing varbinds. If the MIB is not loaded in NNMi, only the NNMi specific varbinds are appended to the trap, which is then forwarded.

Note the following about third-party SNMP traps:

- Because NNMi reconstructs a trap from its SNMP trap incident, the forwarded trap is in SNMPv2c format regardless of the format of the original trap when NNMi received it.
- The forwarded SNMP trap shows the NNMi management server as the source object. To determine the original source object, examine the values of the $(n + 21)^{th}$ varbind, `nnmiIncidentSourceNodeHostname` (`1.3.6.1.4.1.11.2.17.19.2.2.21`), and the $(n + 24)^{th}$ varbind, `nnmiIncidentSourceNodeMgmtAddr` (`1.3.6.1.4.1.11.2.17.19.2.2.24`), where n is the number of varbinds defined for the trap in the MIB.

If any of the devices that NNMi manages also send traps to the Northbound application, the Northbound application must manage the duplicate device traps.

For a comparison of trap forwarding mechanisms, see 8.1.2 Trap and incident forwarding.

25.3.2 Incident lifecycle state change notifications

The information in this section varies with the selections made to the **Sending Options** on the **NNMi Northbound Interface Destination** page.

(1) Enhanced closed traps

When the Northbound destination includes enhanced closed notifications, NNMi sends an `nnmiEvClosed` (`1.3.6.1.4.1.11.2.17.19.2.0.1000`) trap to the Northbound application when the lifecycle state of an incident changes to `CLOSED` in NNMi. The `nnmiEvClosed` trap includes much of the data from the original incident. The previous lifecycle state value is not included.

The `nnmiEvClosed` trap identifies the original incident in the sixth varbind, `nnmiIncidentUuid` (`1.3.6.1.4.1.11.2.17.19.2.2.6`).

(2) State change traps

When the Northbound destination includes lifecycle state changed notifications, NNMi sends a `nnmiEvLifecycleStateChanged` (`1.3.6.1.4.1.11.2.17.19.2.0.1001`) trap to the Northbound application when the lifecycle state of an incident changes to the `IN PROGESS`, `COMPLETED`, or `CLOSED` lifecycle state in NNMi. The Northbound application can associate the `nnmiEvLifecycleStateChanged` with the original incident.

The `nnmiEvLifecycleStateChanged` trap identifies the original incident and the lifecycle state change in the following varbinds:

- `nnmiIncidentUuid`, the sixth varbind (`1.3.6.1.4.1.11.2.17.19.2.2.6`)
  This value matches the value of the sixth varbind in a management event or the $(n + 6)^{th}$ varbind in a third-party SNMP trap varbind.
- `nnmiIncidentLifecycleStatePreviousValue`, the seventh varbind (`1.3.6.1.4.1.11.2.17.19.2.2.200`)
- `nnmiIncidentLifecycleStateCurrentValue`, the eighth varbind (`1.3.6.1.4.1.11.2.17.19.2.2.201`)

The following table lists the possible integer values for the lifecycle states:

Name	Integer value
`registered`	`1`
`inprogress`	`2`
`completed`	`3`
`closed`	`4`
`dampened`	`5`

25.3.3 Incident correlation notifications

When the Northbound destination includes incident correlation notifications, NNMi sends incident correlation traps to the Northbound application as NNMi causal analysis correlates incidents. The Northbound application can use the information in the traps to replicate the correlation changes.

(1) Single correlation traps

For the single correlation trap option, the integration sends the following correlation traps:

- `nnmiEvCorrelationDedup` (`1.3.6.1.4.1.11.2.17.19.2.0.1100`)
- `nnmiEvCorrelationImpact` (`1.3.6.1.4.1.11.2.17.19.2.0.1101`)
- `nnmiEvCorrelationPairwise` (`1.3.6.1.4.1.11.2.17.19.2.0.1102`)
- `nnmiEvCorrelationRate` (`1.3.6.1.4.1.11.2.17.19.2.0.1103`)
- `nnmiEvCorrelationApa` (`1.3.6.1.4.1.11.2.17.19.2.0.1104`)
- `nnmiEvCorrelationCustom` (`1.3.6.1.4.1.11.2.17.19.2.0.1105`)

Each trap identifies one parent-child incident correlation relationship in the following varbinds:

- `nnmiIncidentUuid`, the sixth varbind (`1.3.6.1.4.1.11.2.17.19.2.2.6`)
- `nnmiCorrelatedChildUuid`, the seventh varbind (`1.3.6.1.4.1.11.2.17.19.2.2.300`)

(2) Group correlation traps

For the group correlation trap option, the integration sends the following correlation traps:

- `nnmiEvCorrelationGrpDedup` (`1.3.6.1.4.1.11.2.17.19.2.0.2100`)
- `nnmiEvCorrelationGrpImpact` (`1.3.6.1.4.1.11.2.17.19.2.0.2101`)
- `nnmiEvCorrelationGrpPairwise` (`1.3.6.1.4.1.11.2.17.19.2.0.2102`)
- `nnmiEvCorrelationGrpRate` (`1.3.6.1.4.1.11.2.17.19.2.0.2103`)
- `nnmiEvCorrelationGrpApa` (`1.3.6.1.4.1.11.2.17.19.2.0.2104`)
- `nnmiEvCorrelationGrpCustom` (`1.3.6.1.4.1.11.2.17.19.2.0.2105`)

Each trap identifies the parent-child incident correlation relationships in the following varbinds:

- `nnmiIncidentUuid`, the sixth varbind (`1.3.6.1.4.1.11.2.17.19.2.2.6`)
- `nnmiCorrelatedChildrenCount`, the seventh varbind (`1.3.6.1.4.1.11.2.17.19.2.2.301`)
- `nnmiCorrelatedChildrenUuidCsv`, the eighth varbind (`1.3.6.1.4.1.11.2.17.19.2.2.302`)
  This value is a comma-separated-value list of child incident UUIDs.

25.3.4 Incident deletion notifications

When the Northbound destination includes incident deletion notifications, NNMi sends an `nnmiEvDeleted` (`1.3.6.1.4.1.11.2.17.19.2.0.3000`) trap to the Northbound application when an incident is deleted in NNMi. The `nnmiEvDeleted` trap identifies the original incident in the sixth varbind, `nnmiIncidentUuid` (`1.3.6.1.4.1.11.2.17.19.2.2.6`).

25.3.5 Event forwarding filter

When the Northbound destination includes an incident filter, the object identifiers (OIDs) in the filter include or exclude (depending on the selected configuration option) the following event types:

- NNMi management event incidents
- Third-party SNMP traps
- `nnmiEvClosed` traps
- `nnmiEvLifecycleStateChanged` traps
- `nnmiEvDeleted` traps
- Correlation notification traps#

#: The following notes apply to correlation notification traps:

- If the incident filter prevents forwarding of the parent incident for a correlation, NNMi does not send a correlation notification trap to the Northbound application.
- If the incident filter prevents forwarding of a child incident for a correlation, the forwarded correlation notification trap does not include that child incident's UUID. In other words, if the correlation notification trap would not contain any child incident UUIDs, NNMi does not send that trap to the Northbound application.
- The DuplicateCorrelation management event is forwarded independently of the `nnmiEvCorrelationDedup` or `nnmiEvCorrelationGrpDedup` correlation notification traps. Likewise, the RateCorrelation management event is forwarded independently of the `nnmiEvCorrelationRate` or `nnmiEvCorrelationGrpRate` correlation notification traps. If the incident filter prevents forwarding of one of these correlation notification traps, NNMi might still forward the associated management events.

25.4 Changing the NNMi Northbound interface

To change the NNMi Northbound interface configuration parameters:

1. In the NNMi console, open the **NNMi Northbound Interface Destinations** form (**Integration Module Configuration** > **Northbound Interface**).
2. Select a destination, and then click **Edit**.
3. Modify the values as appropriate.

   For details about the fields on this form, see 25.8 NNMi Northbound Interface Destination form reference.
4. Verify that the **Enabled** check box at the top of the form is selected, and then click **Submit** at the bottom of the form.

   The changes take effect immediately.

25.5 Disabling the NNMi Northbound interface

SNMP trap queuing does not occur while a Northbound destination is disabled.

To discontinue forwarding of NNMi incidents to a Northbound application:

1. In the NNMi console, open the **NNMi Northbound Interface Destinations** form (**Integration Module Configuration** > **Northbound Interface**).
2. Select a destination, and then click **Edit**. Alternatively, click **Delete** to entirely remove the configuration for the selected destination.
3. Clear the **Enabled** check box at the top of the form, and then click **Submit** at the bottom of the form.
   The changes take effect immediately.

25.6 Troubleshooting the NNMi Northbound interface

If the NNMi Northbound interface does not function as expected, follow the steps below until you have resolved the problem.

To troubleshoot the NNMi Northbound interface:

1. Verify that the trap destination port is not blocked by a firewall.
   Ensure that the NNMi management server can directly address the Northbound application by host and port.
2. Verify that the integration is running correctly:
   a. In the NNMi console, open the **NNMi Northbound Interface Destinations** form (**Integration Module Configuration** > **Northbound Interface**).
   b. Select a destination, and then click **Edit**.
   c. Verify that the **Enabled** check box is selected.
3. If the Northbound destination includes management events, verify this functionality:
   a. In the **Closed Key Incidents** view of the NNMi console, open any incident.
   b. Set the incident lifecycle state to **Registered**, and then click **Save**.
   c. Set the incident lifecycle state to **Closed**, and then click **Save and Close**.
   d. After 30 seconds, determine whether the Northbound application received an `nnmiEvClosed` trap (or `nnmiEvLifecycleStateChanged` trap) for this incident.
   - If the Northbound application received the trap, continue with step 4.
   - If the Northbound application did not receive the trap, configure a new Northbound destination to connect with a different Northbound application, and then repeat this test from step a.
     If the repeated test succeeds, the problem is with the first Northbound application. Consult that application's documentation for troubleshooting information. If the repeated test fails, contact Support for assistance.
4. If the Northbound destination includes SNMP traps, verify this functionality:
   a. Generate an SNMP trap against a node in the NNMi topology by entering the following command on the NNMi management server:

   ```
   nnmsnmpnotify.ovpl -a \
   discovered_node NNMi_node .1.3.6.1.6.3.1.1.5.1
   ```

   (In this command, `discovered_node` is the host name or IP address of a node in the NNMi topology, and `NNMi_node` is the host name or IP address of the NNMi management server.)
   b. After 30 seconds, determine whether the Northbound application received the forwarded trap.
   - If the Northbound application received the trap, the NNMi Northbound interface is working correctly.
   - If the Northbound application did not receive the trap, configure a new Northbound destination to connect with a different Northbound application, and then repeat this test from step a.

   If the repeated test succeeds, the problem is with the first Northbound application. Consult that application's documentation for troubleshooting information. If the repeated test fails, contact Support for assistance.

25.7 Application failover and the NNMi Northbound interface

If the NNMi management server will participate in NNMi application failover, the information in this topic applies to any integration that implements the NNMi Northbound interface for sending traps to a Northbound application.

The traps that NNMi sends to a Northbound application include the NNMi URL in the `NmsUrl` varbind (`1.3.6.1.4.1.11.2.17.19.2.2.2`). Traps received before application failover reference what is now the standby NNMi management server.

When the URL points to the standby NNMi management server, any actions that use the URL value will fail (such as launching the NNMi console).

25.7.1 Local Northbound application

If the trap-receiving component of the Northbound application is located on the NNMi management server, the following considerations apply to the configuration of the NNMi Northbound interface:

- The trap-receiving component of the Northbound application must be installed and configured identically on the active and standby NNMi management servers. Configure SNMP trap reception on the same port on both NNMi management servers.
- Configure the NNMi Northbound interface on the primary NNMi management server only.

  On the **NNMi Northbound Interface Destination** form, select either the **NNMi FQDN** or the **Use Loopback** option for **Host** identification.

At startup, the NNMi Northbound interface determines the correct name or IP address of the current NNMi management server. In this way, the Northbound interface sends traps to the trap-receiving component of the Northbound application on the active NNMi management server.

25.7.2 Remote Northbound application

If the trap-receiving component of the Northbound application is not located on the NNMi management server, configure the NNMi Northbound interface on the primary NNMi management server only. On the **NNMi Northbound Interface Destination** form, select the **Other** option for **Host** identification.

25.8 NNMi Northbound Interface Destination form reference

The **HP NNMi Northbound Interface Destination** form contains the parameters for configuring communications between NNMi and a Northbound application. This form is available from the **Integration Module Configuration** workspace. On the **NNMi Northbound Interface Destinations** form, click **New**; alternatively, select a destination, and then click **Edit**.

- Only NNMi users with the Administrator role can access the **NNMi Northbound Interface Destination** form.

  The **NNMi Northbound Interface Destination** form contains information for the following areas:

  - 25.8.1 NNMi Northbound application connection parameters
  - 25.8.2 NNMi Northbound interface integration content
  - 25.8.3 NNMi Northbound interface destination status information

To apply changes to the integration configuration, update the values on the **NNMi Northbound Interface Destination** form, and then click **Submit**.

25.8.1 NNMi Northbound application connection parameters

The following table lists the parameters for configuring the connection to the Northbound application.

Table 25-1: NNMi Northbound application connection information

Field	Description
Host	The fully-qualified domain name (preferred) or the IP address of the server that contains the trap-receiving component of the Northbound application. The integration supports the following methods for identifying the server: • **NNMi FQDN** NNMi manages the connection to the Northbound application on the NNMi management server, and the **Host** field becomes read-only. This is the recommended configuration for Northbound applications on the NNMi management server. • **Use Loopback** NNMi manages the connection to the Northbound application on the NNMi management server, and the **Host** field becomes read-only. • **Other** Enter a host name or IP address for identifying the Northbound application server in the **Host** field. NNMi validates that the host name or IP address in the **Host** field is not configured as a loopback adapter. This is the default configuration. Note: If the NNMi management server participates in NNMi application failover, see 25.7 Application failover and the NNMi Northbound interface for information about the impact of application failover on the integration.
Port	The UDP port where the Northbound application receives SNMP traps. Enter the port number specific to the Northbound application. Note: If the trap-receiving component of the Northbound application is on the NNMi management server, this port number must be different from the port NNMi uses to receive SNMP traps, as set in the **SNMP Port** field on the **Communication Configuration** form in the NNMi console.
Community String	A read-only community string for the Northbound application to receive traps.

Field	Description
Community String	If the Northbound application configuration requires a community string in the received SNMP traps, enter that value. If the Northbound application configuration does not require a specific community string, use the default value, which is `public`.

25.8.2 NNMi Northbound interface integration content

The following table lists the parameters for configuring the content the NNMi Northbound interface sends to the Northbound application.

Table 25-2: NNMi Northbound interface content configuration information

Field	Description
Incidents	The incident forwarding specification: • **Management** NNMi forwards only NNMi-generated management events to the Northbound application. • **3rd Party SNMP Trap** NNMi forwards only SNMP traps that NNMi receives from managed devices to the Northbound application. • **Syslog** NNMi forwards only `ArcSight Syslog` messages that NNMi receives from managed devices to the Northbound application using the NorthBound Integration module. NNMi begins forwarding incidents as soon as you enable the Northbound destination. For details, see 25.3.1 Incident forwarding.
Lifecycle State Changes	The incident change notification specification: • **Enhanced Closed** NNMi sends an incident-closed trap to the Northbound application for each incident that changes to the `CLOSED` lifecycle state. This is the default configuration. • **State Changed** NNMi sends an incident lifecycle state changed trap to the Northbound application for each incident that changes to the `IN PROGESS`, `COMPLETED`, or `CLOSED` lifecycle state. • **Both** NNMi sends an incident-closed trap to the Northbound application for each incident that changes to the `CLOSED` lifecycle state. Additionally, the integration sends an incident lifecycle state changed trap to the Northbound application for each incident that changes to the `IN PROGESS`, `COMPLETED`, or `CLOSED` lifecycle state. Note: In this case, each time an incident changes to the `CLOSED` lifecycle state, the integration sends two notification traps, an incident-closed trap and an incident lifecycle state changed trap. For details, see 25.3.2 Incident lifecycle state change notifications.
Correlations	The incident correlation notification specification: • **None** NNMi does not notify the Northbound application of incident correlations resulting from NNMi causal analysis. This is the default configuration. • **Single**

Field	Description
Correlations	NNMi sends a trap for each parent-child incident correlation relationship resulting from NNMi causal analysis. • **Group** NNMi sends one trap per correlation that lists all child incidents correlated to a parent incident. For details, see 25.3.3 Incident correlation notifications.
Deletions	The incident deletion specification. This selection configures whether to send a deletion trap to the Northbound application for the selections made in the **Incidents** field: • **Don't Send** NNMi does not notify the Northbound application when incidents are deleted in NNMi. This is the default configuration. • **Send** NNMi sends a deletion trap to the Northbound application for each incident that is deleted in NNMi. For details, see 25.3.4 Incident deletion notifications.
NNMi Console Access	The connection protocol specification in the URL for browsing to the NNMi console from the Northbound application. The traps that NNMi sends to the Northbound application include the NNMi URL in the `NmsUrl` varbind (`1.3.6.1.4.1.11.2.17.19.2.2.2`). The configuration page defaults to the setting that matches the NNMi configuration. If the NNMi console is configured to accept both HTTP and HTTPS connections, you can change the HTTP connection protocol specification in the NNMi URL. For example, if all users of the Northbound application are on an intranet, you can set NNMi console access from the Northbound application to be over HTTP. To change the protocol for connecting to the NNMi console from the Northbound application, select the **HTTP** option or the **HTTPS** option as appropriate.
Incident Filters	A list of object identifiers (OIDs) the integration uses to filter the events sent to the Northbound application. Each filter entry can be a valid numeric OID (such as `.1.3.6.1.6.3.1.1.5.4.1.3.6.1.4.1.9`) or OID prefix (such as `.1.3.6.1.6.3.1.1.5.*`). Select one of the following options: • **None** NNMi sends all events to the Northbound application. This is the default configuration. • **Include** NNMi sends only the specific events that match the OIDs identified in the filter. • **Exclude** NNMi sends all events except for the specific events that match the OIDs identified in the filter. Specify the incident filter: • To add a filter entry, enter the text in the lower text box, and then click **Add**. • To delete a filter entry, select that entry from the list in the upper box, and then click **Remove**. For details, see 25.3.5 Event forwarding filter.

25.8.3 NNMi Northbound interface destination status information

The following table lists the read-only status information for the Northbound destination. This information is useful for verifying that the integration is working correctly.

Table 25-3: NNMi Northbound interface destination status information

Field	Description
Trap Destination IP Address	The IP address to which the destination host name resolves. This value is unique to this Northbound destination.
Uptime (seconds)	The time (in seconds) since the Northbound component was last started. The traps that NNMi sends to a Northbound application include this value in the `sysUptime` field (`1.3.6.1.2.1.1.3.0`). This value is the same for all integrations that use the NNMi Northbound interface. To see the latest value, either refresh or close then re-open the form.
NNMi URL	The URL for connecting to the NNMi console. The traps that NNMi sends to a Northbound application include this value in the `NmsUrl` varbind (`1.3.6.1.4.1.11.2.17.19.2.2.2`). This value is unique to this Northbound destination.

25.8.4 MIB information used by the NNMi Northbound interface

To load specific MIBs into NNMi, then view the management information used for incident notifications sent by the NNMi Northbound integration:

1. Move to the following directory:
   - Windows: `%NnmInstallDir%misc\nnm\snmp-mibs\Vendor\Hewlett-Packard`
   - Linux: `/opt/OV/misc/nnm/snmp-mibs/Vendor/Hewlett-Packard`
2. Execute the following command to load the `hp-nnmi.mib` file:

   ```
   nnmloadmib.ovpl -load hp-nnmi.mib
   ```

3. Execute the following command to load the `hp-nnmi-registrations.mib` file:

   ```
   nnmloadmib.ovpl -load hp-nnmi-registrations.mib
   ```

4. Execute the following command to load the `hp-nnmi-nbi.mib` file:

   ```
   nnmloadmib.ovpl -load hp-nnmi-nbi.mib
   ```

5. From the NNMi console, open the **Configuration** workspace.
6. Click **MIB** > **Loaded MIBs**.
7. Double-click each of the MIBs you just loaded; then click **MIB Variables** to view the MIB information.

25.8.5 SNMP trap information used by the NNMi Northbound interface

The SNMP traps used by the Northbound interface are defined in the `hp-nnmi-nbi.mib` file. If you use NNMi as a Northbound application, define SNMP trap incidents.

To define SNMP trap incidents:

1. Perform steps 1 through 4 in 25.8.4 MIB information used by the NNMi Northbound interface.
2. Execute the following command to add the SNMP trap incident definition:

```
nnmincidentcfg.ovpl -loadTraps HP-NNMI-NBI-MIB
```

26

Integration with JP1/IM3 Intelligent Integrated Management Base

26.1 Integration with JP1/IM3 Intelligent Integrated Management Base

By linking with JP1/IM3's platform for intelligent integrated management, you can use the following functions:

- Displaying information about nodes managed by NNMi in the JP1/IM3 integrated operation viewer.
- Opening the NNMi console, Node form or L2/L3 neighbor view from JP1/IM3 integrated operation viewer.
- Using the suggestion function for response actions of JP1/IM3, you can take response actions such as performing status polling, displaying node form and so on for the nodes where JP1 events occurred.
- Using the custom UI display function of JP1/IM3, you can open the node form or L2 neighbor view of the selected nodes in JP1/IM3 integrated operation viewer.

To link with JP1/IM3's platform for intelligent integrated management, you need to set up a plugin for JP1/IM3.

If you use JP1/IM2, please read JP1/IM3 as JP1/IM2 above.

For details about the linkage function and the setup method, see the *Release Notes*.

27 RESTful API

You can use the NNMi RESTful API to link NNMi with other products.

27.1 RESTful API

You can retrieve and update the incident, node, IP address, and interface information of NNMi by using the RESTful API.

You can display and update the information of NNMi in another product or in a web portal by using the RESTful API from the other product or the web portal to link with NNMi.

For details about the RESTful API, see the *Release Notes*.

Appendixes

A. When NNMi Manpages Cannot Be Displayed (Linux)

If you cannot display NNMi manpages on the NNMi management server, check that the `/opt/OV/man` location is set in the `MANPATH` variable. If it is not, add the `/opt/OV/man` location to the `MANPATH` variable.

B. List of MIBs Read During a New Installation

The table below lists the MIBs that are read during a new installation of NNMi.

These MIBs are not read during upgrading.

The MIB files shown in the table are relative paths from the following path:

- Windows

  ```
  %NnmInstallDir%misc\nnm\snmp-mibs\
  ```

  In Windows, the path demarcator is the backward slash (\), not the forward slash (/).

- Linux

  ```
  $NnmInstallDir/misc/nnm/snmp-mibs/
  ```

Table B-1: MIBs read during a new installation

MIB name	MIB file
ATM-FORUM-MIB	Vendor/Cisco/ATM-FORUM-MIB.my
ATM-FORUM-TC-MIB	Vendor/Cisco/ATM-FORUM-TC-MIB.my
ATM-MIB	Standard/rfc2515-ATM-MIB.mib
ATM-TC-MIB	Standard/rfc2514-ATM-TC-MIB.mib
ATM2-MIB	Standard/rfc3606-ATM2-MIB.mib
ArcsightModule	Vendor/Hewlett-Packard/hp-arcsight.mib
BGP4-MIB	Standard/rfc4273-BGP4-MIB.mib
BRIDGE-MIB	Standard/rfc4188-BRIDGE-MIB.mib
CISCO-AAL5-MIB	Vendor/Cisco/CISCO-AAL5-MIB.my
CISCO-ATM-IF-MIB	Vendor/Cisco/CISCO-ATM-IF-MIB.my
CISCO-ATM-SWITCH-ADDR-MIB	Vendor/Cisco/CISCO-ATM-SWITCH-ADDR-MIB.my
CISCO-C2900-MIB	Vendor/Cisco/CISCO-C2900-MIB.my
CISCO-CDP-MIB	Vendor/Cisco/CISCO-CDP-MIB.my
CISCO-DOT11-ASSOCIATION-MIB	Vendor/Cisco/CISCO-DOT11-ASSOCIATION-MIB.my
CISCO-DOT11-IF-MIB	Vendor/Cisco/CISCO-DOT11-IF-MIB.my
CISCO-ENTITY-FRU-CONTROL-MIB	Vendor/Cisco/CISCO-ENTITY-FRU-CONTROL-MIB.my
CISCO-ENTITY-VENDORTYPE-OID-MIB	Vendor/Cisco/CISCO-ENTITY-VENDORTYPE-OID-MIB.my
CISCO-ENVMON-MIB	Vendor/Cisco/CISCO-ENVMON-MIB.my
CISCO-FLASH-MIB	Vendor/Cisco/CISCO-FLASH-MIB.my
CISCO-FRAME-RELAY-MIB	Vendor/Cisco/CISCO-FRAME-RELAY-MIB.my
CISCO-HSRP-MIB	Vendor/Cisco/CISCO-HSRP-MIB.my
CISCO-IETF-IP-MIB	Vendor/Cisco/CISCO-IETF-IP-MIB.my
CISCO-IETF-IPMROUTE-MIB	Vendor/Cisco/CISCO-IETF-IPMROUTE-MIB.my

MIB name	MIB file
CISCO-IETF-PIM-EXT-MIB	Vendor/Cisco/CISCO-IETF-PIM-EXT-MIB.my
CISCO-IETF-PIM-MIB	Vendor/Cisco/CISCO-IETF-PIM-MIB.my
CISCO-IETF-PW-ENET-MIB	Vendor/Cisco/CISCO-IETF-PW-ENET-MIB.my
CISCO-IETF-PW-MIB	Vendor/Cisco/CISCO-IETF-PW-MIB.my
CISCO-IETF-PW-MPLS-MIB	Vendor/Cisco/CISCO-IETF-PW-MPLS-MIB.my
CISCO-IETF-PW-TC-MIB	Vendor/Cisco/CISCO-IETF-PW-TC-MIB.my
CISCO-MEMORY-POOL-MIB	Vendor/Cisco/CISCO-MEMORY-POOL-MIB.my
CISCO-MVPN-MIB	Vendor/Cisco/CISCO-MVPN-MIB.my
CISCO-NBAR-PROTOCOL-DISCOVERY-MIB	Vendor/Cisco/CISCO-NBAR-PROTOCOL-DISCOVERY-MIB.my
CISCO-PIM-MIB	Vendor/Cisco/CISCO-PIM-MIB.my
CISCO-PRODUCTS-MIB	Vendor/Cisco/CISCO-PRODUCTS-MIB.my
CISCO-QOS-PIB-MIB	Vendor/Cisco/CISCO-QOS-PIB-MIB.my
CISCO-RF-MIB	Vendor/Cisco/CISCO-RF-MIB.my
CISCO-RHINO-MIB	Vendor/Cisco/CISCO-RHINO-MIB.my
CISCO-RTTMON-MIB	Vendor/Cisco/CISCO-RTTMON-MIB.my
CISCO-RTTMON-TC-MIB	Vendor/Cisco/CISCO-RTTMON-TC-MIB.my
CISCO-SMI	Vendor/Cisco/CISCO-SMI.my
CISCO-STACK-MIB	Vendor/Cisco/CISCO-STACK-MIB.my
CISCO-TC	Vendor/Cisco/CISCO-TC.my
CISCO-VTP-MIB	Vendor/Cisco/CISCO-VTP-MIB.my
CISCOWAN-SMI	Vendor/Cisco/CISCOWAN-SMI.my
DHCP-MIB	Vendor/Microsoft/dhcp.mib
DIFFSERV-DSCP-TC	Standard/rfc3289-DIFFSERV-DSCP-TC.mib
DIFFSERV-MIB	Standard/rfc3289-DIFFSERV-MIB.mib
DISMAN-NSLOOKUP-MIB	Standard/rfc4560-DISMAN-NSLOOKUP-MIB.mib
DISMAN-PING-MIB	Standard/rfc4560-DISMAN-PING-MIB.mib
DISMAN-TRACEROUTE-MIB	Standard/rfc4560-DISMAN-TRACEROUTE-MIB.mib
DRAFT-MSDP-MIB	Vendor/Cisco/MSDP-MIB.my
DS1-MIB	Standard/rfc4805-DS1-MIB.mib
DS3-MIB	Standard/rfc3896-DS3-MIB.mib
DVMRP-MIB	Vendor/Nortel/DVMRP-MIB.mib
ENTITY-MIB	Standard/rfc4133-ENTITY-MIB.mib
ENTITY-STATE-MIB	Standard/rfc4268-ENTITY-STATE-MIB.mib
ENTITY-STATE-TC-MIB	Standard/rfc4268-ENTITY-STATE-TC-MIB.mib
EXTREME-BASE-MIB	Vendor/Extreme/v730b49.mib

MIB name	MIB file
EXTREME-CABLE-MIB	Vendor/Extreme/v730b49.mib
EXTREME-DLCS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-DOS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-EAPS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-EDP-MIB	Vendor/Extreme/v730b49.mib
EXTREME-ENH-DOS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-ESRP-MIB	Vendor/Extreme/v730b49.mib
EXTREME-FDB-MIB	Vendor/Extreme/v730b49.mib
EXTREME-FILETRANSFER-MIB	Vendor/Extreme/v730b49.mib
EXTREME-NETFLOW-MIB	Vendor/Extreme/v730b49.mib
EXTREME-NP-MIB	Vendor/Extreme/v730b49.mib
EXTREME-OSPF-MIB	Vendor/Extreme/v730b49.mib
EXTREME-PBQOS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-POE-MIB	Vendor/Extreme/v730b49.mib
EXTREME-PORT-MIB	Vendor/Extreme/v730b49.mib
EXTREME-POS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-QOS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-RTSTATS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-SERVICES-MIB	Vendor/Extreme/v730b49.mib
EXTREME-SLB-MIB	Vendor/Extreme/v730b49.mib
EXTREME-SNMPV3-MIB	Vendor/Extreme/v730b49.mib
EXTREME-STP-EXTENSIONS-MIB	Vendor/Extreme/v730b49.mib
EXTREME-SYSTEM-MIB	Vendor/Extreme/v730b49.mib
EXTREME-TRAP-MIB	Vendor/Extreme/v730b49.mib
EXTREME-TRAPPOLL-MIB	Vendor/Extreme/v730b49.mib
EXTREME-V2TRAP-MIB	Vendor/Extreme/v730b49.mib
EXTREME-VC-MIB	Vendor/Extreme/v730b49.mib
EXTREME-VLAN-MIB	Vendor/Extreme/v730b49.mib
EXTREME-WIRELESS-MIB	Vendor/Extreme/v730b49.mib
EXTREMEdot11AP-MIB	Vendor/Extreme/v730b49.mib
EXTREMEdot11f-MIB	Vendor/Extreme/v730b49.mib
EtherLike-MIB	Standard/rfc3635-EtherLike-MIB.mib
FDDI-SMT73-MIB	Standard/Historic/rfc1512-FDDI-SMT73-MIB.mib
FOUNDRY-SN-ROOT-MIB	Vendor/Foundry/FOUNDRY-SN-ROOT-MIB.mib
FRAME-RELAY-DTE-MIB	Standard/rfc2115-FRAME-RELAY-DTE-MIB.mib

MIB name	MIB file
FtpServer-MIB	Vendor/Microsoft/ftp.mib
HC-RMON-MIB	Standard/rfc3273-HC-RMON-MIB.mib
HCNUM-TC#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc2856-HCNUM-TC.mib
HOST-RESOURCES-MIB	Standard/rfc2790-HOST-RESOURCES-MIB.mib
HOST-RESOURCES-TYPES	Standard/rfc2790-HOST-RESOURCES-TYPES.mib
HP-ICF-OID	Vendor/Hewlett-Packard/ProCurve/hpicfOid.mib
HP-SITESCOPE-MIB	Vendor/Hewlett-Packard/HP-SITESCOPE-MIB.mib
HP-SN-AGENT-MIB	Vendor/Hewlett-Packard/hpEtherSwitch/hp-sn-agent.mib
HP-SN-ROOT-MIB	Vendor/Hewlett-Packard/hpEtherSwitch/hp-sn-root.mib
HP-SN-SWITCH-GROUP-MIB	Vendor/Hewlett-Packard/hpEtherSwitch/hp-sn-switch.mib
HP-UNIX	Vendor/Hewlett-Packard/hp-unix
HttpServer-MIB	Vendor/Microsoft/http.mib
IANA-ADDRESS-FAMILY-NUMBERS-MIB	Standard/IANA-ADDRESS-FAMILY-NUMBERS-MIB.mib
IANA-MAU-MIB	Standard/rfc4836-IANA-MAU-MIB.mib
IANA-RTPROTO-MIB	Vendor/Cisco/IANA-RTPROTO-MIB.my
IANATn3270eTC-MIB	Standard/IANATn3270eTC-MIB.mib
IANAifType-MIB	Standard/IANAifType-MIB.mib
IEEE8021-TC-MIB	IEEE/IEEE8021-TC-MIB.mib
IEEE8023-LAG-MIB	IEEE/IEEE8023-LAG-MIB.mib
IEEE802dot11-MIB	IEEE/IEEE802dot11-MIB.mib
IF-MIB	Standard/rfc2863-IF-MIB.mib
IGMP-MIB	Vendor/Cisco/IGMP-MIB.my
IGMP-STD-MIB	Vendor/Cisco/IGMP-STD-MIB.my
INET-ADDRESS-MIB	Standard/rfc4001-INET-ADDRESS-MIB.mib
INTEGRATED-SERVICES-MIB	Standard/rfc2213-INTEGRATED-SERVICES-MIB.mib
IP-FORWARD-MIB	Standard/rfc4292-IP-FORWARD-MIB.mib
IP-MIB	Standard/rfc4293-IP-MIB.mib
IPMCAST-MIB	Standard/rfc5132-IPMCAST-MIB.mib
IPMROUTE-MIB	Vendor/Cisco/IPMROUTE-MIB.my
IPMROUTE-STD-MIB	Vendor/Cisco/IPMROUTE-STD-MIB.my
IPV6-FLOW-LABEL-MIB	Standard/rfc3595-IPV6-FLOW-LABEL-MIB.mib
IPV6-MIB	Standard/rfc2465-IPV6-MIB.mib
IPV6-TC	Standard/rfc2465-IPV6-TC.mib
ISDN-MIB	Standard/rfc2127-ISDN-MIB.mib
InternetServer-MIB	Vendor/Microsoft/inetsrv.mib

MIB name	MIB file
JUNIPER-CHASSIS-DEFINES-MIB	Vendor/Juniper/mib-jnx-chas-defines
JUNIPER-JS-IF-EXT-MIB	Vendor/Juniper/mib-jnx-js-if-ext
JUNIPER-JS-SMI	Vendor/Juniper/mib-jnx-js-smi
JUNIPER-MIB	Vendor/Juniper/mib-jnx-chassis
JUNIPER-SMI	Vendor/Juniper/mib-jnx-smi
JUNIPER-V1-TRAPS	Vendor/Juniper/v1_traps
JUNIPER-VPN-MIB	Vendor/Juniper/mib-jnx-vpn
Juniper-MIBs	Vendor/Juniper/Juniper-MIBs.mib
Juniper-UNI-SMI	Vendor/Juniper/Juniper-UNI-SMI.mib
LANGTAG-TC-MIB	Standard/rfc5131-LANGTAG-TC-MIB.mib
LLDP-MIB	IEEE/lldp.mib
LanMgr-Mib-II-MIB	Vendor/Microsoft/lmmib2.mib
MAU-MIB	Standard/rfc4836-MAU-MIB.mib
MGMD-STD-MIB	Standard/rfc5519-MGMD-STD-MIB.mib
MPLS-L3VPN-STD-MIB	Standard/rfc4382-MPLS-L3VPN-STD-MIB.mib
MPLS-LSR-MIB	Vendor/Cisco/MPLS-LSR-MIB.my
MPLS-LSR-STD-MIB	Standard/rfc3813-MPLS-LSR-STD-MIB.mib
MPLS-MIB	Vendor/Juniper/mib-jnx-mpls
MPLS-TC-STD-MIB	Standard/rfc3811-MPLS-TC-STD-MIB.mib
MPLS-TE-MIB	Vendor/Cisco/MPLS-TE-MIB.my
MPLS-TE-STD-MIB	Standard/rfc3812-MPLS-TE-STD-MIB.mib
MPLS-VPN-MIB	Vendor/Cisco/MPLS-VPN-MIB.my
MSDP-MIB	Vendor/Nortel/MSDP-MIB.mib
Nortel-Magellan-Passport-StandardTextualConventionsMIB	Vendor/Nortel/Nortel-Magellan-Passport-StandardTextualConventionsMIB.mib
Nortel-Magellan-Passport-TextualConventionsMIB	Vendor/Nortel/Nortel-Magellan-Passport-TextualConventionsMIB.mib
Nortel-Magellan-Passport-UsefulDefinitionsMIB	Vendor/Nortel/Nortel-Magellan-Passport-UsefulDefinitionsMIB.mib
Nortel-MsCarrier-MscPassport-StandardTextualConventionsMIB	Vendor/Nortel/Nortel-MsCarrier-MscPassport-StandardTextualConventionsMIB.mib
Nortel-MsCarrier-MscPassport-TextualConventionsMIB	Vendor/Nortel/Nortel-MsCarrier-MscPassport-TextualConventionsMIB.mib
Nortel-MsCarrier-MscPassport-UsefulDefinitionsMIB	Vendor/Nortel/Nortel-MsCarrier-MscPassport-UsefulDefinitionsMIB.mib
OLD-CISCO-CHASSIS-MIB	Vendor/Cisco/OLD-CISCO-CHASSIS-MIB.my
OLD-CISCO-INTERFACES-MIB	Vendor/Cisco/OLD-CISCO-INTERFACES-MIB.my
OLD-CISCO-SYS-MIB	Vendor/Cisco/OLD-CISCO-SYS-MIB.my

MIB name	MIB file
OSPF-MIB	Standard/rfc4750-OSPF-MIB.mib
P-BRIDGE-MIB	Standard/rfc4363-P-BRIDGE-MIB.mib
PIM-MIB	Vendor/Cisco/PIM-MIB.my
PIM-STD-MIB	Standard/rfc5060-PIM-STD-MIB.mib
POWER-ETHERNET-MIB	Standard/rfc3621-POWER-ETHERNET-MIB.mib
PerfHist-TC-MIB	Standard/rfc3593-PerfHist-TC-MIB.mib
Q-BRIDGE-MIB	Standard/rfc4363-Q-BRIDGE-MIB.mib
RAPID-CITY	Vendor/Nortel/RAPID-CITY.mib
RFC-1212#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc1212-RFC1212.mib
RFC-1215	Standard/rfc1215-RFC1215.mib
RFC1155-SMI#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc1155-RFC1155-SMI.mib
RFC1213-MIB#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc1213-RFC1213-MIB.mib
RFC1271-MIB#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc1271-RFC1271-MIB.mib
RFC1315-MIB	Standard/rfc1315-RFC1315-MIB.mib
RIPv2-MIB	Standard/rfc1724-RIPv2-MIB.mib
RMON-MIB	Standard/rfc2819-RMON-MIB.mib
RMON2-MIB	Standard/rfc4502-RMON2-MIB.mib
RS-232-MIB	Standard/rfc1659-RS-232-MIB.mib
SMON-MIB	Standard/rfc2613-SMON-MIB.mib
SNMP-FRAMEWORK-MIB	Standard/rfc3411-SNMP-FRAMEWORK-MIB.mib
SNMP-REPEATER-MIB	Standard/rfc2108-SNMP-REPEATER-MIB.mib
SNMP-TARGET-MIB	Standard/rfc3413-SNMP-TARGET-MIB.mib
SNMP-VIEW-BASED-ACM-MIB	Standard/rfc3415-SNMP-VIEW-BASED-ACM-MIB.mib
SNMPv2-CONF#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc1904-SNMPv2-CONF.mib
SNMPv2-MIB#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc3418-SNMPv2-MIB.mib
SNMPv2-SMI#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc2578-SNMPv2-SMI.mib
SNMPv2-TC#	NNM/server/lib/nms-mib-model.jar/com/hp/ov/nms/mib/model/hibernate/rfc2579-SNMPv2-TC.mib
SONET-MIB	Standard/rfc3592-SONET-MIB.mib
TOKEN-RING-RMON-MIB	Standard/Historic/rfc1513-TOKEN-RING-RMON-MIB.mib
TRANSPORT-ADDRESS-MIB	Standard/rfc3419-TRANSPORT-ADDRESS-MIB.mib
TUNNEL-MIB	Standard/rfc4087-TUNNEL-MIB.mib

MIB name	MIB file
VMWARE-AGENTCAP-MIB	Vendor/VMware/VMWARE-AGENTCAP-MIB.mib
VMWARE-ENV-MIB	Vendor/VMware/VMWARE-ENV-MIB.mib
VMWARE-OBSOLETE-MIB	Vendor/VMware/VMWARE-OBSOLETE-MIB.mib
VMWARE-PRODUCTS-MIB	Vendor/VMware/VMWARE-PRODUCTS-MIB.mib
VMWARE-RESOURCES-MIB	Vendor/VMware/VMWARE-RESOURCES-MIB.mib
VMWARE-ROOT-MIB	Vendor/VMware/VMWARE-ROOT-MIB.mib
VMWARE-SYSTEM-MIB	Vendor/VMware/VMWARE-SYSTEM-MIB.mib
VMWARE-TC-MIB	Vendor/VMware/VMWARE-TC-MIB.mib
VMWARE-VC-EVENT-MIB	Vendor/VMware/VMWARE-VC-EVENT-MIB.mib
VMWARE-VMINFO-MIB	Vendor/VMware/VMWARE-VMINFO-MIB.mib
VPN-TC-STD-MIB	Standard/rfc4265-VPN-TC-STD-MIB.mib
VRRP-MIB	Standard/rfc2787-VRRP-MIB.mib
WINDOWS-NT-PERFORMANCE	Vendor/Microsoft/WINDOWS-NT-PERFORMANCE.mib
WINS-MIB	Vendor/Microsoft/wins.mib
X-DDI-MIB	Vendor/Nortel/x-ddi-adapter-mib
XYLAN-BASE-MIB	Vendor/OTHER-VENDORS/XYLAN-BASE-MIB.mib
XYLAN-HEALTH-MIB	Vendor/OTHER-VENDORS/XYLAN-HEALTH-MIB.mib

#: Some MIB files are contained in JAR files. The MIB files in the table are relative paths within the JAR files shown below.

Windows

```
%NnmInstallDir%NNM\server\lib\nms-mib-model.jar
```

Linux

```
$NnmInstallDir/NNM/server/lib/nms-mib-model.jar
```

C. NNMi Environment Variables

NNMi provides many environment variables that are available for your use in navigating the file system and writing scripts.

C.1 Environment variables used in this manual

This manual primarily uses the following two NNMi environment variables to reference file and directory locations. This list shows the default values. The actual values depend on the selections that you made during NNMi installation.

- Windows:
  - `%NnmInstallDir%`: *drive*`:\Program Files (x86)\Hitachi\Cm2NNMi\`
  - `%NnmDataDir%`: *drive*`:\ProgramData\Hitachi\Cm2NNMi\`

  Note

  On Windows systems, the NNMi installation process creates these system environment variables, so they are always available to all users.

  Important

  If a path name contains a space, enclose the entire path name in double quotation marks (").

  Example:

  ```
  "%NnmInstallDir%bin\ovstatus" -c
  ```

- Linux:
  - `$NnmInstallDir`: `/opt/OV`
  - `$NnmDataDir`: `/var/opt/OV`

  Note

  On Linux systems, you must manually create these environment variables if you want to use them.

The following environment variables are should be replaced with the following path in this manual.

- Windows:
  `%jdkdir%: %NnmInstallDir%nonOV\jdk\zulu\zulu8.56.0.21-ca-jdk8.0.302-win_x64`
- Linux:
  `$jdkdir: /opt/OV/nonOV/jdk/zulu/zulu8.56.0.21-ca-jdk8.0.302-linux_x64`

Additionally, this document references some of the NNMi environment variables that you can source as part of your user log-on configuration on the NNMi management server. These variables are of the form `NNM_*`. For details about this extended list of NNMi environment variables, see C.2 Other available environment variables.

C.2 Other available environment variables

NNMi administrators access some NNMi file locations regularly. NNMi provides a script that sets up many environment variables for navigating to commonly accessed locations.

To set up the extended list of NNMi environment variables, use a command similar to the following example:

- Windows: `%NnmInstallDir%bin\nnm.envvars.bat`
- Linux: `. /opt/OV/bin/nnm.envvars.sh`
  A space must be inserted between the period (`.`) and the forward slash (`/`).

After you run the command for your operating system, you can use the NNMi environment variables shown in Table C-1 (Windows) or Table C-2 (Linux) to get to commonly used NNMi file locations.

Table C-1: Environment variable default locations for the Windows operating system

Variable	Windows (example)
%NNM_BIN%	C:\Program Files (x86)\Hitachi\Cm2NNMi\bin
%NNM_CONF%	C:\ProgramData\Hitachi\Cm2NNMi\Conf
%NNM_DATA%	C:\ProgramData\Hitachi\Cm2NNMi
%NNM_DB%	C:\ProgramData\Hitachi\Cm2NNMi\shared\nnm\databases
%NNM_JAVA%	C:\Program Files (x86)\Hitachi\Cm2NNMi\nonOV\jdk\hpsw\bin\java.exe
%NNM_JAVA_DIR%	C:\Program Files (x86)\Hitachi\Cm2NNMi\java
%NNM_JBOSS%	C:\Program Files (x86)\Hitachi\Cm2NNMi\nmsas
%NNM_JBOSS_DEPLOY%	C:\Program Files (x86)\Hitachi\Cm2NNMi\nmsas\server\nms\deploy
%NNM_JBOSS_LOG%	C:\ProgramData\Hitachi\Cm2NNMi\log\nnm
%NNM_JBOSS_SERVERCONF%	C:\Program Files (x86)\Hitachi\Cm2NNMi\nmsas\server\nms
%NNM_JRE%	C:\Program Files (x86)\Hitachi\Cm2NNMi\nonOV\jdk\hpsw
%NNM_LOG%	C:\ProgramData\Hitachi\Cm2NNMi\log
%NNM_LRF%	C:\ProgramData\Hitachi\Cm2NNMi\shared\nnm\lrf
%NNM_PRIV_LOG%	C:\ProgramData\Hitachi\Cm2NNMi\log
%NNM_PROPS%	C:\ProgramData\Hitachi\Cm2NNMi\shared\nnm\conf\props
%NNM_SHARED_CONF%	C:\ProgramData\Hitachi\Cm2NNMi\shared\nnm\conf
%NNM_SHARE_LOG%	C:\ProgramData\Hitachi\Cm2NNMi\log
%NNM_SNMP_MIBS%	C:\Program Files (x86)\Hitachi\Cm2NNMi\misc\nnm\snmp-mibs
%NNM_TMP%	C:\ProgramData\Hitachi\Cm2NNMi\tmp
%NNM_USER_SNMP_MIBS%	C:\ProgramData\Hitachi\Cm2NNMi\shared\nnm\user-snmp-mibs
%NNM_WWW%	C:\ProgramData\Hitachi\Cm2NNMi\shared\nnm\www

Table C-2: Environment variable default locations for the Linux operating system

Variable	Linux (example)
$NNM_BIN	/opt/OV/bin
$NNM_CONF	/var/opt/OV/conf
$NNM_DATA	/var/opt/OV
$NNM_DB	/var/opt/OV/shared/nnm/databases
$NNM_JAVA	/opt/OV/nonOV/jdk/hpsw/bin/java
$NNM_JAVA_DIR	/opt/OV/java
$NNM_JBOSS	/opt/OV/nmsas
$NNM_JBOSS_DEPLOY	/opt/OV/nmsas/server/nms/deploy
$NNM_JBOSS_LOG	/var/opt/OV/log/nnm
$NNM_JBOSS_SERVERCONF	/opt/OV/nmsas/server/nms
$NNM_JRE	/opt/OV/nonOV/jdk/hpsw
$NNM_LOG	/var/opt/OV/log
$NNM_LRF	/var/opt/OV/shared/nnm/lrf
$NNM_PRIV_LOG	/var/opt/OV/log
$NNM_PROPS	/var/opt/OV/shared/nnm/conf/props
$NNM_SHARED_CONF	/var/opt/OV/shared/nnm/conf
$NNM_SHARE_LOG	/var/opt/OV/log
$NNM_SNMP_MIBS	/opt/OV/misc/nnm/snmp-mibs
$NNM_USER_SNMP_MIBS	/var/opt/OV/shared/nnm/user-snmp-mibs
$NNM_TMP	/var/opt/OV/tmp
$NNM_WWW	/var/opt/OV/shared/nnm/www

D. The Causal Engine and NNMi Incidents

Communications and data networks have grown significantly in size and complexity, and so has the number of faults that occur. A single failure can trigger many alarms. Distinguishing real problems from anecdotal alarms has become a bottleneck for network operators. Traditional event correlation systems are able to reduce the number of alarms, but these systems tend to fall short in terms of identifying the root causes in an automated manner.

The NNMi Causal Engine technology applies *root cause analysis* (RCA) to network symptoms, using a causality-based approach to incident generation.

D.1 Causal relationship analysis - advanced consideration

Causal Engine technology provides the following advanced features:

- Uses the `NmsApa` (NMS Active Problem Analyzer) JBoss service to analyze your network
- Uses a model-based approach to RCA
  - Models the behavioral relationship between managed objects.
  - Uses an object model in addition to event causality to drive analysis.
  - Determines root cause and impact based on the MINCAUSE algorithm.
  - Effectively handles ambiguity and partial symptoms.
- Is dynamic
  - Actively solicits symptoms during analysis.
  - Reacts dynamically to topology changes.
- Is extendable
  - Employs a hierarchy of modules (import/export).
  - Provides an end-to-end diagnosis of network faults.
  - Provides the ability to add rule sets in future offerings.

D.2 Causal Engine concept

Causal Engine uses the following sequential approach to incident generation:

1. Formally define the root-cause problems and symptoms.
2. Perform analysis by relating symptoms to root-cause problems using the behavioral and object models. Symptoms come from two sources:
   - State Poller, where the symptoms are state changes
   - Events, where the symptoms are traps
3. Generate conclusions that relate to the root causes.
   Causal Engine conclusions include the artifacts related to the model, which include the following details:
   - Generated incidents
   - Correlated incidents
   - Suppressed incidents
   - Canceled incidents

- Status on relevant objects

D.3 Concept of status

In addition to incident manipulation, the NmsApa service sets status on relevant objects. Status indicates the overall health of an object and is determined from the outstanding conclusions. Every conclusion has a severity associated with it. The status reported is the most severe of all outstanding conclusions. In addition, conclusions inform the user of the root cause (or reason) for an object's status.

The NmsApa service manages the following objects:

- SNMP agents
- IPv4 addresses
- Interfaces
- Connections
- Nodes
- Node groups

The NmsApa service uses the following status categories in decreasing order of severity:

- Unknown
- Disabled
- Critical
- Major
- Minor
- Warning
- Normal
- No Status

D.4 About episodes

The goal of the NmsApa service is to present a single incident that the operator or network engineer can investigate. To do this, the NmsApa service uses the concept of an *episode*. An episode exists for a specific duration, during which secondary failures are either correlated or suppressed based on the incident configuration.

Examples

- The AddressNotResponding incident is suppressed by the InterfaceDown incident, according to the following scenario:
  - When an IP address stops responding to ICMP, an episode begins, which exists for a duration of 60 seconds.
  - Within that duration, if the interface associated with that IP address goes down, the NmsApa service concludes that an interface down condition caused the IPv4 address to stop responding.
  - Therefore, the AddressNotResponding incident is suppressed.

Only the InterfaceDown incident is generated.

- To ensure that the InterfaceDown incident is discovered within that period, the NmsApa service issues specified polling to that interface. This enables the network engineer to correct the root cause of the problem (the interface in this case).
- If the interface does not go down during the episode, the NmsApa service generates an AddressNotResponding incident. If the interface goes down after the episode, NNMi generates an InterfaceDown incident. In this case, the network engineer must treat the two problems separately.

- The NodeDown incident correlates the InterfaceDown incident from one-hop neighbor interfaces, according to the following scenario:
  - When an interface goes down, a NodeDown episode begins for the neighboring node, which exists for a duration of 300 seconds.
  - Within that duration, if the node goes down, NNMi correlates the InterfaceDown incident beneath the NodeDown incident.
  - The InterfaceDown incidents from all one-hop neighbors are correlated beneath the NodeDown incident. You can review the InterfaceDown incidents as supporting evidence for the NodeDown incident.

D.5 What does NNMi analyze?

Using SNMP, NNMi utilizes SNMP agents (processes running on managed nodes that provide management functions) to acquire information from managed nodes. The SNMP agents manage the interfaces and ports on the managed nodes, and can associate them with one or more nodes.

The following list shows the status categories that can be associated with SNMP agents:

- Unknown - Not applicable
- Disabled - Not applicable
- Critical - Indicates the SNMP agent does not respond to SNMP queries.
- Minor - Not applicable
- Warning - Not applicable
- Normal - Indicates the SNMP agent responds to SNMP queries.
- No Status - Indicates the SNMP agent is not polled.

An *IPv4 address* is a routable address that responds to ICMP. An IPv4 address is normally associated with a node. NNMi reports the status of a node as follows:

- Unknown - Not applicable
- Disabled - Indicates the interface associated with this IPv4 address cannot be managed or is disabled.
- Critical - Indicates the IPv4 address does not respond to ICMP queries (pings the device).
- Minor - Not applicable
- Warning - Not applicable
- Normal - Indicates the IPv4 address responds to ICMP queries.
- No Status - Indicates the IPv4 address is not polled.

An *interface* is a physical port that can be used to connect a node to the network. NNMi reports the status of an interface as follows:

- `Unknown` - The SNMP agent associated with the interface does not respond to SNMP queries. The `NmsApa` service cannot determine the health because the `ifAdminStatus` and `ifOperStatus` values cannot be measured.
- `Disabled` - Indicates the interface is administratively down (`ifAdminStatus=down`).
- `Critical` - Indicates the interface is operationally down (`ifOperStatus=down`).
- `Minor` - Not applicable
- `Warning` - Not applicable
- `Normal` - Indicates the interface is operationally up (`ifOperStatus=up`).
- `No Status` - Indicates the interface is not polled.

A *node* is a device that NNMi finds as a result of the spiral discovery process. A node can contain interfaces, boards, and ports. You can separate nodes into the following two categories:

1. Network nodes, which are active devices such as switches, routers, bridges, and hubs
2. End nodes, such as Linux or Windows servers

NNMi typically manages network nodes, reporting node status as follows:

- `Unknown` - The SNMP agent associated with the node does not respond to SNMP queries and the polled IPv4 address does not respond to the ICMP query. This indicates that NNMi is unable to manage the node.
- `Disabled` - Not applicable
- `Critical` - Indicates any one of the following:
  - The node is down as determined by neighbor analysis.
  - The node is marked as important and is unmanageable (NNMi cannot access the node from the NNMi server).
  - The node is an island (if it has no neighbor), and therefore is unmanageable.
  - The `NmsApa` service cannot determine whether the node is down or the incoming connection is down.
- `Minor` - Indicates any one of the following:
  - The SNMP agent associated with the node does not respond to SNMP queries.
  - At least one interface in the node is down.
  - At least one IPv4 address on the node does not respond to ICMP.
- `Warning` - Not applicable
- `Normal` - Indicates the SNMP agent of the node, polled interfaces, and polled IPv4 addresses are up.
- `No Status` - Indicates the SNMP agent, all interfaces, and all IPv4 addresses of the node are not polled.

Connections are Layer 2 physical connections and Layer 3 network connections. NNMi discovers connection information by reading *forwarding database* (FDB) tables from other network devices and by using devices that support discovery protocols, such as *Cisco Discovery Protocol* (CDP) and *Extreme Discovery Protocol* (EDP). NNMi reports the status of a connection as follows:

- `Unknown` - Indicates all endpoints of the connection have `Unknown` status.
- `Disabled` - Indicates one endpoint of the connection is disabled.
- `Critical` - Indicates all endpoints are operationally down.
- `Minor` - Indicates one endpoint is down.

- `Warning` - Indicates endpoints have unknown and non-critical status.
- `Normal` - Indicates all endpoints are operationally up.
- `No Status` - Indicates one endpoint is not polled.

A *node group* is a logical collection of nodes created by an NNMi administrator to customize the polling configuration. For example, some nodes, such as routers, might be critical to a business and therefore must be polled more frequently. For such a case, the NNMi administrator would define a node group containing the critical routers and configure them for a shorter polling cycle.

NNMi reports the status of a node group as follows:

- `Unknown` - Indicates all nodes in the group have `Unknown` status.
- `Disabled` - Not applicable
- `Critical` - Indicates all nodes in the group have `Critical` status.
- `Minor` - Indicates at least one node in the group has `Critical` status.
- `Warning` - Indicates nodes have unknown and non-critical status.
- `Normal` - Indicates all nodes in the group have `Normal` status.
- `No Status` - Indicates all nodes in the group have no status.

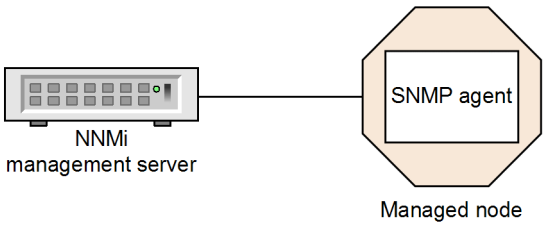
D.6 Failure scenarios

The following subsections describe the network fault scenarios that the NNMi Causal Engine analyzes and how the failures are diagnosed. The following table shows incident examples indicated by these scenarios, together with other examples:

Table D-1: Incident definition

Incident name	Description
`AddressNotResponding`	IPv4 address does not respond to ICMP. The following are possible reasons: 1. The node is down. 2. Because of an error in the device (such as a router) configuration, several IPv4 addresses cannot be reached.
`InterfaceDown`	The interface is not up.
`ConnectionDown`	Both (or all) connection endpoints are down.
`NodeDown`	This incident indicates that the `NmsApa` service has determined that the node is down based on the following analysis: • 100% of the IPv4 addresses assigned to this node cannot be reached. • The SNMP agents installed in this machine are not responding. Indicates that at least two neighboring devices can be reached, but reports that there is a problem in the connectivity to this node.
`NodeOrConnectionDown`	This incident indicates that the node is not responding to ICMP or SNMP queries. Moreover, because only one of the neighboring interfaces is down, the `NmsApa` service cannot determine whether the node is down or the connection is down.

(1) SNMP agent not responding to SNMP queries



Legend:
Managed node: Network device, such as an Ethernet switch
SNMP agent: With new community string for managed node
MS communication configuration settings: Not updated with new community strings

Scenario: The SNMP agent is not responding. For example, the community string for this SNMP agent has been changed, or NNMi's communication configuration settings have not yet been updated, but the node is operational (IPv4 address can be pinged).

Root cause: The SNMP agent is not responding.

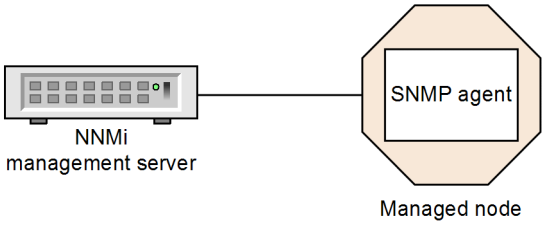
Incident: An `SNMPAgentNotResponding` incident is generated.

Status: The SNMP agent is in `Critical` status.

Conclusion: `SNMPAgentNotResponding`

Effect: The node status is `Minor`. The conclusion on the node is `UnresponsiveAgentInNode`. All polled interfaces have `Unknown` status because they cannot be managed by NNMi. The conclusion on each interface is `InterfaceUnmanageable`.

(2) SNMP agent responding to SNMP queries



Legend:
Managed node: Network device, such as an Ethernet switch
SNMP agent: With new community string for managed node
MS communication configuration settings: Updated with new community strings

Scenario: This scenario continues the previous (1) SNMP agent not responding to SNMP queries scenario. An NNMi administrator has updated the community configuration settings to include the new community string. The SNMP agent for the managed node starts responding to SNMP queries.

Root cause: SNMP agent is responding.

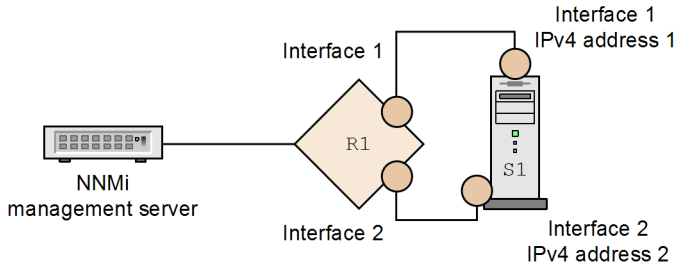
Incident: None generated. The `SNMPAgentNotResponding` incident is closed.

Status: SNMP agent is in `Normal` state.

Conclusion: `SNMPAgentResponding`

Effect: The node status is `Normal`. The conclusion on the node is `ResponsiveAgentInNode`. `InterfaceUnmanageable` is cleared from all polled interfaces and the interfaces return to their previous status.

(3) IPv4 address not responding to ICMP



Legend:

`R1`	: Router 1
Route	: Changed from interface 1 to interface 2 on the router
`S1`	: Server 1
Managed node `S1`	: Multi-homed server
`S1` interface 1	: Associated with IPv4 address 1
`S1` interface 2	: Associated with IPv4 address 2

Scenario: IPv4 address 1 on Server 1 (`S1`) is not responding. For example, the route on Router 1 (`R1`) has changed from Interface 1 to Interface 2, so that packets destined for Interface 1 on Server 1 are now routed out of Interface 2 on Router 1. The associated interface is operational, and the node can be reached because you can ping some IPv4 addresses. The SNMP agent is up.

Root cause: IPv4 address is not responding.

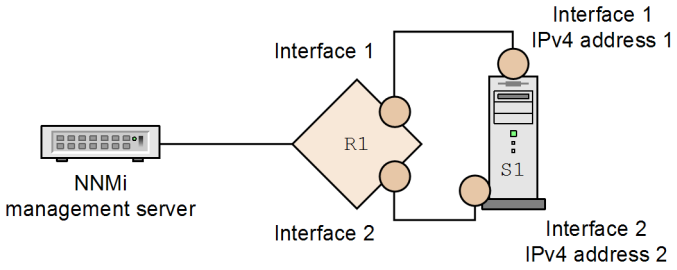
Incident: An `AddressNotResponding` incident is generated.

Status: IPv4 address is in `Critical` status.

Conclusion: `AddressNotResponding`

Effect: The node status is `Minor`. The conclusion on the node is `SomeUnresponsiveAddressesInNode`.

(4) IPv4 address responding to ICMP



Legend:

`R1`	: Router 1
Route	: Changed from interface 2 to interface 1 on the router
`S1`	: Server 1
Managed node `S1`	: Multi-homed server
`S1` interface 1	: Associated with IPv4 address 1
`S1` interface 2	: Associated with IPv4 address 2

Scenario: This scenario continues the previous (3) IPv4 address not responding to ICMP scenario. The IPv4 address is now responding, the associated interface is operational, and the node can be reached (for example, you can ping some IPv4 addresses, or the SNMP agent is up, or both).

Root cause: IPv4 address is responding.

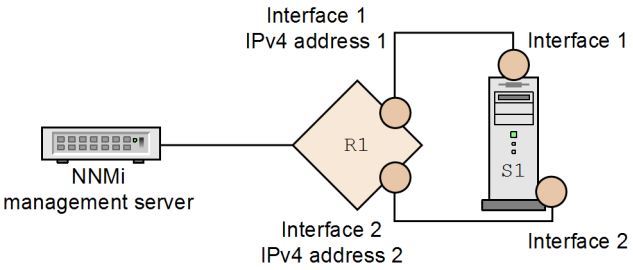
Incident: None generated. The `AddressNotResponding` incident is closed.

Status: The IPv4 address is in `Normal` state.

Conclusion: `AddressResponding`

Effect: The node status is `Normal`. The conclusion on the node is `ResponsiveAddressesInNode`.

(5) Interface is operationally down



Legend:
`R1` : Router 1
Interface 1 for `R1`: Configured to be administratively up but operationally down
Interface 1 for `R1`: Configured for IPv4 address 1
Interface 2 for `R1`: Configured for IPv4 address 2
`S1` : Server 1

Scenario: Interface 1 for `R1` is operationally down (`ifOperStatus=down`) and administratively up (`ifAdminStatus=up`). Router 1 sends a `LinkDown` trap. Router 1 can be reached because some IPv4 addresses, such as IPv4 address 2, respond to ping. The SNMP agent is up. IPv4 address 1 is associated with Interface 1 and has stopped responding to ICMP.

Root cause: The interface is down.

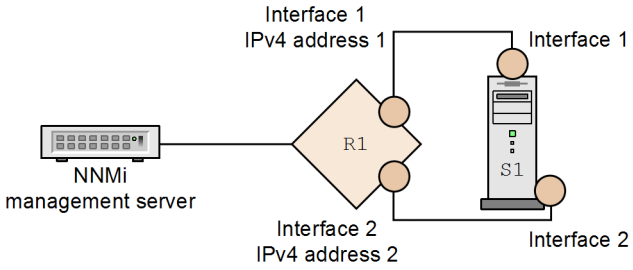
Incident: An `InterfaceDown` incident is generated. The `LinkDown` incident is correlated beneath the `InterfaceDown` incident.

Status: The interface is in `Critical` status.

Conclusion: `InterfaceDown`

Effect: The node status is `Minor`. The conclusion on the node is `InterfacesDownInNode`. No `AddressNotResponding` incident is associated with the IPv4 address.

(6) Interface is operationally up



Legend:
R1 : Router 1
Interface 1 for R1: Configured to be administratively up and operationally up
Interface 1 for R1: Configured for IPv4 address 1
Interface 2 for R1: Configured for IPv4 address 2
S1 : Server 1

Scenario: This scenario continues the previous (5) Interface is operationally down scenario. Interface 1 for `R1` is now operationally up (`ifOperStatus=up`). The node can be reached. All of its IPv4 addresses respond to ping. The SNMP agent is up.

Root cause: The interface is up.

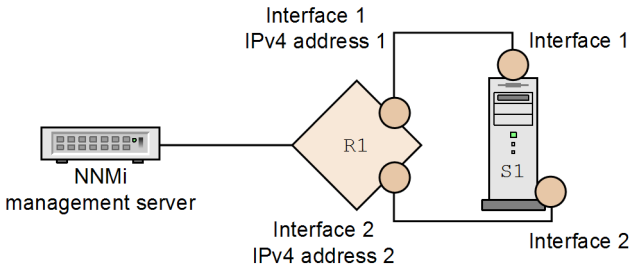
Incident: None generated. The `InterfaceDown` incident is closed.

Status: The interface is in `Normal` status.

Conclusion: `InterfaceUp`

Effect: The node status is `Normal`. The conclusion on the node is `InterfacesUpInNode`.

(7) Interface is administratively down



Legend:
R1 : Router 1
Interface 1 for R1: Configured to be administratively down and operationally down
Interface 1 for R1: Configured for IPv4 address 1
S1 : Server 1

Scenario: Interface 1 for `R1` is administratively down (`ifAdminStatus=down`), but the node can be reached. For example, Interface 2 responds to ping and the SNMP agent is up. Disabling Interface 1 for `R1` brings that interface operationally down. The IPv4 address associated with this interface, IPv4 address 1, stops responding to ICMP.

Root cause: Interface 1 for `R1` is disabled.

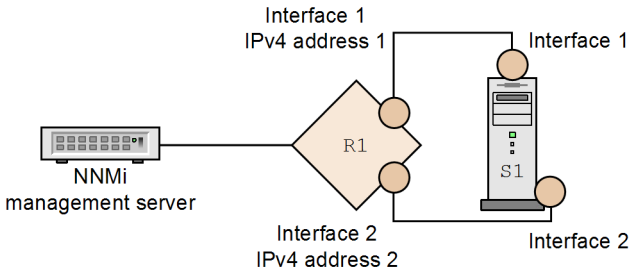
Incident: None generated.

Status: The interface is in `Disabled` status.

Conclusion: `InterfaceDisabled`

Effect: The IPv4 address associated with Interface 1 for `R1` has a status of `Disabled`. The conclusion on the IPv4 address is `AddressDisabled`.

(8) Interface is administratively up



Legend:
`R1` : Router 1
Interface 1 for `R1`: Configured to be administratively up and operationally up
Interface 1 for `R1`: Configured for IPv4 address 1
`S1` : Server 1

Scenario: This scenario continues the previous (5) Interface is operationally down scenario. Interface 1 for `R1` is now administratively up (`ifAdminStatus=up`). The node can be reached because some of the IPv4 addresses of that interface respond to ping. The SNMP agent is up. Enabling Interface 1 for `R1` brings it operationally up. The IPv4 address associated with this interface starts responding to ICMP.

Root cause: The interface is enabled.

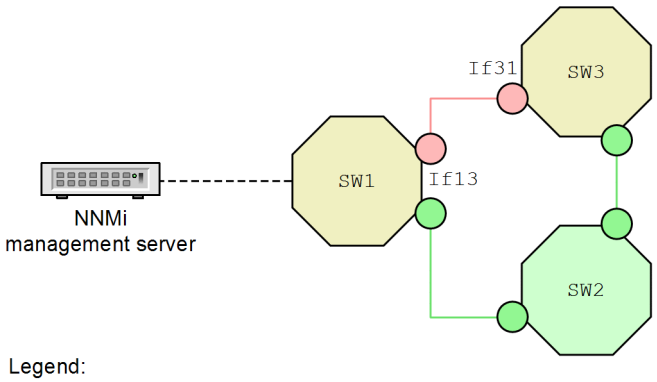
Incident: None generated.

Status: The interface is in `Normal` status.

Conclusion: `InterfaceEnabled`

Effect: The IPv4 address associated with Interface 1 for `R1` has a status of `Enabled`. The conclusion on the IPv4 address is `AddressEnabled`.

(9) Connection is operationally down



Legend:
SW1 : Switch 1
SW2 : Switch 2
SW3 : Switch 3
If31: Interface on Switch 3 connecting to Switch 1
If13: Interface on Switch 1 connecting to Switch 3

Scenario: The connection between the interface on Switch 3 connecting to Switch 1 (If13) and the interface on Switch 1 connecting to Switch 3 (If31) is down. Traffic flows from the Management server through Switch 1 (SW1) and Switch 2 (SW2). Both If13 and If31 are marked down.

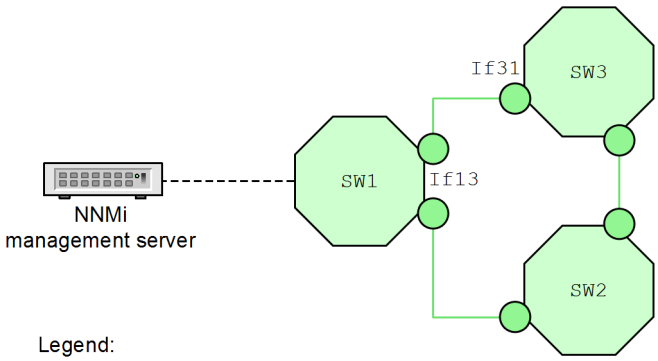
Root cause: The connection between If13 and If31 is down.

Incident: A ConnectionDown incident is generated. The InterfaceDown incident from If13 and If31 are correlated beneath ConnectionDown.

Status: The connection is in Critical status.

Conclusion: ConnectionDown

(10) Connection is operationally up



Legend:
SW1 : Switch 1
SW2 : Switch 2
SW3 : Switch 3
If31: Interface on Switch 3 connecting to Switch 1
If13: Interface on Switch 1 connecting to Switch 3

Scenario: This scenario continues the previous (9) Connection is operationally down scenario. The connection between If13 and If31 is now up.

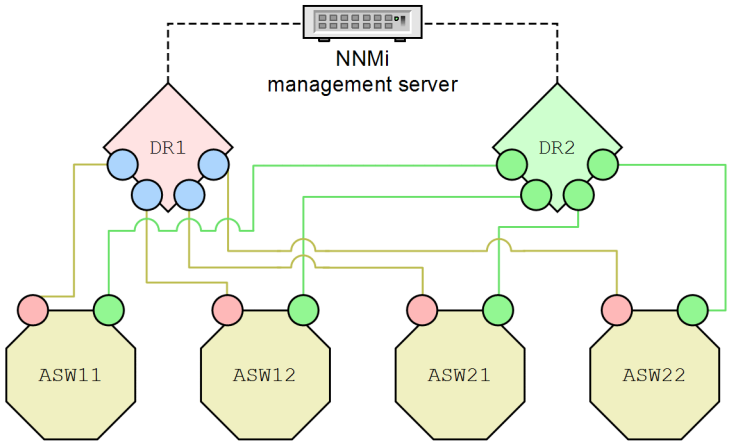
Root cause: The connection between If13 and If31 is up.

Incident: None generated. The ConnectionDown incident is closed.

Status: The connection is in `Normal` status.

Conclusion: `ConnectionUp`

(11) Directly connected node is down



Legend:
`DR1` : Distribution router 1
`DR2` : Distribution router 2
`ASW11`: Access switch 11
`ASW12`: Access switch 12
`ASW21`: Access switch 21
`ASW22`: Access switch 22

Scenario: Access switches `ASW11`, `ASW12`, `ASW21`, and `ASW22` are redundantly connected to the distribution routers as shown. Distribution routers `DR1` and `DR2` are directly connected to each another. Distribution router `DR1` goes down.

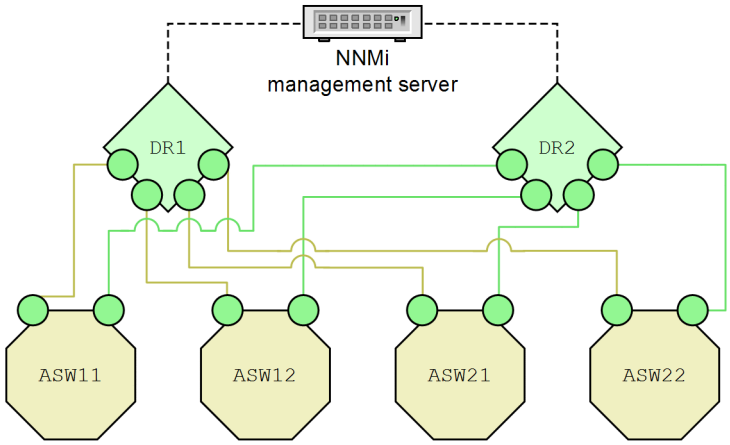
Root cause: Node `DR1` is down according to neighbor analysis.

Incident: A `NodeDown` incident is generated. The `InterfaceDown` incidents from one-hop neighbors are correlated beneath the `NodeDown` incident.

Status: The node is in `Critical` status.

Conclusion: `NodeDown`

(12) Directly connected node is up



Legend:
DR1 : Distribution router 1
DR2 : Distribution router 2
ASW11: Access switch 11
ASW12: Access switch 12
ASW21: Access switch 21
ASW22: Access switch 22

Scenario: This scenario continues the previous (11) Directly connected node is down scenario. Distribution router DR1 comes back up.

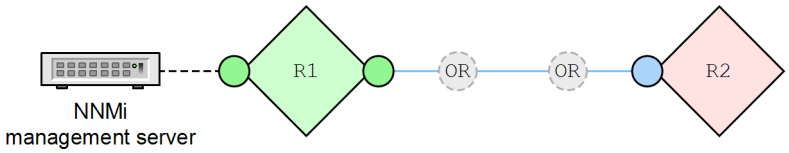
Root cause: Node DR1 is up.

Incident: None generated. The NodeDown incident is closed.

Status: The node is in Normal status.

Conclusion: NodeUp

(13) Indirectly connected node is down



Legend:
R1: Router 1
OR: Optical repeaters (not discovered by NNMi)
R2: Router 2

> **Note**
>
> The diagram is conceptual. It does not represent an actual NNMi topology map or workspace view.

Scenario: This scenario can occur with any indirect connection where NNMi cannot discover the intermediate devices. In this example, Routers R1 and R2 appear to be directly connected in NNMi topology maps, but in reality these two routers are indirectly connected through optical repeaters (because the optical repeaters do not respond to SNMP or ICMP queries, they are not discovered by NNMi).

Router 2 becomes unreachable, either because its connected interface is down or because the connection between the optical repeaters is down. The interface on Router 1 that indirectly connects it to Router 2 is still up because its optical repeater is still up.

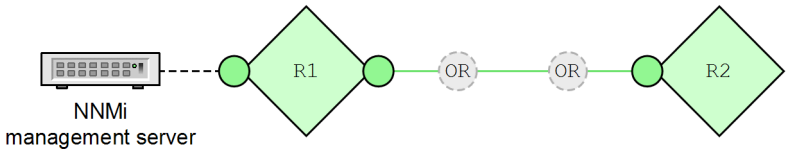
Root cause: Router 2 is down according to neighbor analysis.

Incident: A `NodeDown` incident is generated.

Status: Node router `R2` is in `Critical` status.

Conclusion: `NodeDown`

(14) Indirectly connected node is up



Legend:
`R1`: Router 1
`OR`: Optical repeater (not discovered by NNMi)
`R2`: Router 2

> **Note**
>
> The diagram is conceptual. It does not represent an actual NNMi topology map or workspace view.

Scenario: This scenario continues the previous (13) Indirectly connected node is down scenario. The failed connection comes back up. Router 2 becomes reachable.

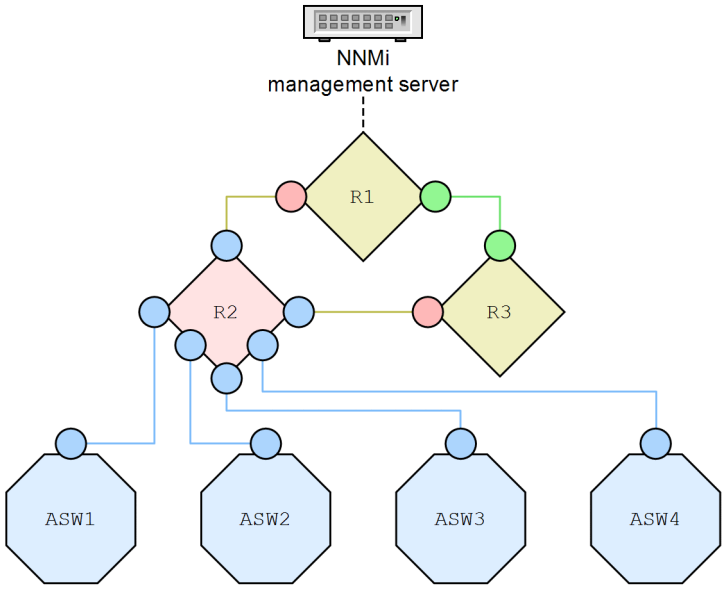
Root cause: The connection between Router 1 and Router 2 is up.

Incident: None generated. The `NodeDown` incident is closed.

Status: Router 2's status is `Normal`. The connection Status is `Normal`.

Conclusion: `NodeUp`

(15) Directly connected node is down and creates a shadow



Legend:
R1 : Router 1
R2 : Router 2
R3 : Router 3
ASW1: Access switch 1
ASW2: Access switch 2
ASW3: Access switch 3
ASW4: Access switch 4

Scenario: Router 2 (R2) goes down as shown above.

Root cause: Node (Router 2) is down according to NNMi's neighbor analysis.

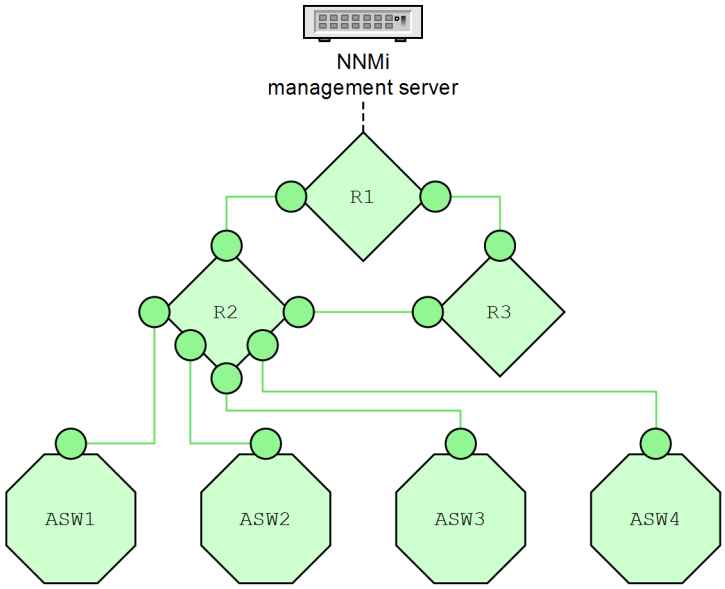
Incident: A NodeDown incident is generated. The InterfaceDown incidents from one-hop neighbors are correlated beneath the NodeDown incident.

Status: The node is in Critical status.

Conclusion: NodeDown

Effect: All of the access switches are unreachable. The status of all nodes in the shadow is Unknown and the conclusion on each of them is NodeUnmanageable.

(16) Directly connected node is up, clearing the shadow



Legend:
R1 : Router 1
R2 : Router 2
R3 : Router 3
ASW1: Access switch 1
ASW2: Access switch 2
ASW3: Access switch 3
ASW4: Access switch 4

Scenario: This scenario continues the previous (15) Directly connected node is down and creates a shadow scenario. Router 2 comes back up.

Root cause: Node Router 2 is up.

Incident: None generated. The `NodeDown` incident is closed by the `NodeUp` incident.

Status: The node is in `Normal` Status.

Conclusion: `NodeUp`

Effect: All of the access switches are now reachable. The status of all nodes in the shadow is `Normal`.

(17) Important node is unreachable

Scenario: A node that is part of the Important Nodes node group cannot be reached.

> **Note**
>
> You must add a node to the Important Nodes node group before the `NmsApa` service can analyze it. If a node becomes unreachable before being added to the Important Nodes node group, the `NmsApa` service does not generate a `NodeDown` incident.

Root cause: The node is down. The `NmsApa` service does not do neighbor analysis, but concludes that the node is down because it was marked as important.

Incident: A NodeDown incident is generated. There are no correlated incidents.

Status: The node is in Critical status.

Conclusion: NodeDown

(18) Important node is reachable

Scenario: This scenario continues the previous (17) Important node is unreachable scenario. The important node comes back up and can be reached.

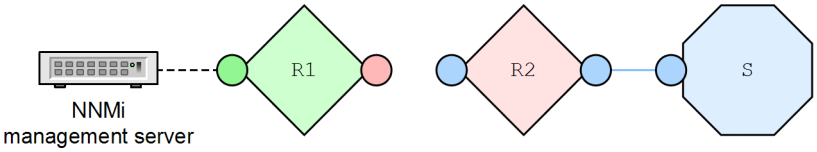
Root cause: The node is up.

Incident: None generated. The NodeDown incident is closed by the NodeUp incident.

Status: The node is in Normal status.

Conclusion: NodeUp

(19) Node or connection is down



Legend:
R1: Router 1
R2: Router 2
S : Access switch

Scenario: There is no redundancy for Router 2 (R2). Either Router 2 is down or the connection between Router 1 (R1) and Router 2 is down.

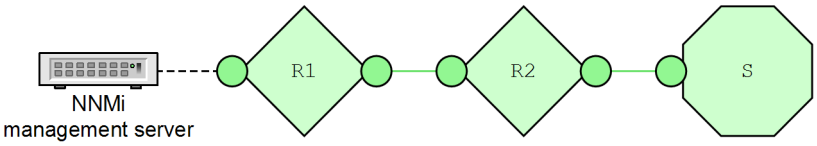
Root cause: The node or the connection is down.

Incident: The NodeOrConnectionDown incident is generated. The source node in this scenario is Router 2.

Status: The Node is in Critical status. The connection is in Minor status.

Conclusion: NodeOrConnectionDown

(20) Node or connection is up



Legend:
R1: Router 1
R2: Router 2
S : Access switch

Scenario: This scenario continues the previous (19) Node or connection is down scenario. Router 2 is now up.

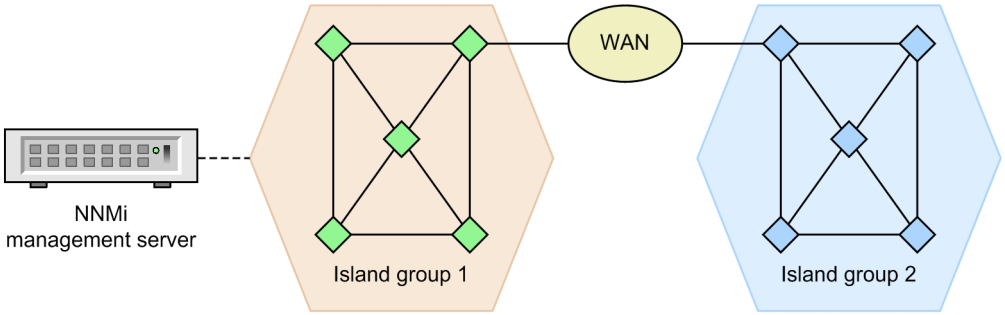
Root cause: `NodeUp`

Incident: None generated. The `NodeOrConnectionDown` incident is closed.

Status: The node is in `Normal` status. The connection is in `Normal` status.

Conclusion: `NodeUp`

(21) Island group is down



Note

The diagram is conceptual. It does not represent an actual NNMi topology map or workspace view.

Scenario: NNMi has partitioned your network into two island groups. The NNMi management server is connected to a node in Island Group 1. Island Group 2 has become unreachable due to problems in your service provider's WAN.

Note

Island groups contain highly connected sets of nodes that are not connected or are only minimally connected to the rest of the network. For example, NNMi can identify multiple island groups for an enterprise network with geographically distributed sites connected by a WAN. Island groups are created by NNMi and cannot be modified by the user. For details about island groups, see *NNMi Console* in NNMi Help.

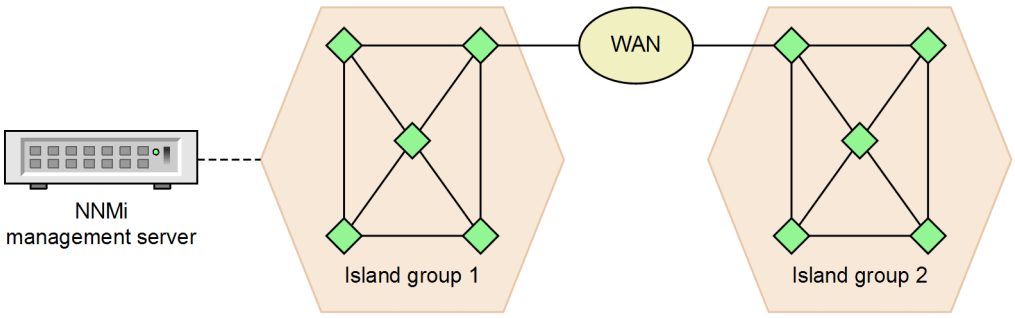
Root cause: Island Group 2 is down according to neighbor analysis.

Incident: The `IslandGroupDown` incident is generated. NNMi chooses a representative node from Island Group 2 as the source node for the incident.

Status: The status of Island Group 2 is set to `Unknown`. Objects in Island Group 2 have `Unknown` status. The connecting interface from Island Group 1 is up because the connection from the interface to the WAN is still up.

Conclusion: Not applicable for island groups.

(22) Island group is up



Note

The diagram is conceptual. It does not represent an actual NNMi topology map or workspace view.

Scenario: This scenario continues the previous (21) Island group is down scenario. The service provider's WAN problems are fixed, and Island Group 2 can be reached.

Root cause: The WAN connection to Island Group 2 is back up.

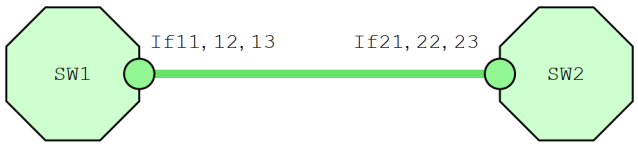
Incident: None generated. The `IslandGroupDown` incident is closed.

Status: The status for Island Group 2 is set to `Normal`. Objects in Island Group 2 return to `Normal` status.

Conclusion: Not applicable for island groups.

(23) Link aggregated ports (NNMi Advanced)

Aggregator is up



Legend:
`SW1`: Switch 1
`SW2`: Switch 2
`If11`, `If12`, `If13`: Aggregated ports on `SW1`
`If21`, `If22`, `If23`: Aggregated ports on `SW2`
`If11` and `If21`: Master interfaces

A one-link aggregated connection made up of the following connections exists:

- `If11`, `If21`
- `If12`, `If22`
- `If13`, `If23`

Scenario: All ports within the port aggregator are operationally and administratively up.

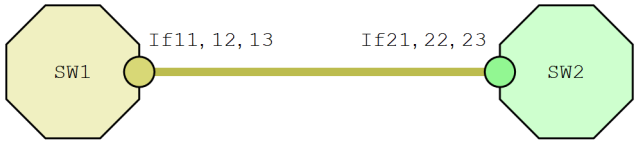
Root cause: All operational and administrative states are up.

Incident: No incident is generated.

Status: The status of the aggregator is set to `Normal`.

Conclusion: AggregatorUp

Aggregator is degraded



Legend:
SW1: Switch 1
SW2: Switch 2
If11, If12, If13: Aggregated ports on SW1
If21, If22, If23: Aggregated ports on SW2
If11 and If21: Master interfaces

A one-link aggregated connection made up of the following connections exists:

- If11, If21
- If12, If22
- If13, If23

Scenario: Some (but not all) ports within the port aggregator are operationally down.

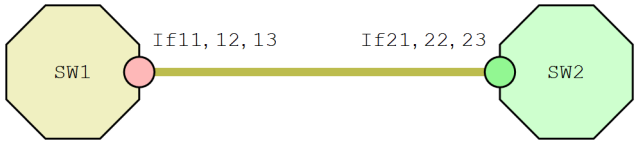
Root cause: Operational states on some ports are down.

Incident: An AggregatorDegraded incident is generated.

Status: The status of the aggregator is set to Minor.

Conclusion: AggregatorDegraded

Aggregator is down



Legend:
SW1: Switch 1
SW2: Switch 2
If11, If12, If13: Aggregated ports on SW1
If21, If22, If23: Aggregated ports on SW2
If11 and If21: Master interfaces

A one-link aggregated connection made up of the following connections exists:

- If11, If21
- If12, If22
- If13, If23

Scenario: All ports within the port aggregator are operationally down.

Root cause: Operational states on all ports are down.

Incident: An AggregatorDown incident is generated.

Status: The status of the aggregator is set to Critical.

Conclusion: AggregatorDown

(24) Link aggregated connections (NNMi Advanced)

Link aggregated connection is up

Legend:
- SW1: Switch 1
- SW2: Switch 2
- If11, If12, If13: Aggregated ports on SW1
- If21, If22, If23: Aggregated ports on SW2
- If11 and If21: Master interfaces

A one-link aggregated connection made up of the following connections exists:
- If11, If21
- If12, If22
- If13, If23

Scenario: All port aggregator members of the connection are up.

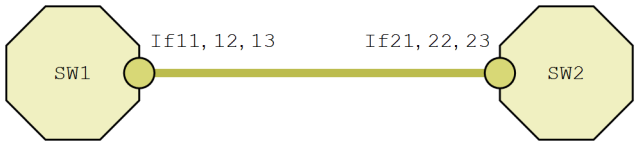
Root cause: The aggregator is up on all members of the connection.

Incident: No incident is generated.

Status: The status of the aggregated connection is set to `Normal`.

Conclusion: `AggregatorLinkUp`

Link aggregated connection is degraded



Legend:
- SW1: Switch 1
- SW2: Switch 2
- If11, If12, If13: Aggregated ports on SW1
- If21, If22, If23: Aggregated ports on SW2
- If11 and If21: Master interfaces

A one-link aggregated connection made up of the following connections exists:
- If11, If21
- If12, If22
- If13, If23

Scenario: Some (but not all) port aggregator members of the connection are down.

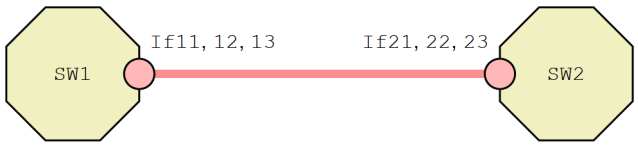
Root cause: The aggregator is down on some members of the connection.

Incident: An `AggregatorLinkDegraded` incident is generated.

Status: The status of the aggregated connection is set to `Minor`.

Conclusion: `AggregatorLinkDegraded`

Link aggregated connection is down



Legend:
SW1: Switch 1
SW2: Switch 2
If11, If12, If13: Aggregated ports on SW1
If21, If22, If23: Aggregated ports on SW2
If11 and If21: Master interfaces

A one-link aggregated connection made up of the following connections exists:

- If11, If21
- If12, If22
- If13, If23

Scenario: All port aggregator members of the connection are down.

Root cause: The aggregator is down on all members of the connection.

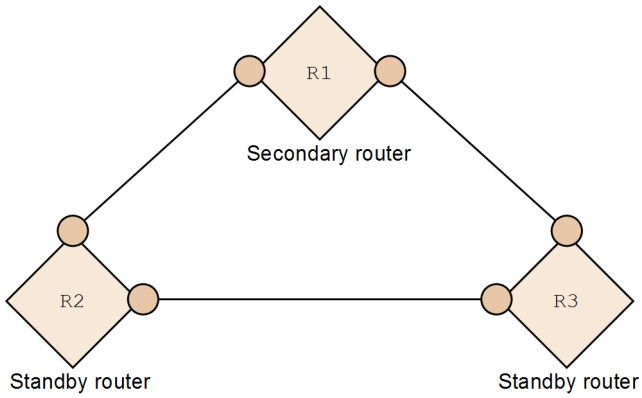
Incident: An AggregatorLinkDown incident is generated.

Status: The status of the aggregated connection is set to Critical.

Conclusion: AggregatorLinkDown

(25) Router redundancy groups: HSRP and VRRP (NNMi Advanced)

Router redundancy group has no primary



Legend:
R1: Router 1, acting as secondary
R2: Router 2, acting as standby
R3: Router 3, acting as standby

Scenario: A router redundancy group does not have a primary member. A properly functioning HSRP or VRRP router redundancy group must have one operational primary router and one operational secondary router.

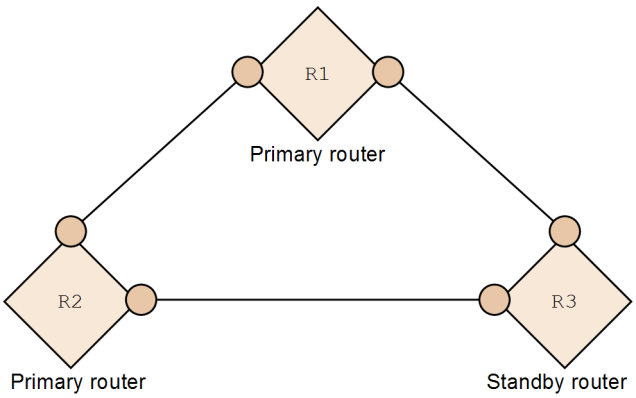
Root cause: This scenario could be the result of an interface on the primary router failing, when the secondary was not active or there was a misconfiguration of the router redundancy group.

Incident: An `RrgNoPrimary` incident is generated. The `RrgNoPrimary` incident is impacted. If there is an identified root cause such as `InterfaceDown`, the `InterfaceDown` incident is correlated under the `RrgNoPrimary` incident as an impact correlation.

Status: The status of the router redundancy group is set to `Critical`.

Conclusion: `RrgNoPrimary`

Router redundancy group has multiple primaries



Legend:
`R1`: Router 1, acting as primary
`R2`: Router 2, acting as primary
`R3`: Router 3, acting as standby

Scenario: A router redundancy group has multiple routers reporting as the primary router. A properly functioning HSRP or VRRP router redundancy group must have only one operational primary router.

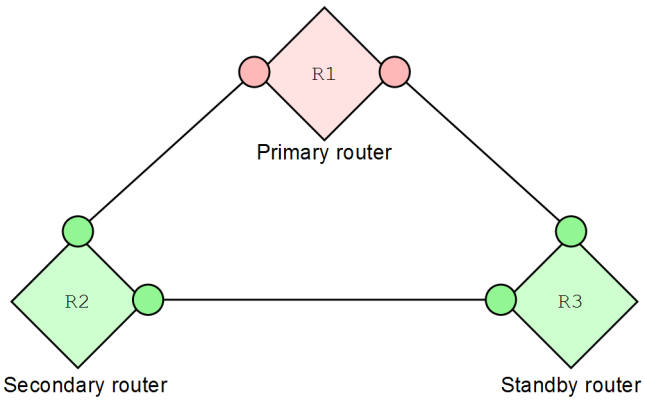
Root cause: This scenario could be due to a faulty configuration of the router redundancy group.

Incident: An `RrgMultiplePrimary` incident is generated. The `RrgMultiplePrimary` incident is impacted.

Status: The status of the router redundancy group is set to `Major`.

Conclusion: `RrgMultiplePrimary`

Router redundancy group has failed over



Legend:
`R1`: Original Primary Router 1, failed
`R2`: Secondary Router 2, acting as primary
`R3`: Standby Router 3, acting as secondary

Scenario: A router redundancy group has had a failure on the primary router and the secondary router has taken over as primary. The standby usually becomes the secondary, which is not a problem; the group is functioning as intended. The incident generated for this scenario is for informational purposes to report that the group has had a failover.

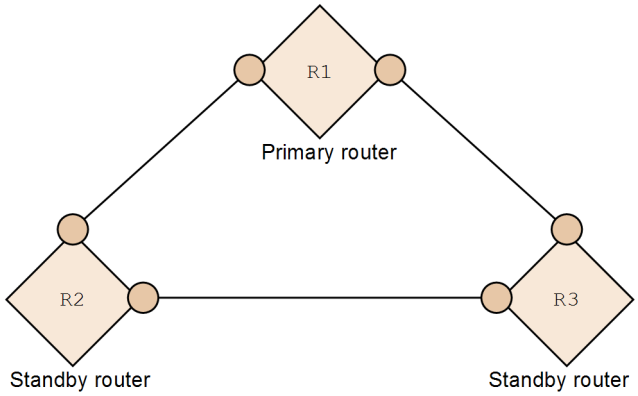
Root Cause: This scenario is most likely due to a failure on the primary router.

Incident: An `RrgFailover` incident is generated. The correlation nature of `RrgFailover` is service impact. If an identified root cause such as `InterfaceDown` exists, the `InterfaceDown` incident is correlated under the `RrgFailover` incident as an impact correlation.

Status: None generated.

Conclusion: `RrgFailover`

Router redundancy group has no secondary



Legend:
`R1`: Primary Router 1
`R2`: Secondary Router 2, failed
`R3`: Standby Router 3, did not become secondary

Scenario: A router redundancy group has had a failure on the secondary router. Either there is no standby or the standby did not take over as the secondary.

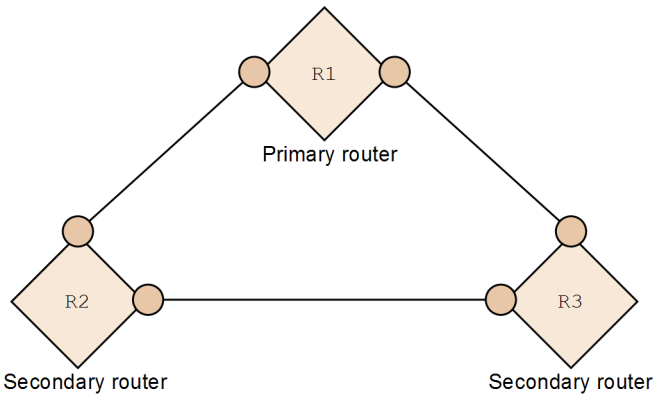
Root Cause: This scenario could be due to an interface failure on the router or some misconfiguration of the router redundancy group.

Incident: An `RrgNoSecondary` incident is generated. The correlation nature of `RrgNoSecondary` is service impact. If an identified root cause such as `InterfaceDown` exists, the correlation nature between the `RrgNoSecondary` and `InterfaceDown` interfaces is service impact.

Status: The status of the router redundancy group is set to `Minor`.

Conclusion: `RrgNoSecondary`

Router redundancy group has multiple secondaries



Legend:
R1: Primary Router 1
R2: Secondary Router 2
R3: Standby Router 3, acting as secondary

Scenario: A router redundancy group has multiple routers reporting as the secondary router. A properly functioning HSRP or VRRP router redundancy group must have only one operational secondary router.

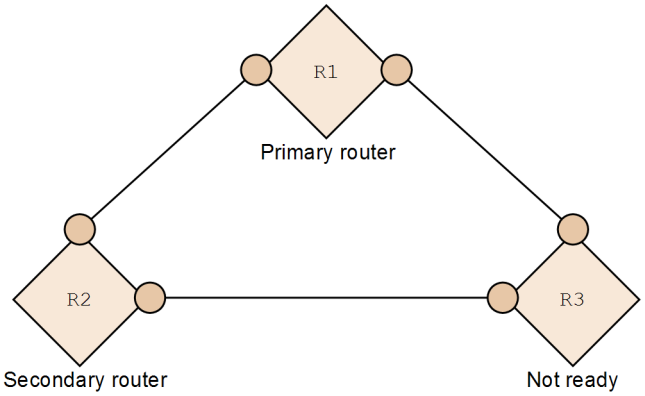
Root Cause: This scenario could be due to misconfiguration of the router redundancy group.

Incident: An `RrgMultipleSecondary` incident is generated. The correlation nature of `RrgMultipleSecondary` is service impact.

Status: The status of the router redundancy group is set to `Minor`.

Conclusion: `RrgMultipleSecondary`

Router redundancy group has degraded



Legend:
R1: Primary Router 1
R2: Secondary Router 2
R3: Standby Router 3

Scenario: The router redundancy group has experienced some change. The group is functioning, and there is one primary router and one secondary router, but there is some non-normal condition that could be an issue. For example, there might be several routers not in `Standby` state.

Root Cause: This scenario could be due to some misconfiguration of the router redundancy group.

Incident: An `RrgDegraded` incident is generated. The correlation nature of `RrgDegraded` is service impact.

Status: The status of the router redundancy group is set to `Warning`.

Conclusion: `RrgDegraded`

(26) Node component scenarios

Fan failure or malfunctioning

Scenario: A fan sensor detects a failed fan in a chassis.

Incident: A `FanOutOfRangeOrMalfunctioning` incident is generated.

Status: The status of the fan sensor node component is `Critical`. The status of `Major` is propagated to the node.

Conclusion: `FanOutOfRangeOrMalfunctioning`

Power supply failure or malfunctioning

Scenario: A power supply sensor detects a failed power supply in a chassis.

Incident: A `PowerSupplyOutOfRangeOrMalfunctioning` incident is generated.

Status: The status of the power supply node component is `Critical`. The status of `Major` is propagated to the node.

Conclusion: `PowerSupplyOutOfRangeOrMalfunctioning`

Temperature exceeded or malfunctioning

Scenario: A temperature sensor detects a high temperature in a chassis.

Incident: A `TemperatureOutOfRangeOrMalfunctioning` incident is generated.

Status: The status of the temperature sensor node component is `Critical`. The status of the node does not change.

Conclusion: `TemperatureOutOfRangeOrMalfunctioning`

Voltage out of range or malfunctioning

Scenario: A voltage sensor detects a voltage problem in a chassis.

Incident: A `VoltageOutOfRangeOrMalfunctioning` incident is generated.

Status: The status of the voltage sensor node component is `Critical`. The status of the node does not change.

Conclusion: `VoltageOutOfRangeOrMalfunctioning`

D.7 Network configuration changes

During the course of a day, an NNMi operator might complete several configuration changes. The following scenarios illustrate some common network configuration changes and show how NNMi responds to these changes.

(1) Node updated

Suppose that a network operator modifies a node, for example, by swapping a failed interface board with a working replacement. When NNMi notices this change, the discovery process sends a notification to the `NmsApa` service. The `NmsApa` service completes the following tasks:

- Recalculates the status of the node.
- Closes all registered incidents for the deleted IPv4 addresses and interfaces on the node.

(2) Interface moves to and from connections

Suppose that a network operator changes the way network devices are connected. When an interface joins a connection or leaves one connection to join another, the NNMi discovery process sends a notification to the `NmsApa` service. The `NmsApa` service recalculates the status of the connection.

(3) Device-generated traps

`ColdStart` and `WarmStart` traps - The `NmsApa` service subscribes to notifications from the Events system for `ColdStart` and `WarmStart` traps. These notifications trigger the `NmsApa` service to initiate a rediscovery of device information from the node that generated the trap.

`LinkUp` and `LinkDown` traps - The `NmsApa` service subscribes to notifications from the Events system for `LinkUp` and `LinkDown` traps, as well as for some vendor-specific link traps. These notifications trigger the `NmsApa` service to initiate a rediscovery of device information from the node that generated the trap.

> **Note**
>
> For a complete list of the trap incident configurations that NNMi provides, see NNMi Help or select **SNMP Trap Configurations** from **Incidents** in the **Configuration** workspace.

D.8 NNMi management configuration changes

During the course of a day, an NNMi administrator might complete several NNMi configuration changes. The following scenarios illustrate some common NNMi management configuration changes and show how NNMi responds to these changes.

- The NNMi administrator does not manage an IP address or puts it out-of-service
  The `NmsApa` service receives a notification from State Poller after the `pingState` is set to `Not Polled`. The `NmsApa` service sets the status of the IPv4 address to `No Status`.
- The NNMi administrator manages an IPv4 address or puts it back in service
  The `NmsApa` service receives a notification from State Poller after the `pingState` is set to the measured value. The `NmsApa` service calculates the status of the IPv4 address based upon the measured value.
- The NNMi administrator does not manage an interface or puts it out-of-service
  The `NmsApa` service receives a notification from State Poller after the `operState` is set to `Not Polled`. In response to this notification, the `NmsApa` service sets the status of the interface to `No Status`.
- The NNMi administrator manages an interface or puts it back in service

The NmsApa service receives a notification from State Poller after the operState is set to the measured value. The NmsApa service calculates the status of the interface based upon the measured value.

- The NNMi administrator does not manage a node or puts it out-of-service

  The NmsApa service receives a notification from State Poller after the agentState is set to Not Polled. operState is set to Not Polled for all interfaces, and pingState is set to Not Polled for all IPv4 addresses. In response to this notification, the NmsApa service sets the status of the node to No Status.

- The NNMi administrator manages a node or puts it back in service

  The NmsApa service receives a notification from State Poller after the agentState is set to the measured value. operState is set to the measured value for all interfaces, and pingState is set to the measured value for all IPv4 addresses. In response to this notification, the NmsApa service calculates the status of the node.

E. List of Ports Used by NNMi

The following table lists the ports NNMi uses on the management server. NNMi listens on these ports. If port conflicts occur, you can change most of these port numbers as shown in the *Change configuration* column.

Important

For application failover to work successfully, use the following configurations:

- Open TCP ports `7800` to `7810`.
- The active and standby NNMi management servers must have unrestricted network access to each other.

To run NNMi in a cluster system in an HA configuration, the port number configurations used on the primary and secondary cluster nodes must be the same. When you change a port in the `nms-local.properties` file, you must configure each node (the port change is not copied by file replication of the HA configuration).

Table E-1: Ports used on the NNMi management server

Port	Type	Name	Purpose	Change configuration
`162`	UDP	`trapPort`	SNMP trap port	Modify using the `nnmtrapconfig.ovpl Perl` script.

`1098`	TCP	`nmsas.server.port.naming.rmi`	• Used by NNMi command line tools to communicate with a variety of services used by NNMi.
			• We recommend configuring the system firewall to restrict access to this port to local host only.
				Modify the `nms-local.properties` file.
				• Windows
				`%NNM_CONF%\nnm\props\nms-local.properties`
				• Linux
				`$NNM_CONF/nnm/props/nms-local.properties`

`1099`	TCP	`nmsas.server.port.naming.port`	• Used by NNMi command line tools to communicate with a variety of services used by NNMi.
			• We recommend configuring the system firewall to restrict access to this port to local host only.
				Modify the `nms-local.properties` file.
				• Windows
				`%NNM_CONF%\nnm\props\nms-local.properties`
				• Linux
				`$NNM_CONF/nnm/props/nms-local.properties`

`3873`	TCP	`nmsas.server.port.remoting.ejb3`	• Used by NNMi command line tools to communicate with a variety of services used by NNMi.
			• We recommend configuring the system firewall to restrict access to this port to local host only.
				Modify the `nms-local.properties` file.
				• Windows
				`%NNM_CONF%\nnm\props\nms-local.properties`
				• Linux
				`$NNM_CONF/nnm/props/nms-local.properties`

`4444`	TCP	`nmsas.server.port.jmx.jrmp`	• Used by NNMi command line tools to communicate with a variety of services used by NNMi. • We recommend configuring the system firewall to restrict	Modify the `nms-local.properties` file. • Windows `%NNM_CONF%\nnm\props\nms-local.properties`

Port	Type	Name	Purpose	Change configuration
4444	TCP	nmsas.server.port.jmx.jrmp	access to this port to local host only.	• Linux $NNM_CONF/nnm/props/nms-local.properties
4445	TCP	nmsas.server.port.jmx.rmi	• Used by NNMi command line tools to communicate with a variety of services used by NNMi. • We recommend configuring the system firewall to restrict access to this port to the local host only.	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
4446	TCP	nmsas.server.port.invoker.unified	• Used by NNMi command line tools to communicate with a variety of services used by NNMi. • We recommend configuring the system firewall to restrict access to this port to local host only.	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
4457	TCP	nmsas.server.port.hq	• Used for un-encrypted global network management traffic. • Messaging travels from the global manager to the regional managers. • Once this port is open, it becomes bi-directional.	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
4459	TCP	nmsas.server.port.hq.ssl	• Used for encrypted global network management traffic. • Messaging travels from the global manager to the regional managers. • Once this port is open, it becomes bi-directional.	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
4712	TCP	nmsas.server.port.ts.recovery	Internal transaction service port	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
4713	TCP	nmsas.server.port.ts.status	Internal transaction service port	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux

Port	Type	Name	Purpose	Change configuration
4713	TCP	nmsas.server.port.ts.status	Internal transaction service port	$NNM_CONF/nnm/props/nms-local.properties
4714	TCP	nmsas.server.port.ts.id	Internal transaction service port	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
5432	TCP	com.hp.ov.nms.postgres.port	This PostgreSQL port is the port the embedded database listens on for this NNMi management server.	Modify the nms-local.properties file. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
5447	TCP	trapReceiverNettyPort	Port that stands by for a connection from JBoss. This port is used by TrapReceiver.	Modify with the nnmtrapconfig.ovpl Perl script.
7500	UDP	nnmcluster	Port used by nnmcluster.	Configuration cannot be modified.
7800 to 7810	TCP	--	• JGroups ports used for application failover. • If application failover is not used, we recommend configuring the system firewall to restrict access to these ports.	Modify the nms-cluster.properties file. • Windows %NNM_CONF%\nnm\props\nms-cluster.properties • Linux $NNM_CONF/nnm/props/nms-cluster.properties
8886	TCP	OVsPMD_MGMT	NNMi ovspmd (process manager) management port	1. Run the ovstop command to stop the NNMi service. 2. Open the services file: - Windows: %Windir%\system32\drivers\etc\services - Linux: /etc/services 3. Add the following line to the file: ovspmd_mgmt *port-number*/tcp 4. Run the ovstart command to start the NNMi service.
8887	TCP	OVsPMD_REQ	NNMi ovsmpd (process manager) request port	1. Run the ovstop command to stop the NNMi service. 2. Open the services file: - Windows: %Windir%\system32\drivers\etc\services - Linux: /etc/services

Port	Type	Name	Purpose	Change configuration
8887	TCP	OVsPMD_REQ	NNMi ovsmpd (process manager) request port	3. Add the following line to the file: ovspmd_req *port-number*/tcp 4. Run the ovstart command to start the NNMi service.
8989	TCP	com.hp.ov.nms.events.action.server.port	Enables an action server port so that it can be configured.	Modify the nnmaction.properties file: • Windows %NnmDataDir%shared\nnm\conf\props\nnmaction.properties • Linux $NnmDataDir/shared/nnm/conf/props/nnmaction.properties
20480	TCP	nmsas.server.port.web.http	Default HTTP port • Used for Web UI & Web Services. • In GNM configurations, NNMi uses this port to establish communication from the global manager to the regional managers. • Once this port is open, it becomes bi-directional.	Modify the nms-local.properties file. You can also change this during installation. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties
20481	TCP	nmsas.server.port.web.https	Default secure HTTPS port (SSL) • Used for Web UI & Web Services.	Modify the nms-local.properties file. You can also change this during installation. • Windows %NNM_CONF%\nnm\props\nms-local.properties • Linux $NNM_CONF/nnm/props/nms-local.properties

Legend:

--: No name

Table E-2 lists some of the ports NNMi uses to communicate with other systems. If a firewall separates NNMi from these systems, open many of these ports in the firewall. The actual set of ports to open depends on the system to be linked to NNMi and how that system is configured.

Table E-2: Firewall pass-through direction

Purpose	Port No. (Port/Type)	Firewall pass-through direction
SNMP request	161/udp	NNMi → Monitored node
SNMP response	ANY/udp	NNMi ← Monitored node[#1]
SNMP trap/SNMP inform request	162/udp	NNMi ← Monitored node
Response to SNMP inform request	ANY/udp	NNMi → Monitored node[#2]
SNMP trap transfer	162/udp	NNMi → SNMP manager NNMi → Northbound application

Purpose	Port No. (Port/Type)	Firewall pass-through direction
LDAP	389/tcp	NNMi → LDAP server
LDAP using SSL connection	636/tcp	NNMi → LDAP server
Messaging bisocket connector	4457/tcp	NNMi (global manager) → NNMi (regional manager)
Messaging bisocket connector using SSL connection	4459/tcp	NNMi (global manager) → NNMi (regional manager)
Application failover	7800 to 7810/tcp	NNMi (active) ←→ NNMi (standby)
NNMi console	20480/tcp	• NNMi ← Web browser • NNMi (global manager) → NNMi (regional manager)
NNMi console using SSL connection	20481/tcp	• NNMi ← Web browser • NNMi (global manager) → NNMi (regional manager)

Legend:

←→:

For TCP, the arrow indicates the direction in which a connection is made.

For UDP, the arrow indicates the direction in which a packet is sent.

#1: An SNMP response is made from the SNMP request receiving port to the SNMP request sending port.

#2: A response to an SNMP inform request is made from the SNMP inform request receiving port to the SNMP inform request sending port.

Notes:

1. You must configure the firewall to pass ICMP between NNMi and the monitored node.

2. The port numbers are set to the default settings.

3. For details about configuring application failover, see 18. Configuring NNMi for Application Failover.

If you configure NNMi to use ICMP fault polling or ping sweep for node discovery, configure the firewall to pass ICMP packets through the firewall.

If you plan to use the global network management feature, Table E-3 shows the ports that need to be accessible to a regional NNMi management server from a global NNMi management server. The global network management feature requires these ports to be open for TCP access from the global NNMi management server to the regional NNMi management server. The regional NNMi management server will not open sockets back to the global NNMi management server.

Table E-3: Required accessible sockets for global network management

Security	Parameter	TCP port
Non-SSL	`nmsas.server.port.web.http`	20480
	`nmsas.server.port.hq`	4457
SSL	`nmsas.server.port.web.https`	20481
	`nmsas.server.port.hq.ssl`	4459

Notes:

The port numbers are set to the default settings.

F. Version Changes

F.1 Changes in version 13-00

(1) Changes in manual 3021-3-L32(E)

- The library files, commands, and packages required to install NNMi on a Linux server were changed.
- The following supported operating systems were added.
  - Linux 9.1
  - Oracle Linux 9.1

  The following supported operating systems were removed.
  - Windows Server 2012
  - CentOS
  - Linux 6.1
  - Oracle Linux 6.1
- Following the end of support for the Internet Explorer web browser, the relevant descriptions were changed or deleted.
- The default values of the HTTP port and HTTPS port used by NNMi were changed.
- Descriptions related to distribution without using systemd were deleted.
- The folder to which configuration files are to be copied during the installation of NNMi was changed.
- Authentication protocols that are supported by NNMi for SNMPv3 communication were added.
- The procedure for adding a background image to a node group map was changed.
- Descriptions related to the Subject Alternative Name (SAN) were added.
- Descriptions related to Windows operating systems on which a telnet client runs were changed.
- Notes about using related products for HA configurations were added.
- Notes about the messages that are output when the FQDN settings of NNMi nodes are changed were changed.
- Descriptions of how to configure settings to suppress health incidents when NNMi performs self-monitoring were added.
- Notes about changing the host name or domain name of the NNMi management server were added.
- The description *Upgrading from NNMi Version 9, 10, 11, or 12* was changed to a description of upgrading to version 13-00.
- Following support for JP1/IM3, the relevant descriptions were added or changed.
- The path names of environment variables (`%jdkdir%` and `$jdkdir`) were changed.
- Descriptions related to using certificates with the JKS repository were deleted.
- Descriptions related to migrating NNMi from an HP-UX or Solaris operating system were deleted.
- Descriptions related to JP1/Cm2/Network Node Manager (NNM) version 8 or earlier were deleted.

F.2 Changes in version 12-60

(1) Changes in manual 3021-3-E02-30(E)

- The following was changed: the locales that can be set for Linux.
- The procedure was changed so that the system account password is set during installation of NNMi.
- The following was added: an explanation related to the change in the format of the NNMi license key.
- The following was added: the information needed to apply for a permanent license key.
- The following was added: an explanation related to the model file of the NNMi configuration file.
- The following was added: the procedure specifying whether to output UndefinedSNMPTrap incidents multiple times.
- The following was changed: the explanation related to methods for correctly interpreting and displaying character strings of MIB data from SNMP traps.
- Windows Server 2022 was added to the applicable operating systems.
- The following was changed: the name of the switch used in the example of global network management.
- The following was changed: the procedure for FQDN settings of an NNMi node, in the release of settings in a cluster node.
- The following was added: an explanation related to the procedure for upgrading in global network management.
- The following was added: an explanation related to the upgrade of an application failover configuration.

F.3 Changes in version 12-50

(1) Changes in manual 3021-3-E02-20(E)

- A description about kernel.shmall was added to the preinstallation checklist for the NNMi management server.
- A description about the specification of HTTPS port numbers during the installation of NNMi was added.
- LANG was added as an environment variable to be specified during the installation of NNMi.
- A description about supported certificate formats was added.
- The procedure for replacing a certificate that was created during the installation of NNMi was changed.
- A description about cases where a root CA certificate needs to be imported for multiple LDAP directory servers was added.
- Microsoft Edge was added as a browser to be configured for a telnet or SSH client.
- The description about Windows operating systems that run Internet Explorer or Firefox was changed.
- A description about server elements was changed.
- A description about the default port numbers set by the NNMi installation script was added.
- The expression for enabling the function that auto-trims the oldest incidents was changed.
- The expression for enabling the function that auto-trims the oldest SNMP trap incidents was changed.
- A description about the rotation of archive files was added.

- A description in *Upgrading from NNMi Version 9, 10, or 11*, was changed to explain how to upgrade to version 12-50.
- In the list of ports used by the NNMi management server, a description about changing the settings of port 443 was added.

F.4 Changes in version 12-10

(1) Changes in manual 3021-3-E02-10(E)

- The description of the NNMi management server pre-installation checklist was changed.
- A description of the Compatibility View Setting when Internet Explorer is used was added.
- The following items were added as the packages required by NNMi:
  - `fontconfig` package
  - `liberation-sans-fonts` package
  - `libnsl` package
- A description of checking the completion of NNMi installation in a Windows system was added.
- The following directory was deleted from the files and directories that are excluded from the scan target:
  - /etc/opt/OV
- Descriptions of distribution where systemd is used to manage services were added.
- Descriptions of the automatic trimming setting for incidents were added or changed.
- Descriptions of the directories and files to be deleted after NNMi is removed were changed.
- In the procedure for generating a self-signed certificate, the command that generates a private key from the system was changed.
- In the procedure for generating a CA-signed certificate, the command that imports the certificate into a keystore file was changed. In accordance with this change, the note about the command was changed.
- A description of the owner CN of the Truststore certificate was added.
- A description in *Upgrading from NNMi Version 9, 10, or 11*, was changed to explain how to upgrade to version 12-10.
- A description of linking with JP1/IM2 Intelligent Integrated Management Base was added.
- Descriptions of the environment variables used in this manual were added or deleted.
- The description of the NodeOrConnectionDown incident was changed.
- The following OSs are now supported:
  - CentOS 8.1 or later
  - Linux 8.1 or later
  - Oracle Linux 8.1 or later
  - Windows Server 2019

F.5 Changes in version 12-00

(1) Changes in manual 3021-3-E02(E)

- Windows Server 2008 R2 was removed from the applicable OSs.
- The description of the NNMi management server preinstallation checklist was changed.
- The note on the settings of Internet Explorer when enabling a Web browser for the NNMi console was changed.
- The following item was added under *Installing NNMi (Windows)*:
  - Check the installation results.
- The following items was added as tasks to be performed after installing NNMi:
  - Exclude NNMi files and directories from the scan target
- The description of how to set the language environment after installing NNMi on a Linux server was changed.
- A description about how to switch from trial licenses of NNMi and NNMi Advanced to upper-level trial licenses was added.
- In *Removing NNMi (Windows)*, the following directories and files were added to the temporary directories and temporary files that must be deleted:
  - `%TEMP%\MicroFocusOvInstaller\`
  - `%TEMP%\NNM_`*`X.X.X`*`_MicroFocusOvInstaller.txt`
  - `%TEMP%\ovinstallparams.ini`
  - `%TEMP%\nnmilog\`
  - *`drive`*`:\ProgramData\apregid.com.hpe`
- In *Removing NNMi (Linux)*, the following directories and files were added to the temporary directories and temporary files that must be deleted:
  - `/var/tmp/jp1nnmi`
  - `/tmp/MicroFocusOvInstaller`
  - `/tmp/NNM_`*`X.X.X`*`_MicroFocusOvInstaller.txt`
  - `/usr/share/apregid.com.hpe`
- Descriptions about detailed information of NNMi Help were deleted.
- The title *Configuring Communication for Virtual Environments* was changed to *Discover and monitor VMware hypervisor-based virtual networks*.
- The notes and example of the configuration required to discover and monitor virtual networks on hypervisors were deleted. Also, the description about the procedure for replacing the VMware default certificate was changed to a reference to the VMware documentation.
- The procedure for enabling the TLSv1 cryptographic protocol on an NNMi management server was deleted from the descriptions of *Configuring NNMi to Communicate with Hypervisors Using HTTPS*.
- In *Configuring communications*, the following descriptions were added:
  - Discover and monitor Cisco ACI networks
  - Multihomed NNMi Management Server
- The description of details about the concept of incidents was changed to a reference to the NNMi Help.
- The default value of the `com.hp.ov.nms.trapd.recvSocketBufSize` trap server property was changed.

- The following descriptions were added or changed in the procedure for generating a CA-signed certificate:
  - The note about the command for checking the contents of a CSR file was added.
  - The content of the trust store output format was changed.
- The `storepass` option was added to the example of accessing the trust store by executing the `nnmkeytool.ovpl` command.
- Descriptions about the `ldap.properties` file were changed or deleted, because the file has been removed.
- The following item was deleted from the descriptions of the functions that are not supported by the NNMi IPv6 management function:
  - Discovery of IPv6 subnet connections
- A condition regarding IPv4 addresses was added to the prerequisite conditions for setting up application failover.
- A note was added to the procedure for setting up application failover when either node has multiple IPv4 addresses or NICs.
- A note was added for the situation when the mount point of a shared disk is changed after HA configuration.
- The following description was deleted from *Maintaining NNMi*:
  - Configuring NNMi to enforce strict SNMPv3 inform processing
- The following description was deleted from *NNMi Security*:
  - Configuring NNMi to stop reporting the ovjboss version number
- A description in *Upgrading from NNMi Version 9, 10, or 11*, was changed to explain how to upgrade to version 12-00.

F.6 Changes in version 11-50

(1) Changes in manual 3021-3-A72-20(E)

- Descriptions of how the installation script behaves and how to handle the behavior were added as items to check before installing NNMi on an NNMi management server.
- The unzip command was added as a command required to install NNMi on a Linux server.
- In *Configuring communications*, the following descriptions was changed:
  - *Configuring an SNMP proxy*
- A procedure for using the TLSv1 cryptographic protocol in an environment where a new installation of NNMi 11-50 was performed was added.
- In *Working with Certificates for NNMi*, descriptions were changed to include the use of certificate repositories in the PKCS #12 format and the JKS format. The following descriptions were deleted accordingly:
  - *Configuring the application failover feature to use CA certificates*
  - *Configuring the global network management feature to use a Certificate Authority*
- Certificate repositories in the PKCS #12 format are now supported, and descriptions were added or changed accordingly.
- In *Working with Certificates for NNMi*, descriptions were changed to include the use of certificate repositories in the JKS format. In addition, the commands to be run were changed in the following topics:
  - *Generating a Self-Signed Certificate*

- *Generating a CA-Signed Certificate*
- *Configuring application failover to use self-signed certificates*
- *Configuring an HA cluster to use a new certificate*
- *Configuring an SSL connection to the directory service*

- The file nms-auth-config.xml was added as an LDAP configuration file. Accordingly, the related descriptions were added, and the description of the existing LDAP configuration file ldap.properties was changed.
- The following descriptions were deleted from *Task 3: Configure user access from the directory service* and *Task 5: (Configuring for the external mode only) Configure group retrieval from the directory service*:
  - *Simple approach for Microsoft Active Directory*
  - *Simple approach for other directory services*
- A note about a message that can be ignored in mixed mode when settings are specified for the LDAP configuration file was added.
- A command to be run when the value of the defaultRole parameter is changed was added.
- The following descriptions were deleted from *User identification*.
  - *Configuring NNMi user access from the directory service (detailed approach)*
  - *Determining how the directory service identifies a user (LDAP browser approach)*
  - *Determining how the directory service identifies a user (Web browser approach)*
- A procedure for switching the LDAP configuration file from the file ldap.properties to the file nms-auth-config.xml was added.
- In the subsection *Initial preparation* (in *Global Network Management,*), the description for configuring certificates was changed. In addition, the following description was added:
  - *NNMi management servers upgraded to the version 11-50*
- A description of HTTP access to NNMi was added.
- A procedure for performing a restoration in an NNMi failover environment on a different set of servers was added. In addition, notes were added regarding the backups that are necessary when performing such a restoration.
- In *Configuring NNMi in a High Availability Cluster*, the following descriptions were changed:
  - *Changing virtual IP addresses*
  - *Renaming physical hosts*
  - *Unconfiguring NNMi from an HA cluster*
  - *Unconfiguring NNMi on the passive cluster node*
  - *Unconfiguring NNMi on the active cluster node*
- In *Maintaining NNMi*, the following descriptions were changed:
  - *Configuring communication settings*
  - *Configuring NNMi to require encryption for remote access*
- The description of specifying a file path on the Windows NNMi management server was changed.
- In *Administering SNMP traps*, the following description was added:
  - *Block SNMPv1 or SNMPv2c Traps*
- In the subsections that describe *enabling the auto-trim oldest SNMP trap incidents feature* (in *Maintaining NNMi*), the values used in the description were changed.

- In the subsection *Configuring physical sensor status*, the text to be added to the property file was changed in the following topics:
  - *Propagating physical sensor status to a physical component*
  - *Configuring physical sensor status to not propagate to the physical component*
  - *Overriding physical sensor status values*
- In *NNMi Security*, the following description was changed:
  - *Configure TLS Protocols*
- A description in *Upgrading from NNMi Version 9, 10, or 11*, was changed to explain how to upgrade to version 11-50. In addition, procedures to be performed after upgrading to version 11-50 were added to the following topics:
  - *Global network management upgrade steps*
  - *Upgrading to NNMi 11-50 configured for application failover*
- *Chapter 29. RESTfulAPI* was added to *Part 8: Integration with NNMi*.
- Descriptions were added for the environment variables %jdkdir% and $jdkdir.

F.7 Changes in version 11-10

(1) Changes in manual 3021-3-A72-10(E)

- Windows Server 2016 is now supported.
- The following file was deleted from the library files required when installing NNMi on a Linux server:
  - /usr/lib/libstdc++.so.6
- The description of how to set the language environment after installing NNMi on a Linux server was changed.
- Notes on tracking license information were added.
- The following description was added to *Initial startup problems*:
  - *You cannot start the NNMi console when accessing a Windows NNMi management server*
- A description was added that explains that, if SNMP Agents and Web Agents are configured, NNMi can use additional protocols.
- In *SNMP access control*, the description of SNMPv3 privacy protocols was changed.
- A description was added that explains that, to discover hypervisors, NNMi requires the node name rather than the management address.
- A description of configuring communication for virtual environments was added.
- A description for VMware communication was added to *Checking the communication settings*.
- A description of when the number of nodes discovered by NNMi reaches or exceeds the licensed capacity limit was added to *Concepts of discovery*.
- A description that explains conditions where virtual machine nodes are not deleted was added to *Deleting unresponsive objects*.
- The following descriptions were added or changed in *Planning state polling*:
  - *What Can NNMi Monitor?*
  - *Stop Monitoring*

- *Interfaces to Unmonitored Nodes*
- *Extending Monitoring*

- In the description of node groups, virtual machines were added to node groups provided by default.
- Information of "Web Polling" was added to the information to be collected by the State Poller service.
- "State updater exceptions" was added to the table "State Poller health information".
- The description of "What to forward", which is explained in the table "Supported ways to forward traps and NNMi incidents", was changed.
- In *NNMi Console*, the following descriptions were added or changed:
  - *Configuring Gauges in the Analysis Pane*
  - *Configuring Map Label Scale Size and Borders*
  - *Configuring Auto-Collapse Thresholds for Loom and Wheel Diagrams*
- In *Working with Certificates for NNMi*, the following descriptions were added or changed:
  - *About NNMi Certificates*
  - *Replacing an Existing Certificate with a new Self-Signed or CA-Signed Certificate*
- In *Maintaining NNMi*, the following descriptions were added or changed:
  - *Modifying MIB Browser Parameters*
  - *Configuring NNMi to allow level 2 operators to delete nodes and incidents*
  - *Configuring NNMi to allow level 2 operators to edit maps*
- The following description was added to *NNMi Security*:
  - *Configure TLS Protocols*
- The following description was added to *Upgrading from NNMi Version 9, 10, or 11*:
  - *Upgrading NNMi management servers from version 11-00*
- The following descriptions were added to *Migrating NNMi from an HP-UX or Solaris Operating System*:
  - *Changing NNMi from HP-UX or Solaris to Linux on Application Failover environment*
  - *Changing NNMi from HP-UX or Solaris to Linux on Application Failover environment on the global manager and regional managers*
  - *Changing NNMi from HP-UX or Solaris to Linux in a High Availability Cluster*
- The following MIBs were deleted from those that are read during a new installation:
  - AX-BFD-MIB
  - AX-BOOTMANAGEMENT-MIB
  - AX-DEVICE-MIB
  - AX-FDB-MIB
  - AX-FLOW-MIB
  - AX-LOGIN-MIB
  - AX-MANAGEMENT-MIB
  - AX-NOTIFICATION
  - AX-OSPF-MIB
  - AX-OSPFV3-MIB

- AX-QUEUE-MIB
- AX-SMC-MIB
- AX-SMCSERVICE-MIB
- AX-SMI-MIB
- AX-STATS-MIB
- AX-SYSTEM-MIB
- AX-TRACK-MIB
- AX-VLAN-MIB
- AX-VRF-MIB
- AX1230S
- AX1240S
- AX2000R
- AX2430S
- AX2530S
- AX3630S
- AX4630S
- AX5400S-TRAP
- AX6300S
- AX7700R-TRAP
- AX7800R
- AX7800R-TRAP
- AX7800S
- AX7800S-TRAP
- AXS-6700S-TRAP
- AXS-AX1240S-TRAP
- AXS-AX1250S-TRAP
- AXS-AX2230S-TRAP
- AXS-AX3630S-TRAP
- AXS-AX3640S-TRAP
- AXS-AX3650S-TRAP
- AXS-AX3830S-TRAP
- AXS-AX4630S-TRAP
- AXS-AX6300S-TRAP
- AXS-AX6600S-TRAP
- Apresia-Series
- Apresia-SeriesLightFMGM
- BFD-TC-STD-MIB
- COMETAGT-AIX

- COMETAGT-LINUX
- COMETAGT-SOLARIS
- COMETAGT-TRU64
- RFC1253-MIB
- cmSmsAgt
- cometAgt
- cometAgtEx
- windowsNTAgt

- The following environment variables were deleted from the extended list of NNMi environment variables:
  - %NNM_SUPPORT% (Windows)
  - $NNM_SUPPORT (Linux)

F.8 Changes in version 11-00

(1) Changes in manual 3021-3-A72(E)

- The following OSs are now supported:
  - Windows Server 2008 R2 (x64) SP2
  - CentOS 6.1 or later
  - CentOS 7.1 or later
  - Linux 6.1 (x64) or later
  - Linux 7.1 or later
  - Oracle Linux 6.1 or later
  - Oracle Linux 7.1 or later
  - SUSE Linux 12
- The following OSs are no longer supported:
  - HP-UX (IPF)
  - Solaris
- *Chapter 1. Preinstallation Checklists* and *Chapter 2. Installing and Uninstalling NNMi* were added to *Part 1: Preparation*.
- *Chapter 3. Getting Started with NNMi* was added to *Part 2: Introduction*.
- Notes about using SNMPv3 in NNMi to communicate with devices were added.
- *Appendix A. When NNMi Manpages Cannot Be Displayed (Linux)* and *Appendix B. List of MIBs Read During a New Installation* were added.
- A description of discovery using link aggregation was added.
- A description of how to poll devices by NNMi when SNMP traps are received was added.
- The description of how to implement NAT in NNMi was entirely rewritten.
- A description of how to configure monitoring for static NAT and dynamic NAT was added.

- The procedure for deploying NNMi in a network address translation (NAT) environment was added.
- A description of the SNMP agent status calculations determined by the combined ICMP and SNMP responses when management address polling is enabled was added.
- A description of replicating custom attributes from a regional manager to the global manager was added.
- The procedure for reactivating the IPv6 feature was added.
- The method for automating the configuration of node groups by using a command line tool was added.
- The method for configuring node group maps by using a command line tool was added.
- The method for configuring communication settings by using a command line tool was added.
- A description of how to override settings in the `server.properties` file was added.
- The procedure for configuring NNMi to authenticate SNMPv3 traps for nodes that either are managed using SNMPv2 or SNMPv1 or are not discovered, and the procedure for configuring timeframes within which the Causal Engine accepts traps were added.
- The procedure for determining the original trap addresses from traps sent by a proxy SNMP gateway was added.
- A description of the order of `SNMPv1` and `SNMPv2c` trap addresses was added.
- A description of the standalone `NmsTrapReceiver` process to help minimize the loss of SNMP traps during a failover was added.
- A description of how to schedule outages for an arbitrary set of nodes using NNMi was added.
- The procedure for configuring physical sensor status and node sensor status was added for monitoring status.
- The procedure for configuring NNMi to enable or disable SSLv3 ciphers was added.
- A description of NNMi data encryption was added.

F.9 Changes from version 10-10 to version 10-50

(1) Changes in manual 3021-3-343-20(E)

- The following OSs are now supported:
  - Microsoft(R) Windows Server(R) 2012 R2 Datacenter
  - Microsoft(R) Windows Server(R) 2012 R2 Standard
- Because it is not possible in Windows Server 2008 and later to log in to a console session from a remote desktop, the associated descriptions were removed.
- The description of the NNMi management server preinstallation checklist was changed.
- The following item was added under *Installing NNMi (Windows)*:
  - Confirmation of whether to perform the preinstallation checks and continue the installation
- The following item was added under *Installing NNMi (UNIX)*:
  - Confirmation of whether to perform the preinstallation checks and continue the installation
- The following items were added as tasks to be performed after installing NNMi:
  - Set the language environment (UNIX only)
  - Check the maximum Java heap size
- The steps listed under *Specifying disk drive security settings (Windows)* were changed.

- The following MIBs were added to the list of MIBs that are read during a new installation:
  - AX-BOOTMANAGEMENT-MIB
  - AX-DEVICE-MIB
  - AX-FLOW-MIB
  - AX-LOGIN-MIB
  - AX-NOTIFICATION
  - AX-OSPF-MIB
  - AX-OSPFV3-MIB
  - AX-QUEUE-MIB
  - AX-SMI-MIB
  - AX-STATS-MIB
  - AX-SYSTEM-MIB
  - AX-VRF-MIB
- A limitation related to use of interface groups in the Discovery Excluded Interfaces configuration was added.
- The description of device support when NETCONF is used in the communication configuration was added.
- The description of how to use the excluded IP addresses feature to exclude certain objects from discovery was changed.
- A description of the NNMi Northbound interface was added.
- Changes were made to the parameters of the command used to generate a private key from the system when a Certificate Authority certificate is generated.
- The description of integrating NNMi with a Directory Service when LDAP is used was changed.
- The description of the maps and path views in the section on the effects of limiting object access was changed.
- The description of how to configure the application failover feature was changed.
- A command for restoring in the same cluster a deleted standby server in the NNMi database in an application failover configuration was added.
- A description was added regarding application failover control during a restart after a communication failure.
- The Symantec Cluster Server (SCS) HA cluster software was added.
- Notes about HA configurations were added.
- An example of a configuration of WSFC resources was added.
- A description of enabling actions for secondary root cause management events was added.
- The items to be created or modified with a new author specified were changed.
- A description of merging SSL certificates when the NNMi configuration and database are moved between systems was added.
- The description regarding changing the host name or domain name of an NNMi management server was changed.
- Descriptions regarding the following NNMi security items were added:
  - Providing a password for embedded database tools
  - Configuring NNMi to stop reporting the ovjboss version number

F.10 Changes from version 10-00 to 10-10

(1) Changes in manual 3021-3-343-10(E)

- Descriptions for Windows Server 2012 were added.
- Notes about using network address translation (NAT) for discovering nodes were added.
- Changes were made to the Quick Start Configuration Wizard window and its description.
- The description of uninstalling NNMi was changed.
- Changes were made to the NNMi Help window and the **Communication Configuration** form.
- Changes and additions were made to the description of disk drive security settings for Windows.
- The descriptions of the settings and procedures for enabling Web browsers were changed.
- Additions and changes were made to the description of installing required libraries in Linux.
- Information about the following installation problem was added:
  - A message is displayed during installation indicating that the preinstallation procedure (phase II) has failed and the `/tmp/nnm_preinstall_phaseII.log` file needs to be checked for the details.
- Additions and changes were made to the list of MIBs read during a new installation.
- The description of how to use the `Author` attribute was changed.
- A description concerning menus and menu items was changed.
- Notes were added about using the `nnmconfigimport.ovpl` command to import a large number of settings.
- Information was added about the following aspects of SNMP communication:
  - Changing the encryption method when using SNMPv3 communication
  - Enabling or disabling a specific device's SNMP communication
  - SNMP communication procedure using an SNMP proxy agent
- Information was added about discovery using tenants in a network that contains overlapping address domains.
- Methods for specifying excluded IP addresses and for specifying excluded interface groups were added to the settings for not discovering objects.
- A description was added of how to specify a range of interfaces to be discovered by defining a filter.
- For handling seed discovery errors, a description was added of how to include the corresponding IP addresses in the `ipnolookup.conf` file.
- The description of deleting non-responding objects was changed.
- In NNMi state polling, the following items were changed:
  - Proxy servers were changed to switches.
  - The description of how to set the interface groups and node groups to be monitored was changed.
- Regarding NNMi incidents, descriptions of the following were added or changed:
  - Concepts of incidents
  - Trap and incident forwarding
  - Received SNMP traps
  - CIAs added to closed management event incidents
  - Planning how NNMi is to respond to incidents

    - How to set trap logs
    - How to set incident logs
    - How to set trap server properties
    - Batch loading of incident configurations
    - Evaluating incidents
    - Tuning incidents
- Regarding the NNMi console, descriptions of the following were added or changed:
    - Creating node groups
    - Configuring node group maps
    - Deleting node groups
    - Disabling the **Analysis** pane
    - Customizing device icons
    - Overriding the refresh rate of table views
- In the method for using certificates in NNMi, the following procedure was changed:
    - Generating a Certificate Authority certificate
- The description of configuring an SSL connection to the directory service was changed.
- In integrating NNMi with a directory service through LDAP, the descriptions of the following were changed:
    - NNMi user access information and configuration options
    - Configuring NNMi to access a directory service
    - Changing the directory service access configuration to support the NNMi security model
    - Information owned by the directory service administrator
    - Troubleshooting the directory service integration
- It was made clear that in the NNMi global operator user group (`globalops`), access permissions are granted only to all topology objects.
- A chapter on how to configure a NAT environment was added.
- The description of NNMi security and multi-tenancy configuration was changed.
- In global network management, notes about NAT, PAT, and NAPT were added.
- For the firewall configuration in the initial preparations, the parameters for the required accessible sockets were changed.
- For purposes of global network management, the NNMi window and its description were changed.
- In troubleshooting tips for global network management, the following description was changed:
    - Synchronizing regional manager discovery from a global manager
- The description of upgrading NNMi in a global network management environment was changed.
- A description about global network management and the address translation protocol was added.
- Regarding the NNMi IPv6 management feature, the following descriptions were added or changed:
    - Overview of the NNMi IPv6 management feature
    - Prerequisites for using the NNMi IPv6 management feature
    - Activating the IPv6 management feature capabilities

    - IPv6 inventory following deactivation of the IPv6 management feature
- Prerequisites for setting up application failover were added.
- The following application failover setup methods were added or changed:
    - Configuring NNMi for application failover
    - Configuring application failover by using the cluster setup wizard
    - Configuring application failover communication
    - Application failover behavior
    - Application failover scenarios
    - Disabling application failover
    - Upgrading NNMi (including applying a patch)
    - Changing the NNMi database password
- The following descriptions concerning the HA configuration were added or changed:
    - Verifying the prerequisites for configuring NNMi for HA
    - NNMi HA configuration information
    - Configuring NNMi on the primary cluster node
    - Configuring NNMi on the secondary cluster node
    - Unconfiguring NNMi on the passive node
    - Unconfiguring NNMi on the active node
- The description of NNMi data backup was changed.
- The following descriptions about maintaining NNMi were added or changed:
    - Managing folder access permissions
    - Changing the action server queue size
    - Incident actions log
    - Configuring the character set encoding
    - Configuring to allow level 2 operators to delete nodes
    - Configuring to allow level 2 operators to edit maps
    - Configuring to allow level 2 operators to perform state polling and configuration polling
    - Configuring NNMi to authenticate SNMPv3 traps for unmonitored nodes
    - Configuring NNMi to identify the original trap addresses from traps sent by a proxy SNMP gateway
    - Configuring NNMi to require encryption during remote access
    - Configuring NNMi for strict SNMPv3 inform processing
    - Configuring NNMi to retain the previously supported varbind order
    - Changing the database port
- A change was made to the description of updating the HTTPS configuration with a new certificate when changing the host name and/or domain name of an NNMi management server.
- The following descriptions about upgrading from NNMi version 9 or 10-00 were added:
    - Upgrading a NNMi management server from version 10-00
    - Upgrading a NNMi management server from version 9

    - Upgrading global managers and regional managers from NNMi 10-00 or earlier
    - Upgrading the application failover configuration to NNMi 10-10
- The following descriptions about upgrading from NNMi version 8 or earlier were changed:
    - Configuring SNMP
    - Customizing device profiles
    - Configuring a discovery schedule
    - Setting up auto-discovery rules
    - Specifying a polling interval
    - Selecting a polling protocol
    - Displaying traps from devices
- The default locations of environment variables were changed.
- The list of ports used by NNMi was changed.

G. Reference Material for This Manual

This appendix provides reference information, including various conventions, for this manual.

G.1 Related publications

This manual is part of a related set of manuals. The manuals in the set are listed below (with the manual numbers):

- *JP1 Version 13 Network Management: Getting Started* (3021-3-L31(E))
- *JP1 Version 13 JP1/Network Node Manager i Developer's Toolkit Guide* (3021-3-L33(E))

G.2 Conventions: Abbreviations for product names

This manual uses abbreviations for Hitachi product names and for the names of products of other companies. The following table shows the abbreviated product names as used in this manual, together with each product's full name.

Abbreviation		Full name or meaning
Firefox		Mozilla Firefox(R)
JP1/IM2		JP1/Integrated Management 2
JP1/IM3		JP1/Integrated Management 3
Linux	Linux 7.1	Red Hat Enterprise Linux(R) Server 7.1 (64-bit x86_64)
	Linux 8.1	Red Hat Enterprise Linux(R) Server 8.1 (64-bit x86_64)
	RHEL 8.1	
	Linux 9.1	Red Hat Enterprise Linux(R) Server 9.1 (64-bit x86_64)
	Oracle Linux 7.1	Oracle Linux(R) Operating System 7.1
	Oracle Linux 8.1	Oracle Linux(R) Operating System 8.1
	Oracle Linux 9.1	Oracle Linux(R) Operating System 9.1
	SUSE Linux 12	SUSE Linux(R) Enterprise Server 12
NNMi	NNMi	JP1/Network Node Manager i
	NNMi Advanced	JP1/Network Node Manager i Advanced

G.3 Conventions: Acronyms

This manual also uses the following acronyms:

Acronym	Full name or meaning
ACL	Access Control List
APA	Active Problem Analyzer
ARP	Address Resolution Protocol

Acronym	Full name or meaning
BIND	Berkeley Internet Name Domain
CA	Certification Authority
CIA	Custom Incident Attribute
DNS	Domain Name System
FQDN	Fully Qualified Domain Name
HSRP	Hot Standby Routing Protocol
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Security
ICMP	Internet Control Message Protocol
IPF	Itanium(R) Processor Family
ISP	Internet Services Provider
IT	Information Technology
MD5	Message Digest 5
MIB	Management Information Base
NFS	Network File System
NOC	Network Operations Center
REST	REpresentational State Transfer
SCS	Symantec Cluster Server#
SHA	Secure Hash Algorithm
SNMP	Simple Network Management Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport Layer Security
UUID	Universally Unique IDentifier
VCS	Veritas Cluster Server#
VLAN	Virtual LAN
VRRP	Virtual Router Redundancy Protocol
WAN	Wide Area Network

#

JP1 10-50 or later supports both Veritas Cluster Server and Symantec Cluster Server. JP1 10-10 or earlier supports Veritas Cluster Server only.

G.4 Conventions: KB, MB, GB, and TB

This manual uses the following conventions:

- 1 KB (kilobyte) is 1,024 bytes.

- 1 MB (megabyte) is $1{,}024^2$ bytes.
- 1 GB (gigabyte) is $1{,}024^3$ bytes.
- 1 TB (terabyte) is $1{,}024^4$ bytes.

H. Glossary

account

See *user account*.

active cluster node

The server currently running the NNMi processes in an application failover or high availability configuration.

address hint

See *discovery hint*.

application failover

An optional NNMi capability that transfers control of NNMi processes to a standby server when the currently active server fails. This feature, which must be configured by the user, utilizes JBoss clustering support.

ARP cache

The ARP (Address Resolution Protocol) cache is an operating system table that maps data link layer (OSI Layer 2) addresses to network layer (OSI Layer 3) addresses. Data link layer addresses are typically MAC addresses, while network layer addresses are typically IP addresses. In rule-based discovery, NNMi uses ARP cache entries on discovered nodes (as well as other techniques) to find additional nodes that can be checked against the current discovery rules.

auto-discovery

See *rule-based discovery*.

Causal Engine

NNMi technology that applies root cause analysis (RCA) to network symptoms, using a causality-based approach. Causal Engine RCA is triggered by certain occurrences, such as status polling, SNMP traps, and changes discovered as a result of certain incidents. Causal Engine uses RCA to examine the status of managed objects, clarifies conclusions related to these objects, and generates root cause incidents.

causality

Denotes the relationship between one event (the cause) and another event (the effect), which is the direct consequence (the result) of the first. NNMi uses causality analysis algorithms to analyze event cycles and identify solutions for resolving network issues.

cluster

In an NNMi context, a grouping of hardware and software, linked by high availability technology or by using JBoss clustering capabilities, that works together to ensure functional and data continuity if components overload or fail. The computers in a cluster are commonly connected to each other through high-speed LANs. Clusters are usually deployed to improve availability, performance, or both.

cluster member or node

In an NNMi context, a system within a high availability or JBoss cluster that has been or will be configured to support NNMi high availability or application failover.

community string

A password-like mechanism used in SNMPv1 and SNMPv2c implementations to authenticate SNMP queries to SNMP agents. The community string is passed in cleartext in SNMP packets, making it vulnerable to packet sniffing. SNMPv3 provides stronger security mechanisms for authentication.

conclusion

In NNMi, supporting detail generated and used by the Causal Engine that sheds further light on how the Causal Engine determined status and root cause incidents for a managed object.

console

See *NNMi console*.

controller

In NNMi application failover, a JGroups term for the cluster member that has the master cluster state. The controller is always the oldest member of the cluster.

discovery hint

An IP address found by NNMi using an SNMP ARP cache query; a CDP, EDP, or other discovery protocol query; or a ping sweep. NNMi further queries IP addresses found as discovery hints, then checks the results against the current discovery rules in rule-based discovery.

discovery process

The process by which NNMi gathers information about network nodes so they can be placed under management. Initial discovery runs as a two-phase process, returning device inventory information and then network connectivity information.

After initial discovery, the discovery process is ongoing. In list-based discovery, this means devices in the list of seeds will be updated if their configuration changes. In rule-based discovery, new devices will also be added if they match current discovery rules. Discovery can also be initiated on demand for a device or set of devices from the NNMi console or from the command line.

See also *spiral discovery*, *rule-based discovery*, and *list-based discovery*.

discovery rule

A range of user-defined IP addresses or system object IDs (object identifiers), or both, used to limit the rule-based discovery process. Discovery rules are configured in the **Discovery Configuration** portion of the NNMi console under **Auto-Discovery Rules**. See also *rule-based discovery*.

discovery seed

See *seed*.

episode

A term used in NNMi root cause analysis to refer to a specific connection duration, triggered by a primary failure, during which secondary failures are suppressed or are correlated under the primary failure.

fault polling

A key NNMi monitoring activity, in which NNMi issues ICMP pings, SNMP read-only queries of status MIBs, or both, for its managed interfaces, IP addresses, and SNMP agents to determine the state of each managed object. Users can customize the types of fault polling performed for different interface groups, node groups, and nodes under **Monitoring Settings** in the **Configuration** workspace of the NNMi console. Fault polling is a subset of state polling.

global manager

The NNMi management server in a global network management deployment that consolidates data from distributed NNMi regional manager servers. The global manager provides a unified view of topology and incidents across the entire environment. A global manager must have an NNMi Advanced license.

global network management

A distributed deployment of NNMi with one or more global managers consolidating data from one or more geographically distributed regional managers.

HA

See *high availability (HA)*.

HA resource group

In modern high availability environments, such as Veritas Cluster Server, Symantec Cluster Server, and Microsoft Cluster Service, applications are represented as compounds of resources, such as the application itself, its shared file systems, and a virtual IP address. The resources consist of an *HA resource group*, which represents an application running in a cluster environment.

high availability (HA)

Used in this manual to refer to a hardware and software configuration that provides for uninterrupted service if part of the configuration fails. High availability (HA) means that the configuration has redundant components to keep applications running at all times even when a component fails. NNMi can be configured to support one of several commercially available HA solutions. See also *application failover.*

ICMP

See *Internet Control Message Protocol (ICMP)*.

incident

In NNMi, a notification of an occurrence related to your network, displayed in NNMi console incident views and forms. NNMi includes a number of **Incident Management** and **Incident Browsing** views that enable users to filter incidents based on incident attributes. Most incident views display incidents generated directly by NNMi (sometimes called *management events*). NNMi also includes views for browsing incidents generated from SNMP traps and from NNM events.

interface

A logical connection terminal for utilizing various specifications and protocols used in networks.

interface group

One of NNMi's primary filtering techniques, where interfaces are grouped together to apply settings to a group or to filter visualizations by group. Interface groups can be used for any or all of the following: configuring monitoring, filtering table views, and customizing map views. See also *node group*.

Internet Control Message Protocol (ICMP)

One of the core protocols of the Internet protocol suite (TCP/IP). ICMP ping is used by NNMi together with SNMP queries for status polling.

L2

See *Layer 2 (L2)*.

L3

See *Layer 3 (L3)*.

Layer 2 (L2)

Refers to the data link layer of the Open Systems Interconnection (OSI) multilayered communication model. The data link layer moves data across physical links in the network. NNMi Layer 2 views provide information about the physical connectivity of devices.

Layer 3 (L3)

Refers to the network layer of the Open Systems Interconnection (OSI) multilayered communication model. The network layer is concerned with knowing the addresses of the neighboring nodes in the network, selecting routes, and quality of service. NNMi Layer 3 views provide information about connectivity from a routing perspective.

list-based discovery

A process, based on a list of seeds, that discovers and returns detailed network information only about the nodes that you specify as seeds. List-based discovery maintains a limited network inventory for specific queries and tasks. Contrast with rule-based discovery. See also *discovery process* and *spiral discovery*.

logical volume

A computer storage virtualization term referring to an arbitrarily sized space in a volume group that can be used as a separate file system or as a device swap space. Several of the high availability products supported by NNMi use logical volumes in their shared file systems.

Management Information Base (MIB)

In SNMP, the collection of data about the managed network, organized hierarchically. The data objects within the management information base refer to characteristics of managed devices. NNMi collects network management

information by making SNMP queries to and receiving SNMP traps from managed nodes using MIB data objects (sometimes referred to as *MIB objects*, *objects*, or *MIBs*).

management server

The NNMi management server is the computer system on which the NNMi software is installed. The NNMi processes and services run on the NNMi management server. (Prior NNM revisions used the term *NNM management station* for this system.)

MIB

See *Management Information Base (MIB)*.

NNM events

An NNMi term for events forwarded from previous generation NNM management stations to NNMi. NNMi provides incident views for browsing the incidents that NNMi generates from these forwarded events.

NNMi

Acronym referring to either *Job Management Partner 1/Consolidated Management 2/Network Node Manager i* or *Job Management Partner 1/Consolidated Management 2/Network Node Manager i Advanced*.

NNMi is a software product designed to aid network administration and to consolidate network management activities, including ongoing discovery of network nodes, monitoring for events, and network fault management. NNMi is accessed primarily from the NNMi console.

NNMi console

The NNMi user interface. Operators and administrators use the NNMi console for network management tasks.

NNMi management server

A computer system on which the NNMi software is installed and the NNMi processes and services are run.

NNMi Northbound interface

The NNMi functionality that forwards NNMi incidents as SNMPv2c traps to a Northbound application.

node

In the network context, a computer system or device (for example, printer, router, bridge) in a network. While nodes that are able to respond to SNMP queries provide NNMi with the most comprehensive management information, NNMi can also perform restricted management of non-SNMP nodes.

node group

One of NNMi's primary filtering techniques, where nodes are grouped together to apply settings to the group or to filter visualizations by group. Node groups can be used for any or all of the following: configuring monitoring, filtering table views, and customizing map views. See also *interface group*.

Northbound application

Any application that can receive and process SNMPv2c traps.

Northbound destination

An NNMi Northbound interface configuration that defines a connection to the trap-receiving component of a Northbound application and specifies the types of traps that NNMi sends to that Northbound application.

object identifier (OID)

In SNMP, a numerical sequence that identifies a management information base data object. An OID consists of numbers separated by dots in which each number represents a particular data object at that level of the MIB hierarchy. An OID is the numerical equivalent of an MIB object name; for example, the MIB object name `iso.org.dod.internet.mgmt.mib-2.bgp.bgpTraps.bgpEstablished` is equivalent to the OID `1.3.6.1.2.1.15.0.1`.

OID

See *object identifier (OID)*.

ovstart command

A command that starts the NNMi managed processes. Invoked at a command prompt. See the *ovstart Reference Page*.

ovstatus command

A command that reports the current status of the NNMi managed processes. Can be invoked from the NNMi console (by clicking **Tools**, and then **NNMi Status**) or at a command prompt. See the *ovstatus Reference Page*.

ovstop command

A command that stops the NNMi managed processes. Invoked at a command prompt. See the *ovstop Reference Page*.

Ping sweep

A network probe technique that sends ICMP ECHO requests to multiple IP addresses to determine which addresses are assigned to responsive nodes. When enabled in rule-based discovery, NNMi can use Ping sweep on configured IP address ranges to find additional nodes. Some network administrators block ICMP ECHO requests because Ping sweeps can be used in denial-of-service attacks.

port

In the context of network hardware, a connector for passing information into and out of a network device.

PostgreSQL

An open source relational database that NNMi uses by default to store information such as topology, incidents, and configuration information.

public key certificate

Used in network security and encryption, a file that incorporates a digital signature to bind together a public key with identity information. A certificate is used to verify that a public key belongs to an individual or organization. NNMi uses SSL certificates, which contain a public key and a private key, for authentication and encryption of client-server communication.

Quick Start Configuration Wizard

A wizard that runs automatically immediately after installation of NNMi has been completed. This wizard enables you to configure community strings for reading an SNMPv1 or SNMPv2c environment, to set up discovery for a limited range of nodes, and to create an administrator account.

RCA

See *root cause analysis*.

region

In NNMi, a grouping of devices for the purpose of configuring communication settings such as timeout values and access credentials.

regional manager

The NNMi management server in a global network management deployment that provides discovery, polling, and trap reception for devices, and that forwards information to the global manager.

role

See *user role*.

root cause analysis (RCA)

In NNMi, root cause analysis (RCA) refers to a class of problem-solving methods used by NNMi to determine root causes for network issues. In NNMi, the root cause is the actionable issue that will resolve associated problem symptoms if it is addressed. NNMi uses the identification of the root cause in two key ways: to notify the user of the actionable problem, and to suppress reporting of secondary problem symptoms until the root cause issue has been resolved. Determination of root cause might result in status changes for managed objects, generation of root cause incidents, or both.

An example of how NNMi uses RCA is the scenario in which a managed router fails, and managed nodes on the other side of the router from the NNMi management server can no longer respond to state polling queries. NNMi

uses RCA to determine that the state polling failures are secondary problem symptoms. It reports the router failure as the root cause incident and refrains from reporting the problem symptoms for the downstream nodes until the router failure that is the root cause has been resolved.

root cause incident

An NNMi incident in which the `Correlation Nature` attribute is set to `Root Cause`. NNMi uses root cause analysis (RCA) to establish the root cause incident as the actionable issue that will resolve associated problem symptoms if it is addressed. See *root cause analysis*.

rule

See *discovery rule*.

rule-based discovery

Often called *auto-discovery*, NNMi can use rule-based discovery based on user-specified discovery rules to seek out nodes that NNMi needs to add to its database. NNMi looks for discovery hints in data from discovered nodes, and then checks those candidates against the specified discovery rules. You configure discovery rules in the **Discovery Configuration** area of the NNMi console under **Auto-Discovery Rule**. Contrast with *list-based discovery*.

seed

A network node that helps NNMi discover your network by acting as a starting point for the network discovery process. For example, a seed might be a core router in your management environment. Each seed is identified by an IP address or host name. Unless rule-based discovery has been configured, NNMi's discovery process is limited to list-based discovery of specified seeds.

seeded discovery

A process, based on seeds or seed files, that discovers and returns detailed layer-2 connection information only about the nodes that you specify as seeds. Seeded discovery maintains a limited network inventory for specific queries and tasks. Contrast with *auto-discovery*. See also *spiral discovery*.

Simple Network Management Protocol (SNMP)

A simple protocol operating at the application layer (Layer 7) of the OSI model, by which management information for a network element can be inspected or modified by remote users. SNMP is the predominant protocol used by NNMi to exchange network management information with agent processes on managed nodes. NNMi supports SNMPv1, SNMPv2, and SNMPv3, which are the three most common versions of SNMP.

SNMP

See *Simple Network Management Protocol*.

SNMP trap

Network management using polling (requests from an SNMP manager and responses from SNMP agents) is an SNMP design principle that promotes simplicity. However, the protocol does provide for communication of unsolicited messages from SNMP agents to the SNMP manager process (in this case, NNMi). Unsolicited agent messages are known as *traps*, and are generated by SNMP agents in response to internal state changes or fault conditions. NNMi generates incidents from received SNMP traps, displayed in the **SNMP Traps** incident browsing view.

SNMP trap storm

A large number of unsolicited SNMP agent messages, which can overwhelm an SNMP manager process (in this case, NNMi). You can configure an SNMP trap storm threshold in NNMi, using the `nnmtrapconfig.ovpl` command. NNMi blocks traps when incoming trap rates exceed the specified threshold rate, until the trap rates fall below the re-arm rate.

spiral discovery

NNMi's ongoing refinement of network topology information, which includes information about inventory, containment, relationships, and connectivity in networks managed by NNMi. See also *discovery process*, *rule-based discovery*, and *list-based discovery*.

state

NNMi generally uses the term *state* for self-reported managed object responses related to MIB II `ifAdminStatus`, MIB II `ifOperStatus`, performance, or availability. Contrast with *status*.

state polling

The directed monitoring performed by NNMi's State Poller, which uses ICMP ping and SNMP queries to retrieve fault, performance, component health, and availability data from managed objects. See also *fault polling*.

status

In NNMi, an attribute of a managed object that indicates its overall health. The status is calculated by the Causal Engine from the managed object's outstanding conclusions. Contrast with *state*.

sysObjectID

See *system object ID*.

system account

In NNMi, a special account provided for use during NNMi installation. After installation, the NNMi system account is used only for command-line security and recovery purposes. Contrast with *user account*.

system object ID

In NNMi, a specialized term for an SNMP object identifier that identifies a model or type of network element. The system object ID is part of a network element's MIB object, which is queried by NNMi from individual nodes during discovery. Examples of network element types that can be classified by their system object IDs include any member of the HP ProCurve switch family, an HP J8715A ProCurve Switch, and an HP SNMP agent for HP IPF systems. Other vendors' network elements can be likewise classified according to their system object IDs. A key use for the system object ID is in defining NNMi Device Profiles, which specify characteristics of network elements that can be deduced once a network element's type is known.

topology (network)

In communication networks, a schematic description of the arrangement of a network, including its nodes and connections.

trap

See *SNMP trap*.

trap-receiving component

The portion of a Northbound application that receives SNMP traps.

Some applications include a separately installable component that receives SNMP traps and forwards them to another component for processing. For any Northbound application that does not include such a component, *trap-receiving component* is synonymous with *Northbound application*.

unconnected interface

From NNMi's perspective, an unconnected interface is an interface that is not connected to any other device discovered by NNMi. By default, the only unconnected interfaces that NNMi monitors are those that have IP addresses are contained in nodes from the **Routers** node group.

user account

A means in NNMi of providing a user or group of users with access to NNMi. NNMi user accounts are set up in the NNMi console and implement predetermined user roles. See *system account* and *user role*.

user role

As part of setting up user access, the NNMi administrator assigns a pre-configured user role to each NNMi user account. User roles determine which user accounts can access the NNMi console, as well as which workspaces and actions are available to each user account. NNMi provides hierarchical user roles, which are predefined by the program and cannot be modified. Such roles include the following:

- Administrator

- Web service client
- Operator level 2
- Operator level 1
- Guest

See also *user account*.

virtual host name

The host name associated with a virtual IP address.

virtual IP address

An IP address that is not tied to any particular network hardware, used in high availability configurations to send uninterrupted network traffic to the most appropriate server based on current failover or load-balancing needs.

volume group

A computer storage virtualization term referring to one or more disk drives that are configured to form a single large storage area. Several of the high availability products supported by NNMi use volume groups in their shared file systems.

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