MICRO FOCUS

Open Enterprise Server 2015 SP1

Novell Cluster Services™ NetWare to Linux Conversion Guide

June 2016

Legal Notices

For information about legal notices, trademarks, disclaimers, warranties, export and other use restrictions, U.S. Government rights, patent policy, and FIPS compliance, see https://www.novell.com/company/legal/.

Copyright © 2016 Novell, Inc., a Micro Focus company. All Rights Reserved.

Contents

About This Guide 7

1 Planning the Cluster Conversion 9

Supported Conversion Paths . . . 10
Supported Mixed-Mode Clusters . . . 10
SBD Devices Must Be Marked as Shareable for Clustering . . . 10
Master-Election Algorithm . . . 11
Syntax Translation Issues for Load and Unload Scripts . . . 11
Adding a New NetWare Node to a Mixed-Mode Cluster . . . 12
Converting Multiple NetWare Cluster Nodes to OES . . . 12
Converting Nodes that Contain the eDirectory Master Replica or Certificate Authority . . . 12
Failing Over Service Cluster Resources in Mixed-Mode Clusters . . . 12
Failing Over Data Cluster Resources in Mixed-Mode Clusters . . . 13
Using Resources in Mixed-Mode Clusters . . . 13
Managing File Systems in Mixed-Mode Clusters . . . 13
Using Novell iManager in Mixed-Mode Clusters . . . 14
Using Novell Remote Manager to Manage the Cluster Is Not Supported in Mixed-Mode Clusters . . . 14
Using ConsoleOne to Manage the Cluster Is Not Supported in Mixed-Mode Clusters . . . 14
Using the Monitoring Function Is Not Supported in Mixed-Mode Clusters . . . 15

2 Planning the Conversion of Cluster Resources 17

3 Planning the Conversion of Load and Unload Scripts 21

Translation of Cluster Resource Scripts for Mixed NetWare and Linux Clusters . . . 21
Comparing Script Length Limits for NetWare and Linux . . . 22
Comparing Script Commands for NetWare and Linux . . . 23
Comparing Master IP Address Scripts . . . 23
- Master IP Address Resource Load Script . . . 24
- Master IP Address Resource Unload Script . . . 24

Comparing NSS Pool Resource Scripts . . . 25
- NSS Pool Resource Load Script . . . 25
- NSS Pool Resource Unload Script . . . 25

Comparing File Access Protocol Commands in NSS Pool Resource Scripts . . . 26
- File Access Protocol Commands for Load Scripts . . . 26
- File Access Protocol Commands for Unload Scripts . . . 27
- File Access Protocol Commands for Monitor Scripts . . . 28

Customizing the Translation Syntax for Converting Load and Unload Scripts . . . 28
Adding Monitor Scripts on Linux . . . 30

4 Converting NetWare Clusters to OES Clusters 33

Converting NetWare Cluster Nodes to OES (Rolling Cluster Conversion) . . . 33
Adding New OES Nodes to Your NetWare Cluster . . . 36

Removing NetWare Nodes from the Cluster 38
Finalizing the Cluster Conversion 39

5 Novell AFP 41

6 Apache HTTP Server 43

Prerequisites for Reusing NetWare Apache Cluster Resources on Linux 43
Using Apache HTTP Server on OES Servers 44
Understanding the Default OES Setup of Apache HTTP Server 45
Manually Configuring Apache 47
Creating and Configuring a Virtual Host for Each Website 47
Requiring Strong Ciphers 50
Configuring an SSL Certificate for the Server 51
Configuring Apache to Listen on Multiple Ports 51
Configuring Permissions for the Website DocumentRoot Directory 52
Configuring a Web Location that Requires LDAP Authentication 54
Starting, Stopping, or Restarting the Apache Daemon 56
Viewing the Apache Log Files 57
Converting the Apache Cluster Resource 57
Troubleshooting the Apache HTTP Server 58
Apache Server Errors after Using the HTTP Server Option in YaST 58
Files Downloaded from NetStorage Are 0 Bytes 59
Additional Information 59

7 eDirectory Server Certificates 61

Server Certificates Changes in OES 11 and Later 61
Using eDirectory Server Certificates in a Cluster 61
Using eDirectory Server Certificates for HTTPS Services 62
Using Internal Certificates in a Cluster 62
Using External Certificates in a Cluster 62

8 Novell CIFS 65

9 Novell Distributed File Services VLDB 67

Cluster Migrating the Shared NSS Volume for the VLDB 67
Adding a Linux Server as a Replica Site 68

10 DHCP Server 69

Setting Up Novell DHCP on OES 69
Prerequisites for Migration 69
Migrating the DHCP Configuration from NetWare to Linux Clusters in the Same Tree 69
Post-Migration Tasks 70

11 DNS Server 71

Prerequisites for Migration 71
Migrating the DNS Configuration from NetWare to Linux Clusters in the Same Tree 71
Post-Migration Tasks 71

12 Novell iPrint **73**

Installing iPrint on the OES Nodes . . . 73
Setting Up iPrint on the OES Nodes . . . 73
Preparing the OES Nodes for iPrint . . . 73
Setting Up iPrint on the OES iPrint Cluster Resource . . . 75
Setting Up Preferred Nodes for the OES iPrint Cluster Resource . . . 75
Editing the Load and Unload Scripts for the OES iPrint Cluster Resource . . . 75
Verifying the Status of the iPrint Setup . . . 76
Migrating the iPrint Cluster Resource from NetWare to OES . . . 76
Finalizing the Cluster Conversion . . . 77
Additional Information . . . 77

13 MySQL **79**

Prerequisites for Clustering MySQL . . . 80
Installing and Enabling MySQL . . . 80
Creating an LVM Volume Group and Logical Volume . . . 83
Sample Values . . . 83
Setting Up the VG and LV (Overview) . . . 83
Setting up the VG and LV (Detailed) . . . 84
Configuring MySQL on the LVM Logical Volume . . . 88
Cluster-Enabling MySQL on the Logical Volume . . . 90
File Location . . . 93
Security Considerations for the MySQL Configuration . . . 94
MySQL Ports . . . 94
Securing MySQL . . . 94
Additional Information . . . 95

14 Novell Storage Services Pools **97**

NSS Pool Cluster Migration . . . 97
NSS File System Migration to NCP Volumes or Linux POSIX File Systems . . . 97
Estimated Time Taken to Build the Trustee File on Linux . . . 97
Using Antivirus Software for NSS and NCP Volumes on Linux . . . 98

A Comparing Novell Cluster Services for Linux and NetWare **99**

B Comparing Resources Support for Linux and NetWare **107**

About This Guide

This guide describes how to convert Novell Cluster Services cluster nodes and resources from NetWare 6.5 Support Pack (SP) 8 (with the latest patches) to Novell Cluster Services 2.2 on Open Enterprise Server (OES) clusters.

This guide includes the following sections:

- Chapter 1, “Planning the Cluster Conversion,” on page 9
- Chapter 2, “Planning the Conversion of Cluster Resources,” on page 17
- Chapter 3, “Planning the Conversion of Load and Unload Scripts,” on page 21
- Chapter 4, “Converting NetWare Clusters to OES Clusters,” on page 33
- Chapter 5, “Novell AFP,” on page 41
- Chapter 6, “Apache HTTP Server,” on page 43
- Chapter 7, “eDirectory Server Certificates,” on page 61
- Chapter 8, “Novell CIFS,” on page 65
- Chapter 9, “Novell Distributed File Services VLDB,” on page 67
- Chapter 10, “DHCP Server,” on page 69
- Chapter 11, “DNS Server,” on page 71
- Chapter 12, “Novell iPrint,” on page 73
- Chapter 13, “MySQL,” on page 79
- Chapter 14, “Novell Storage Services Pools,” on page 97
- Appendix A, “Comparing Novell Cluster Services for Linux and NetWare,” on page 99
- Appendix B, “Comparing Resources Support for Linux and NetWare,” on page 107

Audience

This guide is intended for Novell Cluster Services administrators and other administrators that are responsible for clustered services and data. It is assumed that readers of this guide have a basic understanding of Novell Cluster Services and of the services and file systems that are being clustered.

Feedback

We want to hear your comments and suggestions about this manual and the other documentation included with this product. Please use the User Comments feature at the bottom of each page of the online documentation.

Documentation Updates

For the most recent version of the *Novell Cluster Services NetWare to Linux Conversion Guide*, visit the OES documentation website (http://www.novell.com/documentation/oes2015/).

Additional Documentation

For information about managing Novell Cluster Services clusters and resources, see the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

For information about managing a NetWare cluster, see the "Clustering NetWare Services" list on the NetWare 6.5 SP8 Clustering (High Availability) documentation website (http://www.novell.com/documentation/nw65/cluster-services.html#clust-config-resources).

1 Planning the Cluster Conversion

Upgrading a NetWare 6.5 SP8 cluster to Open Enterprise Server (OES) 2015 SP1 is a multi-phase process referred to as a rolling cluster conversion. This approach lets you keep your cluster up and running and lets your users continue to access cluster resources while the conversion is in progress. During a rolling cluster conversion, one server is converted to OES while the other servers in the cluster continue running NetWare. Then another server can be converted to OES, and then another, until all servers in the cluster have been converted. During the conversion, you can also add OES servers to the cluster, and remove NetWare servers from the cluster.

Before you begin a conversion, ensure that your system meets the requirements and caveats described in this section. In addition, your OES nodes and network environment must meet the cluster requirements as described in "Planning for OES Cluster Services" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

- "Supported Conversion Paths" on page 10
- "Supported Mixed-Mode Clusters" on page 10
- "SBD Devices Must Be Marked as Shareable for Clustering" on page 10
- "Master-Election Algorithm" on page 11
- "Syntax Translation Issues for Load and Unload Scripts" on page 11
- "Adding a New NetWare Node to a Mixed-Mode Cluster" on page 12
- "Converting Multiple NetWare Cluster Nodes to OES" on page 12
- "Converting Nodes that Contain the eDirectory Master Replica or Certificate Authority" on page 12
- "Failing Over Service Cluster Resources in Mixed-Mode Clusters" on page 12
- "Failing Over Data Cluster Resources in Mixed-Mode Clusters" on page 13
- "Using Resources in Mixed-Mode Clusters" on page 13
- "Managing File Systems in Mixed-Mode Clusters" on page 13
- "Using Novell iManager in Mixed-Mode Clusters" on page 14
- "Using Novell Remote Manager to Manage the Cluster Is Not Supported in Mixed-Mode Clusters" on page 14
- "Using ConsoleOne to Manage the Cluster Is Not Supported in Mixed-Mode Clusters" on page 14
- "Using the Monitoring Function Is Not Supported in Mixed-Mode Clusters" on page 15

Supported Conversion Paths

The NetWare to Linux conversion is supported from NetWare 6.5 SP8 (with the latest patches applied) to OES 2015 SP1 on the SUSE Linux Enterprise Server (SLES) 11 SP4 operating system. The following conversion paths are supported from NetWare to OES:

From this NetWare platform	Interim platform upgrade for all nodes	Before conversion to this platform
NetWare 6.5 SP8	Latest patches applied	OES 2015 SP1 on SLES 11 SP4
NetWare 6.5 SP7 or earlier	NetWare 6.5 SP8 with the latest patches applied	OES 2015 SP1 on SLES 11 SP4

Before converting NetWare clusters to the latest OES release, you must apply all of the latest service packs and patches. See "Upgrading NetWare Clusters" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Administration Guide*.

If you have a NetWare 6.5 SP7 or earlier cluster, you must upgrade all nodes to NetWare 6.5 SP8 (with the latest service packs and patches) before you convert any nodes to OES or add OES nodes to the cluster. See "Upgrading NetWare Clusters" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Administration Guide*.

Supported Mixed-Mode Clusters

During the conversion, the intermediate cluster is referred to as a *mixed-mode* cluster. It contains NetWare nodes and Linux nodes. This is a temporary configuration that is supported for the purpose of converting the cluster from NetWare 6.5 SP8 (with the latest support packs and patches) to OES. It is not supported as a long-term operational state of the cluster.

SBD Devices Must Be Marked as Shareable for Clustering

Novell Cluster Services for Linux requires that the devices used for the SBD partition be explicitly marked as Shareable for Clustering. When converting a NetWare cluster, ensure that the SBD device, or both devices for a mirrored SBD, are marked as Shareable for Clustering before you add the first Linux node to the cluster.

1. Log in to the master NetWare node as the `root` user, then open a terminal console.
2. At the console prompt, enter

   ```
   nssmu
   ```

3. In the NSSMU main menu, select **Devices**, then press Enter.
4. Select the SBD device.
5. If **Shareable for Clustering** is set to `No`, press F6 to share the device.

   Wait for the page to refresh. If the change is successful, **Shareable for Clustering** is set to `Yes`.
6. If the SBD is mirrored, repeat Step 4 and Step 5 for the device that is used as the SBD mirror.

Master-Election Algorithm

Novell Cluster Services for OES 11 SP1 and later introduces some intelligence in the master election process when the master leaves a cluster (voluntarily or involuntarily). The new algorithm substantially reduces the time needed for master election in some cases.

During an upgrade, a master-election dispute can rarely occur in a larger mixed-mode cluster (4 or more nodes) that consists of mixed NetWare 6.5 SP8 and OES nodes. If multiple nodes, including the master, concurrently leave the cluster, the different master-election algorithms might result in a dispute where equal-sized groups of old nodes and new nodes each elects its own master. SBD resolves the dispute by fencing one of the masters.

The fencing does not result in data loss. You can reboot the nodes that are poison-pilled, and they will re-join the cluster.

If you have a larger cluster (4 or more nodes), you can avoid the master-election dispute/fencing problem by upgrading the NetWare nodes with higher IP addresses first, in descending order from highest to lowest. This helps ensure that in master node election disputes between a NetWare node and an OES node, the OES node has the higher IP address and becomes the master.

For example, assume that you have a four-node NetWare 6.5 SP8 cluster with IP address assignments as follows:

Node1, IP: 192.168.99.10
Node2, IP: 192.168.99.11
Node3, IP: 192.168.99.12
Node4, IP: 192.168.99.13

You should first upgrade Node4 because it has the highest IP address. Upgrade Node3 second, then Node2, and finally Node1.

Syntax Translation Issues for Load and Unload Scripts

Executing a script that is valid for the NetWare platform is not necessarily recognized on the OES platform. When you cluster migrate a resource from a NetWare node to an OES node, the resource's load script and unload script need to be translated in-memory while the cluster is in mixed mode. It is also translated in-memory when the cluster is finally converted from NetWare to Linux. This translation is done by the Cluster Translation Library script (`/opt/novell/ncs/bin/clstrlib.py`). For information about the script translations, see Chapter 3, "Planning the Conversion of Load and Unload Scripts," on page 21.

IMPORTANT: If the commands in cluster resource's load or unload scripts are not part of the normal translation library, the cluster resource can end up in a comatose state.

Novell Cluster Services allows you to customize the translation syntax that is used for load and unload scripts in mixed-mode clusters by defining them in the `/var/opt/novell/ncs/customized_translation_syntax` file that you create. The `clstrlib.py` script reads the additional translation syntax from the syntax file. See "Customizing the Translation Syntax for Converting Load and Unload Scripts" on page 28.

Adding a New NetWare Node to a Mixed-Mode Cluster

You cannot add a new NetWare node to your cluster if OES nodes are active in the cluster. To add NetWare cluster nodes after converting part of your cluster to OES, you must first remove the OES nodes from the cluster by using the **cluster leave** command.

Converting Multiple NetWare Cluster Nodes to OES

To concurrently convert multiple NetWare cluster servers to OES, we strongly recommend that you use the old NetWare node IP addresses for your Linux cluster servers. You should record the NetWare node IP addresses before converting them to Linux.

If you must assign new node IP addresses to the OES nodes, we recommend that you convert only one node at a time.

If new cluster node IP addresses are required and the old server hardware is being retired, you can shut down the NetWare nodes that are to be removed, add the new OES cluster nodes, then remove the NetWare nodes' cluster-related objects as described in Step 5 of "Converting NetWare Cluster Nodes to OES (Rolling Cluster Conversion)" on page 33.

IMPORTANT: Failure to follow these recommendations might result in NetWare server abends and OES server restarts.

Converting Nodes that Contain the eDirectory Master Replica or Certificate Authority

If the Novell eDirectory master replica resides on a clustered NetWare node, convert that node last in the rolling cluster conversion to OES. This also applies to a NetWare node that is running the Novell Certificate Server Certificate Authority.

For OES 2015 SP1, the replacement Linux nodes will use NetIQ eDirectory 8.8 SP8 and NetIQ Certificate Server 3.3.8.

Failing Over Service Cluster Resources in Mixed-Mode Clusters

For service cluster resources, the intention is to have a one-time cluster migration of the service from NetWare to OES. After you cluster migrate the resource to an OES node, the relocated resource should be cluster migrated only between nodes running the OES platform.

Failing Over Data Cluster Resources in Mixed-Mode Clusters

Pool cluster resources that were created on NetWare cluster nodes and migrated or failed over to OES cluster nodes can be migrated or failed back to NetWare cluster nodes.

Cluster resources that are created on OES cluster nodes cannot be migrated or failed over to NetWare cluster nodes. If you need to create a new pool as part of a documented conversion procedure, create the pool on a NetWare node, then cluster migrate it to an OES node. For more information, see “Managing File Systems in Mixed-Mode Clusters” on page 13.

If you cluster migrate an NSS pool from a NetWare cluster server to an OES cluster server, it could take several minutes for volume trustee assignments to synchronize between the NSS volumes and the NCP Server on Linux. Users might have limited access to the migrated volumes until after the trustee database is built on Linux.

Using Resources in Mixed-Mode Clusters

In cases where a Linux converted script exceeds the imposed NetWare script size limit of 924 bytes, it is best to avoid bringing the resource online on OES nodes until the final cluster convert command has been run. See “Comparing Script Length Limits for NetWare and Linux” on page 22.

For example, the Linux script for GroupWise exceeds the length limit for NetWare scripts. Therefore, we recommend that you do not online GroupWise resources while running in mixed-mode clusters.

Managing File Systems in Mixed-Mode Clusters

In a mixed cluster of NetWare and OES nodes, Linux POSIX file systems as cluster resources cannot be created until the entire cluster had been successfully converted to OES Linux POSIX file systems as cluster resources cannot be migrated or failed over to NetWare cluster nodes.

Only NSS pool cluster resources that are created on a NetWare cluster node can be failed over between Linux and NetWare nodes of a mixed-mode cluster.

NetWare-to-Linux failover of NSS pool cluster resources requires that the Linux node be configured for NSS.

No storage management functions should be executed in a mixed-mode cluster unless you are performing documented steps for the conversion. That is, do not create, delete, expand, or modify the properties for partitions, pools, or volumes for shared resources in the cluster unless the conversion instructions specifically guide you to do so.

WARNING: Attempting to reconfigure shared storage in a mixed cluster can cause data loss.

If you need to configure (or reconfigure) existing shared NSS pools and volumes in a mixed-mode cluster, you must temporarily bring down all Linux cluster nodes prior to making changes, then make the configuration changes on a NetWare node. Ensure that the resources are working properly on NetWare before having the Linux cluster nodes rejoin the cluster.

Using Novell iManager in Mixed-Mode Clusters

Use Novell iManager 2.7.5 or later for all cluster administration in the mixed-mode cluster. Using the Clusters plug-in to iManager is required to manage the cluster after the first OES node is added to the cluster.

The display of node IDs from the NetWare master node might be incomplete if you use other tools like ConsoleOne and Novell Remote Manager in a mixed-mode cluster. However, you can use `cat /admin/Novell/Cluster/NodeConfig.xml` on any cluster node to get the node IDs.

```
avalon:~/Desktop # cat /admin/Novell/Cluster/NodeConfig.xml
<?xml version="1.0" standalone="yes"?>
<ncsReply>
<nodes>
<node>
<name>avalon</name>
<nodeNumber>0</nodeNumber>
<ipAddress>10.10.10.37</ipAddress>
</node>
</nodes>
</ncsReply>
```

Using Novell Remote Manager to Manage the Cluster Is Not Supported in Mixed-Mode Clusters

Do not use Novell Remote Manager when managing mixed-mode clusters. Novell Remote Manager is not supported for cluster management on OES.

Because different time formats are used in the NCS Event log for NetWare and Linux, Novell Remote Manager might have difficulty displaying the time of logged events. To avoid this problem in a mixed-mode cluster, use iManager to access the NCS Event log.

To reduce any confusion you might have when using Novell Remote Manager, you can unload module `pcluster.nlm` and delete its references in `ldncs` and `uldncs`. This removes the **Cluster** tab in Novell Remote Manager.

Using ConsoleOne to Manage the Cluster Is Not Supported in Mixed-Mode Clusters

Do not use ConsoleOne when managing mixed-mode clusters. ConsoleOne is not supported for cluster management on OES.

Using the Monitoring Function Is Not Supported in Mixed-Mode Clusters

In mixed-mode clusters, the Monitor function in Novell Cluster Services for Linux is not available. You cannot enable the Monitor function or modify the Monitor script for cluster resources on the Linux nodes until all nodes in the cluster are running OES, and the conversion is finalized. In the finalization process, the monitor scripts are automatically created for each of the converted cluster resources.

After the conversion is finalized, you can enable monitoring and view or modify the monitor script for a resource by using the Clusters plug-in to iManager. See "Enabling Monitoring and Configuring the Monitor Script" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

2 Planning the Conversion of Cluster Resources

In addition to changing the operating system, the software and file systems for various clustered services must be considered in your conversion from NetWare 6.5 SP8 to Open Enterprise Server (OES) 2015 SP1. This section provides an overview of the NetWare services and their counterparts in OES. Before you begin a conversion, ensure that your system meets the general requirements and caveats described in this section.

Converting cluster resources for OES services from NetWare to Linux might require more than a simple cluster migration from a NetWare node to a Linux node. For example, the service might require that you use Migration Tool to convert the service from NetWare to Linux. Some services require post-conversion configuration to finalize the conversion. A few OES services on NetWare are not available on OES, so you must use the standard Linux service instead.

See Table 2-1 for information about converting cluster resources for NetWare 6.5 SP8 services:

Table 2-1 *Guidelines for Converting Service Cluster Resources from NetWare to Linux*

Service on NetWare 6.5 SP8	Cluster Migrate the Resource	Converting the Service to OES 2015 or Later
Apache Web Server	Yes	See Chapter 6, “Apache HTTP Server,” on page 43.
Apple Filing Protocol (AFP)	Yes	See Chapter 5, “Novell AFP,” on page 41.
CIFS (Windows File Services)	Yes	See Chapter 8, “Novell CIFS,” on page 65.
DFS VLDB (Distributed File Services volume location database)	Yes	See Chapter 9, “Novell Distributed File Services VLDB,” on page 67.
DHCP Server	Yes	See Chapter 10, “DHCP Server,” on page 69.
DNS Server	Yes	See Chapter 11, “DNS Server,” on page 71.
eDirectory	Not clustered, but requires special handling	See “Converting Nodes that Contain the eDirectory Master Replica or Certificate Authority” on page 12.

Service on NetWare 6.5 SP8	Cluster Migrate the Resource	Converting the Service to OES 2015 or Later
Certificate Server	Not clustered, but requires special handling	Novell Certificate Server provides the Certificate Authority and Server Certificate services. For OES 11 SP2, the product has been rebranded as NetIQ Certificate Server. The Certificate Authority (CA) service is not cluster-enabled for NetWare or OES. There are no cluster-specific tasks for the CA itself. The Server Certificate service issues Server Certificate objects that might need to reside on each node in a cluster, depending on the service that is clustered. NetWare and Linux generate certificates differently, so the NetWare server's certificate is not reused for the OES server. See Chapter 7, "eDirectory Server Certificates," on page 61.
exteNd Application Server and MySQL	Not applicable	The exteNd Application Server was discontinued as an install option for NetWare 6.5 SP3. It is not available for Linux. See also MySQL in this table.
FTP	No	Use the Pure-FTPd service for Linux. See "FTP (Pure-FTPd) and OES" in the *OES 2018 SP2: Planning and Implementation Guide*.
iFolder	No, but you can migrate the settings and data	Novell iFolder 2.1x is not available on OES Linux. You must use Novell iFolder 3.x. After you add a Novell iFolder 3.x server to the NetWare cluster and before you finalize the cluster conversion, use iFolder migration procedures to migrate the iFolder 2.1x server configuration and user data from the source NetWare node to the target Linux node. See "Migrating iFolder Services" in the *Novell iFolder 3.9.2 Administration Guide*.
iPrint	Yes	See Chapter 12, "Novell iPrint," on page 73.
MySQL	No	Use the open source MySQL 5.5.*x* software that is offered under the GPL. A MySQL cluster template is available that uses a shared LVM volume group to store the database. See Chapter 13, "MySQL," on page 79.
NetStorage	Not tested	See "Configuring NetStorage with OES Cluster Services" in the *OES 2018 SP2: NetStorage Administration Guide for Linux*.
NFS	No	Use the standard NFS service for Linux.

Service on NetWare 6.5 SP8	Cluster Migrate the Resource	Converting the Service to OES 2015 or Later
NSS pools and volumes	Yes	See Chapter 14, “Novell Storage Services Pools,” on page 97.
Tomcat	No	Use the standard Tomcat 6.*x* service for Linux.

3 Planning the Conversion of Load and Unload Scripts

You can use a rolling cluster conversion to convert a Novell Cluster Services cluster from NetWare 6.5 SP8 to Open Enterprise Server (OES) 2015 SP1. This section describes how to prepare for and perform the conversion, and how to manage the temporarily mixed cluster during the conversion.

- "Translation of Cluster Resource Scripts for Mixed NetWare and Linux Clusters" on page 21
- "Comparing Script Length Limits for NetWare and Linux" on page 22
- "Comparing Script Commands for NetWare and Linux" on page 23
- "Comparing Master IP Address Scripts" on page 23
- "Comparing NSS Pool Resource Scripts" on page 25
- "Comparing File Access Protocol Commands in NSS Pool Resource Scripts" on page 26
- "Customizing the Translation Syntax for Converting Load and Unload Scripts" on page 28
- "Adding Monitor Scripts on Linux" on page 30

Translation of Cluster Resource Scripts for Mixed NetWare and Linux Clusters

Novell Cluster Services includes specialized script translation functionality, called the Cluster Translation Library script (`/opt/novell/ncs/bin/clstrlib.py`), to help NetWare and Linux servers coexist in the same cluster. It provides an automatic translation of the Master IP Address resource and cluster-enabled NSS pool resource load and unload scripts from NetWare to Linux. This functionality is also beneficial as you migrate NetWare cluster servers to Linux.

The Cluster Translation Library reads the NetWare load and unload scripts from eDirectory, converts them, and writes them as Linux load and unload scripts. The Linux load and unload script files are then searched for NetWare-specific command strings, and the command strings are then either deleted or replaced with Linux-specific command strings. Separate Linux-specific commands are also added, and the order of certain lines in the scripts is also changed to function with Linux.

During the rolling conversion, a resource's Linux load and unload scripts is stored in cache on the Linux cluster node where the resource is mounted. The NetWare script for the resource continues to be stored in eDirectory until the conversion is finalized. The cluster resource name is used in the load and unload script file names. On Linux, scripts are stored in the `/var/opt/novell/ncs/` directory.

IMPORTANT: After the final conversion, you can use the **Properties > Scripts** page in the Clusters plug-in in iManager whenever you make manual changes to the load and unload scripts. The changes are automatically saved to the files.

The normal translations performed by the Cluster Translation Library are described in the following sections:

- “Comparing Script Commands for NetWare and Linux” on page 23
- “Comparing Master IP Address Scripts” on page 23
- “Comparing NSS Pool Resource Scripts” on page 25
- “Comparing File Access Protocol Commands in NSS Pool Resource Scripts” on page 26

IMPORTANT: If the commands in cluster resource’s load or unload scripts are not part of the translation library, the cluster resource can end up in a comatose state.

Novell Cluster Services allows you to customize the translation syntax that us used for load and unload scripts in mixed-platform situations by defining new syntax translations to be used in addition to the normal translations. See “Customizing the Translation Syntax for Converting Load and Unload Scripts” on page 28.

Comparing Script Length Limits for NetWare and Linux

Scripts have different size limits on NetWare and OES. In a mixed-mode cluster, the scripts for NetWare resources that are cluster migrated to OES nodes are restricted to the NetWare script-size limits until the final `cluster convert` command is issued.

The maximum supported lengths for cluster scripts’ content are as follows:

Script	NetWare 6.5 Resources on NetWare Nodes	NetWare 6.5 Resources on OES 11 or Later Nodes	After the Final Conversion to OES 11 or Later
Load script	924 bytes	924 bytes	3200 bytes
Unload script	924 bytes	924 bytes	3200 bytes
Monitor script	Not supported	Not supported	3200 bytes

In cases where a Linux converted script exceeds the imposed NetWare script size limit, it is best to avoid bringing the resource online on OES nodes until the final cluster convert command has been run.

IMPORTANT: Because the Linux script for GroupWise exceeds the length limit for NetWare scripts, we recommend that you do not online GroupWise resources while running in mixed-mode clusters.

Comparing Script Commands for NetWare and Linux

Table 3-1 identifies some of the NetWare cluster load and unload script commands that the Cluster Translation Library script searches for and the Linux commands that it replaces them with (unless the commands are deleted).

Table 3-1 *Cluster Script Command Comparison*

Action	NetWare Cluster Command	Linux Cluster Command
Replace	`IGNORE_ERROR add secondary ipaddress`	`ignore_error add_secondary_ipaddress`
Replace	`IGNORE_ERROR del secondary ipaddress`	`ignore_error del_secondary_ipaddress`
Replace	`del secondary ipaddress`	`ignore_error del_secondary_ipaddress`
Replace	`add secondary ipaddress`	`exit_on_error add_secondary_ipaddress`
Delete	`IGNORE_ERROR NUDP`	(deletes the entire line)
Delete	`IGNORE_ERROR HTTP`	(deletes the entire line)
Replace	`nss /poolactivate=`	`nss /poolact=`
Replace	`nss /pooldeactivate=`	`nss /pooldeact=`
Replace	`mount` *`volume_name`* `VOLID=`*`number`*	`exit_on_error ncpcon mount` *`volume_name=number`*
Replace	`NUDP ADD` *`clusterservername ipaddress`*	`exit_on_error ncpcon bind --ncpservername=`*`ncpservername`* `--ipaddress=`*`ipaddress`*
Replace	`NUDP DEL` *`clusterservername ipaddress`*	`ignore_error ncpcon unbind --ncpservername=`*`ncpservername`* `--ipaddress=`*`ipaddress`*
Delete	`CLUSTER CVSBIND`	(deletes the entire line)
Delete	`CIFS`	(deletes the entire line)

Comparing Master IP Address Scripts

IMPORTANT: You can modify the Master IP Address of the cluster only after the cluster conversion is finalized. See "Moving a Cluster or Changing IP Addresses of Cluster Nodes and Resources" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

- "Master IP Address Resource Load Script" on page 24
- "Master IP Address Resource Unload Script" on page 24

Master IP Address Resource Load Script

This section provides examples of the master IP address resource load scripts on NetWare and Linux.

- "NetWare" on page 24
- "Linux" on page 24

NetWare

```
IGNORE_ERROR set allow ip address duplicates = on
IGNORE_ERROR CLUSTER CVSBIND ADD BCCP_Cluster 10.1.1.175
IGNORE_ERROR NUDP ADD BCCP_Cluster 10.1.1.175
IGNORE_ERROR add secondary ipaddress 10.1.1.175
IGNORE_ERROR HTTPBIND 10.1.1.175 /KEYFILE:"SSL CertificateIP"
IGNORE_ERROR set allow ip address duplicates = off
```

Linux

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs

ignore_error add_secondary_ipaddress 10.1.1.175 -np

exit 0
```

Master IP Address Resource Unload Script

This section provides examples of the master IP address resource unload scripts on NetWare and Linux.

- "NetWare" on page 24
- "Linux" on page 24

NetWare

```
IGNORE_ERROR HTTPUNBIND 10.1.1.175
IGNORE_ERROR del secondary ipaddress 10.1.1.175
IGNORE_ERROR NUDP DEL BCCP_Cluster 10.1.1.175
IGNORE_ERROR CLUSTER CVSBIND DEL BCCP_Cluster 10.1.1.175
```

Linux

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs
ignore_error del_secondary_ipaddress 10.1.1.175
exit 0
```

Comparing NSS Pool Resource Scripts

- "NSS Pool Resource Load Script" on page 25
- "NSS Pool Resource Unload Script" on page 25

NSS Pool Resource Load Script

This section provides examples of the NSS pool resource load scripts on NetWare and Linux.

- "NetWare" on page 25
- "Linux" on page 25

NetWare

```
nss /poolactivate=HOMES_POOL
mount HOMES VOLID=254
CLUSTER CVSBIND ADD BCC_CLUSTER_HOMES_SERVER 10.1.1.180
NUDP ADD BCC_CLUSTER_HOMES_SERVER 10.1.1.180
add secondary ipaddress 10.1.1.180
CIFS ADD .CN=BCC_CLUSTER_HOMES_SERVER.OU=servers.O=lab.T=TEST_TREE.
```

Linux

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs
exit_on_error nss /poolact=HOMES_POOL
exit_on_error ncpcon mount HOMES=254
exit_on_error add_secondary_ipaddress 10.1.1.180

exit_on_error ncpcon bind --ncpservername=BCC_CLUSTER_HOMES_SERVER
--ipaddress=10.1.1.180

exit 0
```

NSS Pool Resource Unload Script

This section provides examples of the NSS pool resource unload scripts on NetWare and Linux.

- "NetWare" on page 25
- "Linux" on page 26

NetWare

```
del secondary ipaddress 10.1.1.180
CLUSTER CVSBIND DEL BCC_CLUSTER_HOMES_SERVER 10.1.1.180
NUDP DEL BCC_CLUSTER_HOMES_SERVER 10.1.1.180
nss /pooldeactivate=HOMES_POOL /overridetype=question
CIFS DEL .CN=BCC_CLUSTER_HOMES_SERVER.OU=servers.O=lab.T=TEST_TREE.
```

Linux

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs

ignore_error ncpcon unbind --ncpservername=BCC_CLUSTER_HOMES_SERVER
--ipaddress=10.1.1.180

ignore_error del_secondary_ipaddress 10.1.1.180
ignore_error nss /pooldeact=HOMES_POOL
exit 0
```

Comparing File Access Protocol Commands in NSS Pool Resource Scripts

- "File Access Protocol Commands for Load Scripts" on page 26
- "File Access Protocol Commands for Unload Scripts" on page 27
- "File Access Protocol Commands for Monitor Scripts" on page 28

File Access Protocol Commands for Load Scripts

This section provides examples of the file access protocol commands for NSS pool cluster resource load scripts on NetWare and Linux.

- "NetWare" on page 26
- "Linux" on page 27

NetWare

Protocol	Script Command for Load Scripts
NCP	`NUDP ADD NCS1_P1_SERVER 10.10.10.194`
Novell AFP	`AFPBIND ADD NCS1_P1_SERVER 10.10.10.204`
Novell CIFS	`CIFS ADD .CN=NCS1_P1_SERVER.O=novell.T=CLUSTER.`

Linux

Protocol	Script Command for Load Scripts

NCP	`# mount the NCP volume`
	`exit_on_error ncpcon mount $NCP_VOLUME=VOL_ID,PATH=$MOUNT_POINT`
	
	`exit_on_error ncpcon bind --ncpservername=NCS1_P1_SERVER`
	`--ipaddress=10.10.10.194`

Novell AFP	`exit_on_error cluster_afp.sh add NCS1_P1_SERVER 10.10.10.204`
Novell CIFS	`exit_on_error novcifs --add --vserver=.CN=NCS1_P1_SERVER.O=novell.T=TREE-188.` `--ip-addr=<`*`virtual_server_ip_address`*`>`

File Access Protocol Commands for Unload Scripts

This section provides examples of the Novell AFP commands for NSS pool cluster resource unload scripts on NetWare and Linux.

- "NetWare" on page 27
- "Linux" on page 27

NetWare

Protocol	Script Command for Unload Scripts
NCP	`NUDP DEL NCS1_P1_SERVER 10.10.10.194`
Novell AFP	`AFPBIND DEL NCS1_P1_SERVER 10.10.10.204`
Novell CIFS	`CIFS DEL .CN=NCS1_P1_SERVER.O=novell.T=TREE-188.`

Linux

Protocol	Script Command for Unload Scripts

NCP	`ignore_error ncpcon unbind --ncpservername=NCS1_P1_SERVER`
	`--ipaddress=10.10.10.194`
	
	`# dismount the NCP volume`
	`ignore_error ncpcon dismount $NCP_VOLUME`

Novell AFP	`ignore_error cluster_afp.sh del NCS1_P1_SERVER 10.10.10.204`

Novell CIFS	`ignore_error novcifs --remove`
	`--vserver=.CN=NCS1_P1_SERVER.O=novell.T=TREE-188.`
	`--ip-addr=<`*`virtual_server_ip_address`*`>`

File Access Protocol Commands for Monitor Scripts

This section provides examples of the Novell AFP commands for NSS pool cluster resource monitor scripts on Linux.

If AFP is enabled as an advertising protocol on an NSS pool cluster resource on NetWare, the AFP monitoring command is added to the new monitor script for the resource on OES.

If CIFS is enabled as an advertising protocol on an NSS pool cluster resource on NetWare, the CIFS monitoring command is added to the new monitor script for the resource on OES.

The default Time-out value for the Monitor script is set to 6 minutes.

Monitoring is disabled while the cluster is in mixed mode. Monitoring can be enabled for the resource after the final cluster conversion is complete. See "Enabling Monitoring and Configuring the Monitor Script" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

- "NetWare" on page 28
- "Linux" on page 28

NetWare

The Monitor script feature is not available in Novell Cluster Services for NetWare.

Linux

Protocol	Script Command for Load Scripts
NCP	`exit_on_error ncpcon volume V_D`
Novell AFP	`exit_on_error afpstat`
Novell CIFS	`exit_on_error rcnovell-cifs monitor`

Customizing the Translation Syntax for Converting Load and Unload Scripts

The syntax for load and unload scripts differs for NetWare and Linux platforms. A script that is valid for the NetWare platform is not necessarily recognized on the OES platform. In a mixed-platform cluster, a cluster resource's load script and unload script must be translated to use the proper syntax when running on the NetWare or Linux nodes. Translation occurs in-memory while the cluster contains mixed-platform nodes, and during the final cluster conversion of the cluster from NetWare to Linux.

The translation between NetWare and Linux versions of the load and unload scripts is performed by the Cluster Translation Library script (`/opt/novell/ncs/bin/clstrlib.py`). The normal translations in the library are described in "Translation of Cluster Resource Scripts for Mixed NetWare and Linux Clusters" on page 21. If the commands in a cluster resource's load or unload scripts are not part of the translation library, the cluster resource can end up in a comatose state.

Novell Cluster Services allows you to customize the translation syntax that is used for load and unload scripts in mixed-platform situations by defining new syntax translations in the `/var/opt/novell/ncs/customized_translation_syntax` file that you create. The `clstrlib.py` script reads the additional translation syntax from the syntax file, and processes them in addition to the normal translations in the Cluster Translation Library.

The customized translation supports using Python regular expressions to search for strings (`(\S+)`), digits (`(\d+)`), and other data types. The search is case insensitive.

NOTE: Refer to information about Python regular expressions to learn how to create searches for other data types.

In a text editor, create the `customized_translation_syntax` file with the additional translation syntax that you need, then copy the file to the `/var/opt/novell/ncs/` directory on each Linux node in the mixed-platform cluster.

The syntax file should contain a four-line command for each type of translation you want to add:

```
<R|D> search_string
[replacement_data]
[preceding_data]
```

You can have any number of the four-line commands in the file. Use the following guidelines for creating the syntax translation commands:

Line	Description
`<R|D>`	Specify whether to replace (R) all matches or to delete (D) all matches of the data type you are looking for in the load or unload script.
`search_string`	Specify the search string that is used to locate a line in the scripts.
[*`replacement_data`*]	Specify the replacement data used to replace a line matched by the search performed. Leave this line empty if there is no replacement.
[*`preceding_data`*]	Specify a line to be inserted before the first line that is matched by the search performed. Leave this line empty if there is no line to be inserted before the first matching line.

The following four lines are sample code for a search command in the customized_translation_syntax file. The fourth line is intentionally left empty.

```
R
^\s*bind\s+IP\s+(\S+)\s(\S+)\s+address=(\d+\.\d+\.\d+\.\d+)
ignore_error bind IP \1 \2 address=\3\n
exit_on_error ip addr add \3/32 dev \1
```

You can use the `cluster convert preview` command to verify that the customized_translation_syntax file is working as intended for a particular resource.

1 On the master node, open a terminal console as the `root` user, then enter

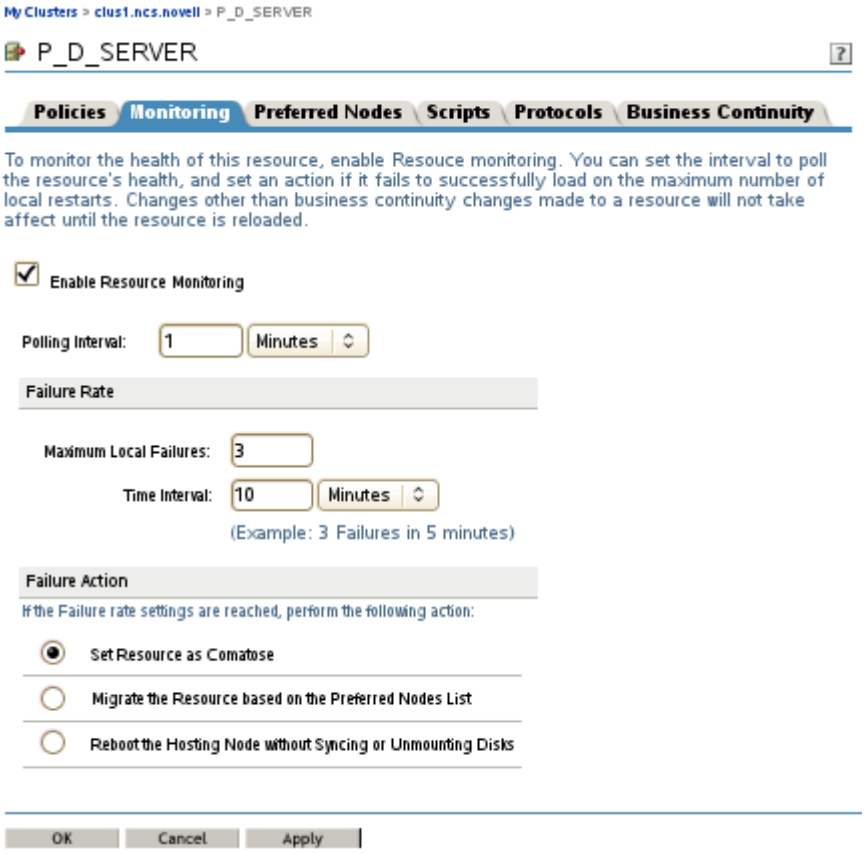
`cluster convert preview` *`resource_name`*

Adding Monitor Scripts on Linux

The monitor script is available for cluster resources in Novell Cluster Services for OES. However, in a mixed-mode cluster, the cluster resources that you cluster migrate from NetWare to Linux will not have a monitor script during the conversion process. A monitor script for each of the former NetWare cluster resources is created automatically after you perform the final cluster conversion step as described in "Finalizing the Cluster Conversion" on page 39.

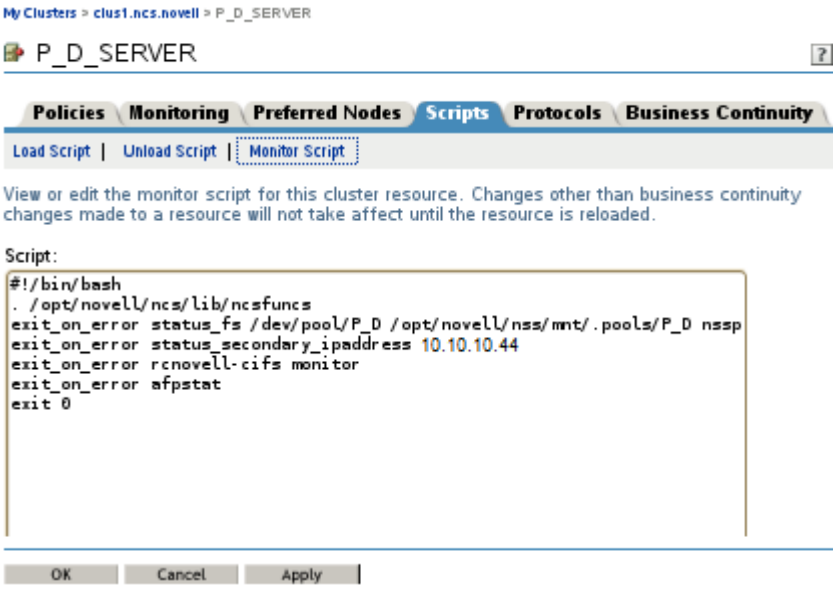
After the conversion is finalized, you can use the Clusters plug-in for Novell iManager to enable monitoring independently for each cluster resource. On the Monitoring page (as shown in Figure 3-1) in the resource properties, you must specify a polling interval, a failure rate, a failure action, and a timeout value. These settings control how error conditions are resolved for the resource.

Figure 3-1 *Monitoring Page in the Cluster Resource Properties*



On the Monitor Script page in the resource properties, you must also configure the resource's monitor script. You must take the resource offline and bring it online to apply the new settings.

Figure 3-2 *Monitor Script in the Cluster Resource Properties*



Sample monitor scripts are available in the cluster resource templates for the various services on OES. The following is a sample monitor script for a pool cluster resource:

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs

# Check the pool status
exit_on_error status_fs /dev/pool/P_D /opt/novell/nss/mnt/.pools/P_D
nsspool

# Check the resource status
exit_on_error status_secondary_ipaddress 10.10.10.44

# Check the volume status
exit_on_error ncpcon volume VOL_D

# Monitor the Novell CIFS service
exit_on_error rcnovell-cifs monitor

# Monitor the Novell AFP service
exit_on_error afpstat

exit 0
```

There might not be a monitor script for iPrint. Print Manager has a built-in monitoring and restart capability. Using the iPrint commands in a cluster resource monitor script for iPrint might cause a conflict.

For detailed information about configuring the monitoring options and scripts, see "Enabling Monitoring and Configuring the Monitor Script" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

4 Converting NetWare Clusters to OES Clusters

You can use a rolling cluster conversion to convert a Novell Cluster Services cluster from NetWare 6.5 SP8 to Open Enterprise Server (OES) 2015 SP1. This section describes how to prepare for and perform the conversion, and how to manage the temporarily mixed cluster during the conversion.

- "Converting NetWare Cluster Nodes to OES (Rolling Cluster Conversion)" on page 33
- "Adding New OES Nodes to Your NetWare Cluster" on page 36
- "Removing NetWare Nodes from the Cluster" on page 38
- "Finalizing the Cluster Conversion" on page 39

Converting NetWare Cluster Nodes to OES (Rolling Cluster Conversion)

Performing a rolling cluster conversion from NetWare to OES lets you keep your cluster up and running and lets your users continue to access cluster resources while the conversion is being performed.

During a rolling cluster conversion, one server is converted to Linux while the other servers in the cluster continue running NetWare. Then another server can be converted to OES, and then another, until all servers in the cluster have been converted to Linux.

IMPORTANT: Before you begin, ensure that you system meets the requirements and caveats in "Planning for OES Cluster Services" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*. Also verify that your system meets the requirements in Chapter 1, "Planning the Cluster Conversion," on page 9.

If you are converting from NetWare on physical servers to OES on virtual servers (guest operating systems running on virtual machines), you can use the same methods and processes as those used on a physical server. No additional changes or special configuration is required. See "Mixed Physical and Virtual Node Clusters" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

To perform a rolling cluster conversion from NetWare to OES:

1 Before you add the first Linux node to the NetWare cluster, if the NetWare cluster uses an SBD, ensure that the device (or devices) being used by the SBD are marked as **Shareable for Clustering**.

   You can use NSSMU or iManager to mark the SBD devices as shareable. It is not necessary to bring the cluster down when changing the device attribute to **Shareable for Clustering**.

   Using NSSMU:

   1a Log in to the master node of the NetWare cluster as the administrator user.

   1b Enter `nssmu` at the server console prompt.

1c In the NSSMU main menu, select **Devices**.

1d In the **Devices** list, highlight the device that contains the SBD partition, then press F5 to select it.

1e Press F6 to mark the device as **Shareable for Clustering**.

1f If the SBD partition is mirrored, repeat Step 1d and Step 1e to also mark the mirror device as **Shareable for Clustering**.

1g Press Esc to exit NSSMU.

2 Make a note of the services that are installed on the server you are converting.

You might want to install the same components on the Linux node if they are available.

3 On the NetWare server that you want to convert to Linux, remove eDirectory.

You can do this by running NWConfig, then selecting **Directory Options <install NDS> > Remove Directory Services from this server**.

4 Bring down the NetWare server you want to convert to Linux.

Any cluster resources that were running on the server should fail over to another server in the cluster.

You can also manually cluster migrate the resources to another server in the cluster prior to bringing down the server. This prevents the resources from failing back to the node after you have completed the upgrade.

5 Use eDirectory tools to remove (delete) the NetWare node's Cluster Node object, the Server object, and all objects related to the downed NetWare server.

Depending on your configuration, there could be 10 or more objects that relate to the downed NetWare server.

6 Run DSRepair from another server in the eDirectory tree to fix any directory problems.

If DSRepair finds errors or problems, run it multiple times until no errors are returned.

7 Install OES on the server, but do not install the Novell Cluster Services option in OES Services at this time.

You can use the same server name and IP address that were used on the NetWare server. This is suggested, but not required.

See the *OES 2018 SP2: Installation Guide* for more information.

8 Set up and verify SAN connectivity for the Linux node.

Consult your SAN vendor documentation for SAN setup and connectivity instructions.

9 Install Novell Cluster Services and add the node to your existing NetWare 6.5 cluster.

9a Log in to the OES server as the `root` user.

9b In YaST, select **Open Enterprise Server > OES Install and Configuration**.

9c On the Software Selection page under **OES Services**, click **Novell Cluster Services**.

Services that you have already installed are indicated by a blue check mark in the status check box next to the service.

For information about other install options, see "Installing OES Cluster Services during an OES Installation" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

9d Click **Accept** to begin the install, then click **Continue** to accept changed packages.

9e Continue through the installation process until you reach the Open Enterprise Server Configuration page.

9f Reconfigure **LDAP Configuration of Open Enterprise Services** to specify the credentials for the container administrator user (or non-administrator user) who has the eDirectory rights needed to install Novell Cluster Services.

For information about what rights are needed, see "Assigning Install Rights for Container Administrators or Non-Administrator Users" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

9f1 On the Open Enterprise Server Configuration page under **LDAP Configuration of Open Enterprise Services**, click the **disabled** link to enable re-configuration.

The sentence changes to **Reconfiguration is enabled**.

9f2 Click the **LDAP Configuration of Open Enterprise Services** link to open the LDAP Configuration page.

9f3 Specify the following values:

- **Admin name and context:** The user name and context (in LDAP form) of the container administrator user (or non-administrator user) who has the eDirectory rights needed to install Novell Cluster Services.
- **Admin password:** The password of the container administrator (or a non-administrator user).

9f4 Click **Next**.

The install returns to the Open Enterprise Server Configuration page.

9g On the Open Enterprise Server Configuration page under **Novell Cluster Services**, click the **disabled** link to enable configuration.

The sentence changes to **Configuration is enabled**.

9h Click the **Novell Cluster Services** link to open the Novell Cluster Services Configuration page.

9i Click **Existing Cluster**, specify the fully distinguished name (FDN) of the cluster, then click **Next**.

IMPORTANT: Use the comma format illustrated in the example. Do not use dots.

This is the name and eDirectory context of the cluster that you are adding this server to.

9j Select the IP address that Novell Cluster Services will use for this node.

Some servers have multiple IP addresses. This step lets you choose which IP address Novell Cluster Services uses.

9k Deselect **Start Services Now**.

9l Click **Next**, then continue through the rest of the OES installation.

9m After the install is complete, use the Software Updater (or other update methods) to install any patches from the OES patch channel and the SUSE Linux Enterprise Server patch channel for the installed versions of OES and SLES.

10 If you have a shared disk system on the cluster, enter `sbdutil -f` at the Linux terminal console to verify that the node can see the cluster (SBD) partition on the SAN.

`sbdutil -f` also tells you the device on the SAN where the SBD partition is located.

11 Reboot the server.

12 (Optional) Manually migrate the resources that were on the old server nodes to this Linux server.

Some cluster resources for services on NetWare cannot be used on Linux. See Chapter 1, “Planning the Cluster Conversion,” on page 9.

The resources can automatically fail back if all of the following apply:

- The failback mode for the resources was set to Auto.
- You used the same node number for this Linux server that was used for the former NetWare server.

  This only applies if this Linux server is the next server added to the cluster.
- This Linux server is the preferred node for the resources.

13 Continue with “Adding New OES Nodes to Your NetWare Cluster” on page 36.

Adding New OES Nodes to Your NetWare Cluster

You can add new OES cluster nodes to your existing NetWare cluster without bringing down the cluster.

1 Before you add the first Linux node to the NetWare cluster, if the NetWare cluster uses an SBD, ensure that the device (or devices) being used by the SBD are marked as **Shareable for Clustering**.

   You can use NSSMU or iManager to mark the SBD devices as shareable. It is not necessary to bring the cluster down when changing the device attribute to **Shareable for Clustering**.

   Using NSSMU:

   1a Log in to the master node of the NetWare cluster as the administrator user.

   1b Enter `nssmu` at the server console prompt.

   1c In the NSSMU main menu, select **Devices**.

   1d In the **Devices** list, highlight the device that contains the SBD partition, then press F5 to select it.

   1e Press F6 to mark the device as **Shareable for Clustering**.

   1f If the SBD partition is mirrored, repeat Step 1d and Step 1e to also mark the mirror device as **Shareable for Clustering**.

   1g Press Esc to exit NSSMU.

2 Install OES on the new node, but do not install the Novell Cluster Services option from OES Services at this time.

   See the “*OES 2018 SP2: Installation Guide*” for more information.

3 Set up and verify SAN connectivity for the new OES node.

   Consult your SAN vendor documentation for SAN setup and connectivity instructions.

4 Install Novell Cluster Services on the OES node.

5 After the install, add the server to the NetWare cluster:

For detailed instructions, see "Adding a Node to an Existing Cluster" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

5a Log in to the OES server as the `root` user.

5b In YaST, select **Open Enterprise Server > OES Install and Configuration**.

5c On the Software Selection page under **OES Services**, verify that **Novell Cluster Services** is selected, then click **Accept** to continue to the configuration.

Services that you have already installed are indicated by a blue check mark in the status check box next to the service.

5d On the Software Configuration page, enable Novell Cluster Services configuration, then click the Novell Cluster Services link.

5e When you are prompted, enter the credentials of the LDAP administrator that is configured for the server.

5f On the Novell Cluster Services Configuration page, add the server to the existing NetWare cluster, then click **Next**.

Parameter	Action
New or Existing Cluster	Select **Existing Cluster**.
Cluster FDN	Browse to select the Cluster object for the NetWare cluster, or type the cluster fully distinguished name. For example: cn=nwcluster,ou=clusters,o=mycompany

5g On the Proxy User Configuration page, specify one of the following users as the NCS Proxy user, then click **Next**.

- **OES Common Proxy User:** If the OES Common Proxy User is enabled in eDirectory, the **Use OES Common Proxy User** check box is automatically selected and the **NCS Proxy User Name** and **Specify NCS Proxy User Password** fields are populated with the credentials of the OES Common Proxy User.
- **LDAP Admin User:** If the OES Common Proxy User is disabled in eDirectory, the **Use OES Common Proxy User** check box is automatically deselected and the **NCS Proxy User Name** and **Specify NCS Proxy User Password** fields are populated with the credentials of the LDAP Admin user. The fields are also automatically populated with the LDAP Admin credentials if you deselect the **Use OES Common Proxy User** check box.
- **Another Administrator User:** Deselect the **Use OES Common Proxy User** check box, then specify the credentials of an administrator user.

You can reset the default settings by clicking **Back** to return to the Novell Cluster Services Configuration page, then clicking **Next** to continue again to the Proxy User Configuration page.

5h On the Configuration page, specify the following parameters, then click **Finish**.

Parameter	Action
IP address of this node	If the server has multiple network adapters, select the IP address that Novell Cluster Services will use for this node.
Start Cluster Services now	Deselect the check box. You will start Novell Cluster Services software on this node manually for the conversion process.

5i On the OES Server Configuration page, scroll down to the Novell Cluster Services entry to review the summary of the Cluster Services configuration, then click **Next**.

Wait while Novell Cluster Services is configured.

5j After the configuration is completed, click **Finish** to exit the OES Configuration page, then exit YaST.

6 If you have a shared disk system on the cluster, enter `sbdutil -f` at the Linux terminal console to verify that the node can see the cluster (SBD) partition on the SAN.

`sbdutil -f` will also tell you the device on the SAN where the SBD partition is located.

7 Start cluster software by going to the `/etc/init.d` directory and running `novell-ncs start`.

You must be logged in as root to run `novell-ncs start`.

8 Add and assign cluster resources to the new Linux cluster node.

See "Configuring Preferred Nodes and Node Failover Order for a Resource" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

9 After you have added OES nodes and cluster migrated all resources to OES nodes, continue with "Removing NetWare Nodes from the Cluster" on page 38.

Removing NetWare Nodes from the Cluster

After your OES cluster nodes are set up and resources have been migrated to them from the NetWare nodes, you are ready to remove the NetWare nodes from the cluster.

To remove the NetWare nodes from the cluster:

1 Log in to the NetWare node as the administrator user.

2 Check the cluster status and verify that all cluster resources have been migrated to the Linux nodes.

```
cluster status
```

3 Remove the NetWare node from the cluster by entering

```
cluster leave
```

4 Stop Novell Cluster Services from running on the NetWare node by entering

```
uldncs
```

5 Remove the NetWare node's Cluster Node object and the NCS attributes from its Server object.

5a In a web browser, open iManager, then log in to the eDirectory tree that contains the node you want to manage.

IMPORTANT: Log in as an administrator user who has sufficient rights in eDirectory to delete and modify eDirectory objects.

5b Delete the node's Cluster Node object from the cluster container:

5b1 Select **Directory Administration > Delete Objects**.

5b2 Browse to the Cluster container ( ) of the cluster, locate and select the Cluster Node object ( ) for the NetWare node in the container, then click **OK**.

5b3 On the Delete Objects page, click **OK**, then click **OK** again to confirm the deletion of the Cluster Node object.

5c Select **Directory Administration > Modify Object**, select the NetWare node's Server object, remove its NCS attributes, then click **OK** to save and apply your changes.

6 Repeat this process to remove each of the remaining NetWare nodes in the cluster.

7 After you have removed each NetWare node from the cluster and removed each node's Cluster Node object and the NCS attributes from its Server object, continue with "Finalizing the Cluster Conversion" on page 39.

Finalizing the Cluster Conversion

After you have converted all nodes in a former NetWare 6.5 SP8 cluster to OES, you must finalize the conversion process by issuing the `cluster convert` command on one Linux cluster node. The `cluster convert` command moves cluster resource load and unload scripts from the files where they were stored on Linux cluster nodes to the Cluster Resource objects in eDirectory. This enables a Linux cluster that has been converted from NetWare to utilize eDirectory like the former NetWare cluster.

WARNING: After you finalize the cluster conversion, rollback to NetWare is not supported. All of the scripts for the NetWare nodes are deleted and are no longer available.

To finalize the cluster conversion:

1 Log in as the `root` user on one of the Linux cluster nodes, then open a terminal console.

2 Verify that NetWare nodes are not part of the cluster. At the command prompt, enter

```
cluster status
```

If there is a NetWare node, remove it as described in "Removing NetWare Nodes from the Cluster" on page 38.

3 Verify that every NetWare nodes Node objects and NCS attributes in the Server object are properly removed from eDirectory.

In iManager, use the **Directory Administration** role to verify that each former NetWare node's Cluster Node object was removed and that the NCS attributes were removed from its Server object. See Step 5 in "Removing NetWare Nodes from the Cluster" on page 38.

4 Verify the load and unload scripts for the cluster resources that you migrated from NetWare to OES. For each resource, enter the following at the command prompt:

```
cluster convert preview resource_name
```

The `preview` switch lets you view the resource load and unload script changes that will be made when the conversion is finalized.

Replace *resource_name* with the name of a resource that you want to preview. You can preview the information for all cluster resources by issuing the command without specifying a resource name. You can use the `cluster convert preview` command at any time before the cluster conversion is finalized.

5 After you have confirmed the readiness of the cluster to be finalized, run `cluster convert commit` as the `root` user at the terminal console of one Linux cluster node to finalize the conversion.

WARNING: After the `cluster convert commit` command is given, the conversion is finalized. There is no rollback to NetWare.

The `cluster convert commit` command generates or regenerates the cluster resource templates that are included with Novell Cluster Services for Linux. In addition to generating Linux cluster resource templates, this command deletes all NetWare cluster resource templates that have the same name as Linux cluster resource templates.

The cluster resource templates are automatically created when you create a new Linux cluster, but are not created when you convert an existing NetWare cluster to Linux.

6 Update the cluster configuration on all nodes by running the cluster configuration daemon. Enter the following command as the `root` user on every node in the cluster:

```
/opt/novell/ncs/bin/ncs-configd.py -init
```

This removes the NetWare nodes from the list of nodes in the cluster so they are not displayed in iManager.

5 Novell AFP

Novell Apple Filing Protocol (AFP) for Linux is available for Open Enterprise Server (OES) 2015 SP1.

After you set up Novell AFP on the Linux node and before you finalize the NetWare-to-Linux conversion, use the AFP function in the Migration Tool to convert the configuration. See "Migrating AFP to OES 2018 SP2" in the *OES 2018 SP2: Migration Tool Administration Guide*.

The commands in the scripts are also different. After the migration, modify the load and unload scripts on the Linux server. See "Comparing File Access Protocol Commands in NSS Pool Resource Scripts" on page 26.

AFP on Linux supports NCP cross-protocol file locking, which allows NCP, AFP, and CIFS users to access files on an NSS volume concurrently without data corruption by locking the files across protocols. On Linux, the cross-protocol file locking parameter for NCP Server is enabled by default. Verify that the Cross-Protocol File Locking parameter is enabled on each node in the cluster if you plan to give both NCP users and AFP users access to NSS volume in the cluster. See "Configuring Cross-Protocol File Locks for NCP Server" in the *OES 2018 SP2: NCP Server for Linux Administration Guide*.

6 Apache HTTP Server

The Apache HTTP Server is an open source web server developed by the Apache Software Foundation (http://www.apache.org). On an Open Enterprise Server (OES) 11 or later cluster, you can use Novell Cluster Services to cluster the web content for your personalized websites. The Apache service is not cluster aware and must run on each server in the cluster.

This section describes key considerations for configuring the Apache virtual hosts for your personalized websites. The scripts for your existing Apache cluster resources and the resource's node preferences must be manually modified to use Apache commands for Linux when you convert a cluster from NetWare to Linux.

- "Prerequisites for Reusing NetWare Apache Cluster Resources on Linux" on page 43
- "Using Apache HTTP Server on OES Servers" on page 44
- "Converting the Apache Cluster Resource" on page 57
- "Troubleshooting the Apache HTTP Server" on page 58
- "Additional Information" on page 59

Prerequisites for Reusing NetWare Apache Cluster Resources on Linux

The following setup is required to reuse the Apache cluster resources from your NetWare cluster:

- When you install OES services on the server, Novell-ready versions of Apache 2 (Prefork, 64-bit) and Tomcat 6 are automatically installed and configured. You manually manage Apache services with the Apache configuration files. Use a text editor to create or modify the configuration files, then gracefully restart the Apache HTTP Server daemon (`rcapache2 graceful`) to apply the changes.

  WARNING: Do not install the Linux **Web and LAMP** pattern. Do not use the **HTTP Server** option in YaST to configure Apache or virtual host settings on an OES server. It overwrites essential OES settings for Apache and breaks the existing setup. For recovery information, see "Apache Server Errors after Using the HTTP Server Option in YaST" on page 58.

- To reuse an NSS pool cluster resource that contains your web content, you must install Novell Storage Services for Linux on each OES node in the cluster. See "Installing and Configuring OES Storage Services" in the *OES 2018 SP2: NSS File System Administration Guide for Linux*.
- If you host multiple websites on a single server on NetWare, you must configure an Apache virtual host for each website on one OES node, then copy the configuration files to every OES node in the cluster.

- In a Novell Cluster Services cluster, the directories you specify in the `DocumentRoot` directive and any `Alias` directives for a virtual host should reside on the same cluster resource so they can fail over together. The location that contains the web content should be a directory on the volume, not the root of the volume. Specify the full Linux path of the directory. Linux paths are case sensitive.

  For example, Novell Cluster Services scripts assume that the pool's volumes are mounted in the default NSS location of `/media/nss/<volume_name>`. The full Linux path of the `/www/mysite` path on an NSS volume APACHEVOL is

  `/media/nss/APACHEVOL/www/mysite`

- The following permissions are required:
  - The user `wwwrun` must be the file owner of the website directories and files. The group can be the system `root` or the Apache group `www`.
  - If web content resides on an NSS volume, the following additional permissions are required:
    - Enable the eDirectory user `wwwrun` and group `www` with Linux User Management (LUM). OES automatically creates and LUM-enables the user and group when you install the first OES server in an eDirectory tree.
    - Assign the eDirectory user `wwwrun` as a file system trustee with Read and File Scan rights for the directory you specify in the `DocumentRoot` directive in the virtual host configuration file.

    These permissions are also required for web content hosted on an NCP-enabled Linux volume.

For information about the default OES setup for Apache and setting up virtual hosts, see "Using Apache HTTP Server on OES Servers" on page 44.

Using Apache HTTP Server on OES Servers

When you set up OES services on the server, Novell-ready versions of Apache 2 HTTP Server software (Prefork, 64-bit) and Tomcat 6 are automatically installed. Apache and the OES Welcome website are automatically configured for non-secure port 80 and secure port 443. The Apache HTTP Server daemon (`httpd2`) starts automatically on server restart.

To set up personalized websites, you must manually create a virtual host configuration file for each website. Templates for secure SSL virtual host and non-secure virtual host configuration files are available in the `/etc/apache2/vhosts.d/` directory. Use a text editor to create or modify the configuration files, then gracefully restart the Apache HTTP Server daemon (`rcapache2 graceful`) to apply the changes.

WARNING: Do not use the **HTTP Server** option in YaST to configure Apache or virtual host settings on an OES server. It overwrites essential OES settings for Apache and breaks the existing setup. For recovery information, see "Apache Server Errors after Using the HTTP Server Option in YaST" on page 58.

- "Understanding the Default OES Setup of Apache HTTP Server" on page 45
- "Manually Configuring Apache" on page 47
- "Creating and Configuring a Virtual Host for Each Website" on page 47

- "Requiring Strong Ciphers" on page 50
- "Configuring an SSL Certificate for the Server" on page 51
- "Configuring Apache to Listen on Multiple Ports" on page 51
- "Configuring Permissions for the Website DocumentRoot Directory" on page 52
- "Configuring a Web Location that Requires LDAP Authentication" on page 54
- "Starting, Stopping, or Restarting the Apache Daemon" on page 56
- "Viewing the Apache Log Files" on page 57

Understanding the Default OES Setup of Apache HTTP Server

When you install services from the OES Add-On disk, the following Apache setup is configured:

- "Apache and Tomcat Installation" on page 45
- "Apache HTTP Server Configuration" on page 45
- "Apache User wwwrun and Group www" on page 45
- "Virtual Host for the OES Welcome Website" on page 46
- "Secure SSL Virtual Host for the Default Website" on page 46
- "Secure SSL Virtual Host for the Novell iManager Website" on page 46

Apache and Tomcat Installation

Novell-ready versions of Apache 2 HTTP Server software (Prefork, 64-bit) and Tomcat 6 are automatically installed when you set up OES services on a server.

Apache HTTP Server Configuration

OES configures Apache settings in the `/etc/sysconfig/apache2` global configuration file and the `/etc/apache2/conf.d/oes_httpd.conf` configuration file.

The `/etc/sysconfig/apache2` configuration file controls some global settings of Apache, such as modules to load, additional configuration files to include, server flags to apply when the Apache HTTP Server daemon (`httpd2`) is started, and flags that should be added to the command line.

Apache User wwwrun and Group www

Apache uses the user `wwwrun` identity to serve files to clients of your website. OES and Apache configure the following during the OES installation:

- The Apache installation creates a local group `www` and user `wwwrun` on the server.

  You configure the user `wwwrun` as the file owner of the website's main directory and files.
- OES creates the group `www` and the user `wwwrun` in eDirectory when you install an OES server in an eDirectory tree for the first time. The user `wwwrun` is added as a member of the group `www`. The user `novlxsrvd` is also created and added to the group `www`.

- OES enables the group `www` and its member users (`wwwrun` and `novlxsrvd`) for Linux with Linux User Management (LUM).

  If your website is hosted on an NSS volume or an NCP-enabled Linux volume, you must assign the eDirectory user `wwwrun` as a file system trustee of the website's main directory, and give the trustee Read and File Scan rights.

For information about changing the file owner or configuring a file system trustee, see "Configuring Permissions for the Website DocumentRoot Directory" on page 52.

Virtual Host for the OES Welcome Website

OES automatically configures the OES Welcome website in the `/etc/opt/novell/httpd/conf.d/welcome-apache.conf` file. Listening is set up on port 80 in the `/etc/apache2/listen.conf` file. Port 80 is opened in the firewall. The Apache HTTP Server daemon (`httpd2`) starts automatically on server restart.

Apache serves the Welcome page for the OES server at

http://<*server_dns_or_ip_address*>

Secure SSL Virtual Host for the Default Website

OES automatically configures a default secure virtual host (`_default_:443`) in the `/etc/apache2/vhost.d/vhost-ssl.conf` file. It sets up listening on port 443 in the `/etc/apache2/listen.conf` file. It opens port 443 in the firewall. The default virtual host configuration is automatically loaded first. It is also used when a domain name does not match a virtual host configuration. The default virtual host defines a custom log `/var/log/apache2/ssl_request_log` to capture events for SSL requests. An `Include` directive in the `/etc/apache2/vhost.d/vhost-ssl.conf` file automatically loads the virtual hosts that are defined in the `/etc/opt/novell/httpd/sslconf.d/*.conf` files.

Secure SSL Virtual Host for the Novell iManager Website

If you install Novell iManager on an OES server, the iManager installation automatically configures a secure virtual host for iManager and Novell Portal Services (NPS) in the `/etc/opt/novell/iManager/nps-Apache.conf` file. A symbolic link in the `/etc/opt/novell/httpd/sslconf.d/` directory points to the `nps-Apache.conf` file. This allows the virtual host to be automatically included along with the default secure virtual host when Apache is restarted.

Aliases are defined in the `nps-Apache.conf` file to hit the website with any of the following URLs:

https://<*server_dns_or_ip_address*>/nps/iManager.html

https://<*server_dns_or_ip_address*>/nps

https://<*server_dns_or_ip_address*>/iManager.html

Manually Configuring Apache

On OES servers and Novell Open Workgroup Suite (NOWS) Small Business Edition (SBE) servers, you must manually configure Apache settings, OES virtual hosts, and virtual hosts for your personalized websites. Use a text editor to create or modify the configuration files, then gracefully restart the Apache HTTP Server daemon (`rcapache2 graceful`) to apply the changes.

WARNING: Do not use the **HTTP Server** option in YaST to manage Apache or the virtual host settings on an OES server. It overwrites essential OES settings for Apache and breaks the existing setup. For recovery information, see "Apache Server Errors after Using the HTTP Server Option in YaST" on page 58.

For information about using the configuration files to manage your Apache HTTP Server and virtual hosts, see "Configuring Apache Manually" (http://www.suse.com/documentation/sles11/book_sle_admin/data/sec_apache2_configuration.html#sec_apache2_configuration_manually) in the *SLES 11 Administration Guide* (http://www.suse.com/documentation/sles11/book_sle_admin/data/book_sle_admin.html).

Creating and Configuring a Virtual Host for Each Website

On Linux, the Apache HTTP server can serve multiple universal resource identifiers (URIs) from a single instance of Apache running on the server. That is, multiple websites, such as www.example.com and www.example.net, can be run from a single web server. Each website is referred to as a **virtual host**. Virtual hosts can be name based, IP based, or port based.

You can set up personalized websites by manually creating a virtual host configuration file for each website. Templates for secure SSL virtual host and non-secure virtual host configuration files are available in the `/etc/apache2/vhosts.d/` directory.

When you cluster-enable the web content by using Novell Cluster Services, use the IP address of the cluster resource for the virtual host. This ensures that the website traffic is directed to the cluster node where the web content cluster resource is currently active. Do not use the server node's IP address or the master IP address of the cluster. Specify the Linux file path to the web content.

On OES servers, you create and configure a separate virtual host configuration file for each website that you want to host in the cluster. The following procedure provides basic information about setting up the file. Refer to other sections in this document to learn about the key settings that are available. For detailed information, see the Apache Virtual Host documentation website (http://httpd.apache.org/docs/2.2/vhosts/).

1. Choose an OES node in the cluster, then log in as the `root` user.
2. Create a copy of the virtual host template file in the `/etc/apache2/vhosts.d/` directory.

   The `/etc/apache2/vhosts.d/` directory contains a basic template (`vhost.template`) for a non-secure virtual host and an SSL template (`vhost-ssl.template`) for a secure virtual host.
3. Rename the file with a name for your virtual host, and add the `.conf` file extension, such as `mysite-Apache.conf`.
4. Open the virtual host file in a text editor and configure the virtual host settings for your personalized website:

   4a If the web content is clustered with Novell Cluster Services, set the `VirtualHost` directive to the IP address or DNS host name assigned to the cluster resource:

```
<VirtualHost hostname>
```

For example, if the DNS name is `mysite.example.com`, specify `mysite` as the `VirtualHost`.

```
<VirtualHost mysite>
```

4b Set the value of the `DocumentRoot` directive to the Linux path of the directory where you placed your web content, and specify the directory options for this location.

The target directory must contain an `index.html` file, which is the root document for the virtual host. Specify the Linux path to the directory. For example, if you place your web content in an NSS volume path `APACHEVOL:\www\mysite`, the Linux path is `/media/nss/APACHEVOL/www/mysite`.

```
DocumentRoot "/media/nss/APACHEVOL/www/mysite"

<Directory  "/media/nss/APACHEVOL/www/mysite">
   # Possible options are "None", "All" or any combination of:
   # Indexes Includes FollowSymLinkx SymLinksifOwnerMatch ExecCGI
MultiViews

   Options Indexes MultiViews
   AllowOverride None
   Order allow,deny
   Allow from all
</Directory>
```

4c Configure the host settings as desired for other directives in the file.

The minimum settings for a non-secure website are shown in the following example:

```
<VirtualHost mysite>

DocumentRoot "/media/nss/APACHEVOL/www/mysite"

ServerAdmin  mysite-admin@example.com
ServerName   mysite.example.com

ErrorLog     /var/log/apache2/error_log
TransferLog  /var/log/apache2/access_log
#CustomLog   /var/log/apache2/mysite.example.com-access_log combined


HostnameLookups On

UseCanonicalName On

ServerSignature Off

<Directory  "/media/nss/APACHEVOL/www/mysite">
   # Possible options are "None", "All" or any combination of:
   # Indexes Includes FollowSymLinkx SymLinksifOwnerMatch ExecCGI
MultiViews

   Options Indexes MultiViews
   AllowOverride None
   Order allow,deny
   Allow from all
</Directory>

</VirtualHost>
```

4d (Optional) Specify alias paths in the virtual host configuration file.

For example, specify an alias for a Support web location that has a `support` directory at the same level as `mysite`. Include the `Alias` and `Directory` directives before the `</VirtualHost>` close tag.

```
Alias /support "/media/nss/APACHEVOL/www/support"
<Directory "media/nss/APACHVOL/www/support">
   Options Indexes MultiViews
   AllowOverride None
   Order deny,allow
   Allow from all
</Directory>
```

For information about alias paths that require LDAP authentication, see "Configuring a Web Location that Requires LDAP Authentication" on page 54.

4e Save the virtual host configuration file.

5 (Optional) In the `/etc/apache2/listen.conf` file, add a `Listen` directive that specifies the IP address that you assigned to your cluster-enabled pool, and specify the port to use.

OES configures Apache to listen on non-secure port 80 by default. It listens for all traffic.

6 Make the websites visible on your network or to the world:

6a Add the site name and IP address resolution to your DNS server to make them visible.

6b If you use a non-standard port, open the port in the node's firewall.

6c If the traffic is from outside the firewall, open the port in the network firewall.

7 Gracefully restart the Apache HTTP Server daemon to apply the virtual host configuration:

```
rcapache2 graceful
```

Each `.conf` file is automatically included in the Apache configuration when you restart Apache.

8 Set up the virtual host for each of the remaining nodes:

8a Log in to the next node as the `root` user.

8b Copy the virtual host configuration file (such as `/etc/apache2/vhosts.d/mysite-apache.conf`) to the next node.

8c Create a local Linux path to the website that you specified in the `DocumentRoot` directive and to any paths you specified in `Alias` directives, then make the user `wwwrun` the owner of the directory and its contents.

When Apache is started or restarted, it looks for the paths specified in your website's virtual host configuration file. If a path does not exist, Apache reports an error but it loads the virtual host. Users access the site via the IP address or DNS name of the cluster resource, so web content is served only on the node where the resource is active.

When a cluster resource is not active on a node, the volume subdirectory (such as `APACHEVOL`) in the `/media/nss` directory is normally removed, and the path to the website does not exist. Creating the local path allows Apache to find the path even when the resource is not active on the node, and no error is reported when Apache loads. When the resource is taken offline, NSS does not remove the volume directory because it is now non-empty (it contains the local paths you create). The local path should not contain files. To add or remove web content files, access the NSS volume via the IP address of the cluster resource.

Enter the following commands for the website path and alias paths. The `chown` command changes the group to the Apache `www` group unless the group is the `root` user.

```
mkdir -p /media/nss/<volume_name>/<path>

chown wwwrun:www /media/nss/<volume_name>/<path>
```

For example, enter

```
mkdir -p /media/nss/APACHEVOL/www/mysite

chown wwwrun:www /media/nss/APACHEVOL/www/mysite

mkdir -p /media/nss/APACHEVOL/www/support

chown wwwrun:www /media/nss/APACHEVOL/www/support
```

8d Open a terminal console as the `root` user, then gracefully restart Apache:

```
rcapache2 graceful
```

8e Repeat these steps on each of the remaining nodes in turn.

IMPORTANT: Any time that you make changes to the virtual host configuration file, you must copy the modified file to every node in the cluster, and gracefully restart Apache on each node.

Requiring Strong Ciphers

We recommend that you secure your web solution by requiring strong ciphers when the client is negotiating the connection in the SSL handshake.

In OES 11 SP1 and later servers, the weak SSL ciphers are disabled by default in the `/etc/apache2/vhosts.d/vhost-ssl.conf` file:

```
# SSL Cipher Suite:
SSLCipherSuite ALL:!aNULL:!eNULL:!SSLv2:!LOW:!EXP:!MD5:@STRENGTH
```

On OES 11 and earlier servers, we recommend that you enable only the strongest ciphers: RSA, HIGH, and SSLv2.

To enable strong ciphers and disable weak ciphers in OES 11 and earlier:

1. In a text editor, modify the `/etc/apache2/vhosts.d/vhost-ssl.conf` file to require strong ciphers. Modify the default settings by placing a plus sign (+) before RSA, HIGH, and SSLv2, and placing an exclamation mark (!) before the weaker ciphers:

   ```
   # SSL Cipher Suite:
   SSLCipherSuite
   ALL:!ADH:!EXPORT56:RC4+RSA:+HIGH:!MEDIUM:!LOW:+SSLv2:!EXP:!eNULL
   ```

2. Gracefully restart Apache on the server:

   ```
   rcapache2 graceful
   ```

3. Repeat this process on every Linux node in the cluster.

   You can alternatively copy the Apache SSL configuration file (`/etc/apache2/vhosts.d/vhost-ssl.conf`) to every Linux node in the cluster, and then restart Apache.

Configuring an SSL Certificate for the Server

OES automatically configures secure SSL communications for a default virtual host (`_default_:443`). SSL is enabled in the Apache global configuration file (`/etc/sysconfig/apache2`) with the following directive:

```
APACHE_SERVER_FLAGS="SSL"
```

The default SSL configuration is defined in the `/etc/apache2/vhosts.d/vhost-ssl.conf` file. It uses an `INCLUDE` directive for the `/etc/opt/novell/httpd/sslconf.d/*.conf` files. This target directory contains the configuration files (or symbolic links to them) for OES virtual hosts that require SSL, such as the `nps-Apache.conf` file that is used for the Novell iManager tool.

By default, OES sets up an SSL certificate file and key file for the server by using certificates generated with the eDirectory Server Certificates service in NetIQ Certificate Server. Table 6-1 identifies the location of the SSL certificate and key files that are referenced by the `SSLCertificateFile` and `SSLCertificateKeyFile` directives in the `/etc/apache2/vhosts.d/vhost-ssl.conf` file.

Table 6-1 *Default OES Server Certificates*

OES Server Certificate File	Location
SSL Certificate File	`/etc/ssl/servercerts/servercert.pem`
SSL Certificate Key File	`/etc/ssl/servercerts/serverkey.pem`

IMPORTANT: If you use SSL, set up a server certificate for each virtual host unless you use a wildcard certificate.

If you modify the content or location of the certificate and key files, gracefully restart the Apache HTTP Server daemon (`rcapache2 graceful`) to apply the new values.

Configuring Apache to Listen on Multiple Ports

The `Listen` directive in the `/etc/apache2/listen.conf` file tells the Apache HTTP Server to accept incoming requests on the specified port or an address-and-port combination. If the directive specifies only a port, the server listens to the given port on all interfaces. If the directive specifies an IP address and port combination, the server listens on the given port and network interface.

By default, OES configures Apache to listen on non-secure port 80 and secure port 443 in the `/etc/apache2/listen.conf` file. If a firewall is used on the server, port 80 and port 443 are automatically opened in the firewall. The ports are not bound to a particular IP address, so Apache responds to requests on all IP interfaces on the server.

```
Listen 80


<IfDefine SSL>
    <IfDefine !NOSSL>
  <IfModule mod_ssl.c>

      Listen 443

  </IfModule>
    </IfDefine>
</IfDefine>
```

You can configure multiple `Listen` directives to specify multiple IP addresses and ports. The server responds to requests from any of the listed addresses and ports. For information about formats and options for the `Listen` directive, see the *Listen Directive* (http://httpd.apache.org/docs/2.2/mod/mpm_common.html#listen) in the *Apache MPM Common Directives* collection.

If you configure non-standard ports for your personalized websites, you must add a `Listen` directive in the `/etc/apache2/listen.conf` file, then gracefully restart the Apache HTTP Server daemon (`rcapache2 graceful`) to apply the changes. Ensure that you open the port in the firewall.

Configuring Permissions for the Website DocumentRoot Directory

Apache uses the user `wwwrun` identity to serve files to clients of your website. You must configure permissions for the website content that allow Apache to serve the files to client users.

- "Setting the User wwwrun as the Owner of the Website's Directory and Files" on page 52
- "Setting User wwwrun as a File System Trustee of the Website's Directory" on page 53

Setting the User wwwrun as the Owner of the Website's Directory and Files

The user `wwwrun` must be the file owner of the website's main directory and files.

1. Log in as the `root` user, and open a terminal console.
2. Change directory to go to the directory that contains the main directory of your website. This is the directory you specify as the `DocumentRoot` in the virtual host configuration file.

   For example, if the `DocumentRoot` is `/media/nss/APACHEVOL/www/mysite`, enter

   ```
   cd /media/nss/APACHEVOL/www
   ```
3. Change the owner of the website's directory and files to user `wwwrun`. Enter:

   ```
   chown -R wwwrun:www mysite
   ```

   This recursively modifies the owner to user `wwwrun` for the directory and the subdirectories and files it contains. It changes the group to `www` unless the group is set to the `root` user.

4 In a file browser, view the directory's properties to verify that the owner was changed.

You can also use the `ls -al <path>` command to list the directory and view the owner, group, and permissions.

Setting User wwwrun as a File System Trustee of the Website's Directory

OES automatically creates the user `wwwrun` and group `www` in eDirectory. Both are LUM-enabled. You can verify their configuration by using the **Directory Administration** option and **Linux User Management** option in Novell iManager.

If your website is hosted on an NSS volume or an NCP-enabled Linux volume, you must assign the eDirectory user `wwwrun` as a file system trustee of the website's main directory, and give the trustee Read and File Scan rights. You can also set the `www` group as a trustee with Read and File Scan rights.

1 Log in to Novell iManager as an administrator user.

2 In the iManager toolbar, click the **View Objects** icon.

3 In the Tree view, select the volume, then browse the file system to locate the directory that contains your website's content.

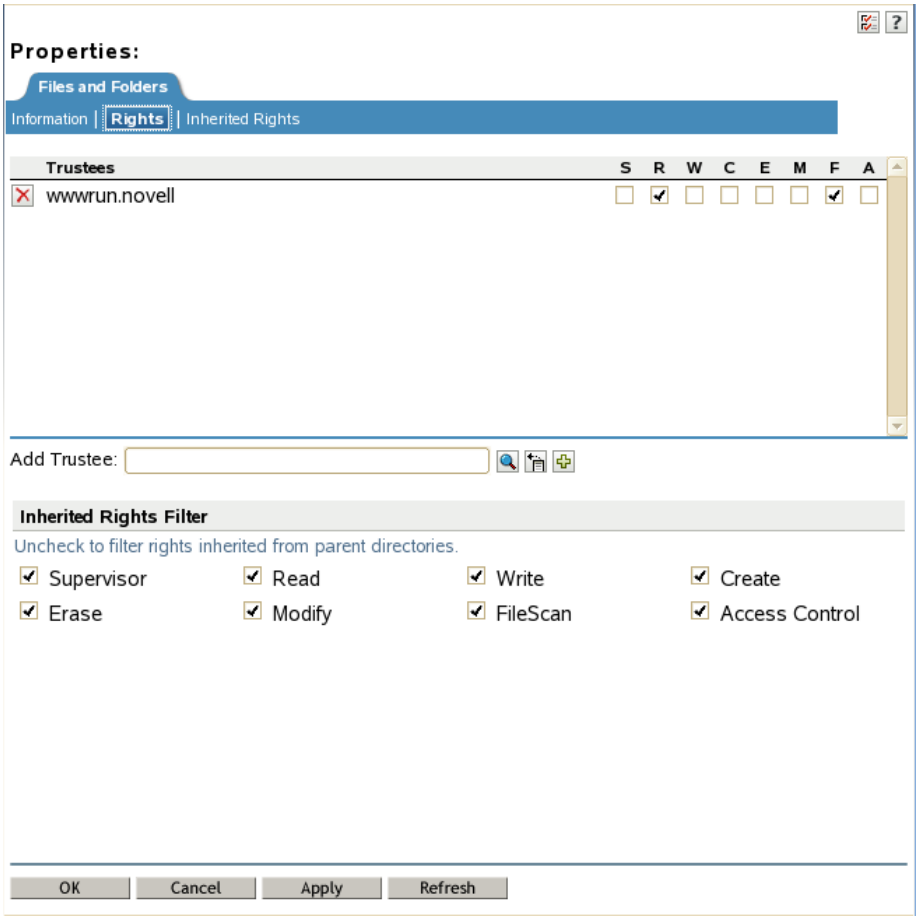
4 Select the check box next to the directory, then select **Actions > Properties.**

5 On the Properties page, select **Rights**.

6 Click the **Add Trustee** browse icon to open the **Object Selector**.

7 Locate and select the user `wwwrun`, then click **OK**.

The user `wwwrun` is added as a trustee with the default Read and File Scan rights.



8 Click **Apply** or **OK** to save the changes.

Configuring a Web Location that Requires LDAP Authentication

If you have documents or a location that requires restricted web access, you can set up Apache to enforce eDirectory authentication and force the authentication to be done over `https`. This solution can be used on individual directories, URLs, or the entire Apache server.

The following example creates a single secure location so that any document that is referenced under the directory requires authentication. For example, the URL www.example.com can have public access, while the URL www.example.com/secure and documents it contains require authentication. Authentication should be done over a secure connection (https) rather than a non-secure connection (`http`). All `http` attempts are redirected to `https` for the given location.

1 Ensure that the `rewrite` module is enabled in the `/etc/sysconfig/apache2` global configuration file. OES enables this module by default.

Open the `/etc/sysconfig/apache2` file in a text editor, and verify that `rewrite` is listed in the modules defined in the APACHE_MODULES directive.

2 Configure the permissions for the user `wwwrun` on the target directory:

2a Change the owner to the Apache user `wwwrun`:

```
chown -R wwwrun:www /media/nss/APACHEVOL/www/secure
```

This changes the group to the Apache group `www` unless the group is the `root` user.

2b For an NSS volume or an NCP-enabled Linux volume, configure the user `wwwrun` as a file system trustee of the `/media/nss/APACHEVOL/www/secure` directory, and give the trustee Read and File Scan rights.

See "Setting User wwwrun as a File System Trustee of the Website's Directory" on page 53.

3 In a text editor, create a copy of the `/etc/apache2/vhosts.d/vhosts-ssl.template` file to create a `secure.conf` configuration file.

4 Allow for all `http` requests for the `/secure` alias to be redirected to `https`. Add the following directives to the `secure.conf` file:

```
RewriteEngine On

RewriteRule ^/secure https://%{SERVER_NAME}/secure [L,R]
```

5 If the location that contains secure information exists outside the `DocumentRoot` directory, create an alias to the directory. Add the following line to the `secure.conf` file:

```
Alias /secure "/<path_to_directory>/secure"
```

For a cluster resource, the secure directory ideally resides on the same clustered volume as the website, and at the same directory level as `DocumentRoot` for the website:

```
Alias /secure "/media/nss/APACHEVOL/www/secure"
```

6 Under the `Alias` directive, add the option for LDAP authentication under the `Directory` directive in the `secure.conf` file. Specify the IP address or DNS name of the website's cluster resource.

```
<Directory "media/nss/APACHVOL/www/secure">
  Options Indexes MultiViews
  AllowOverride None
  Order deny,allow
  Allow from all
  AuthType Basic
  AuthName "Protected"
  require valid-user
  AuthLDAPAuthoritative On
  AuthLDAPURL ldaps://<cluster_resource_ip_address_or_dns_name>/o=corp?uid?sub
</directory>
```

7 Save the `/etc/apache/vhosts.d/secure.conf` file.

8 Open a terminal console as the `root` user, then gracefully restart the Apache daemon:

```
rcapache2 graceful
```

9 Verify that Apache is able to start.

If there are errors, make corrections in the configuration file, then restart the Apache daemon.

10 In a web browser, go to the website with `http` and verify that you are redirected to `https`, and that you can authenticate against the `/secure` alias.

Starting, Stopping, or Restarting the Apache Daemon

The Apache HTTP Server program runs as a daemon (`httpd2`) that executes continuously in the background to handle requests. OES configures the daemon to start automatically on system restart. You must restart Apache to apply any changes you make to the Apache or virtual host configuration files, or to add new virtual host configuration files. A graceful restart does not disrupt the service.

In a cluster, you manually copy the virtual host configuration files for clustered personalized websites to every node in the cluster. When Apache starts on each node, it reads the configuration file and is available to serve the site when the resource is active on the node. You do not add Apache commands in the resource's load and unload scripts. All requests to a clustered website are sent to the DNS name or IP address of the cluster resource, and not to a specific node. The site's requests are served by the Apache process that runs on the node where the cluster resource is currently active.

To start, stop, or restart the Apache daemon, use the `/usr/sbin/rcapache2` commands in Table 6-2:

Table 6-2 */usr/sbin Commands*

Command	Description
`rcapache2 start`	Starts the `httpd2` parent process. The parent process reads its configuration files and opens log files, and then spawns the child processes to serve hits. OES configures the Apache daemon to start automatically on server restart.
`rcapache2 stop`	Causes the parent process to immediately attempt to kill all of its child processes. This can take several seconds. The parent exits after all child processes have exited. Any requests in progress are terminated, and no further requests are served.
`rcapache2 graceful-stop`	Causes the parent process to advise its child processes to exit after their current request (or to exit immediately if they are not serving anything). The parent removes its PID file and ceases listening on all ports. The parent continues to run, and monitors child processes that are handling requests. The parent exits after the child processes complete the pending requests and exit, or when a timeout period has elapsed (as specified by the `GracefulShutdownTimeout`). If the timeout is reached, any remaining child processes are automatically sent the TERM signal to force them to exit, and any requests in progress are terminated.
`rcapache2 restart`	Causes the parent process to immediately kill its child processes like the `stop` option, but the parent does not exit. It re-reads its configuration files, and re-opens any log files. Then it spawns a new set of child processes and continues serving hits.
`rcapache2 graceful`	Causes the parent process to advise the child processes to exit after their current request (or to exit immediately if they are not serving anything). The parent re-reads its configuration files and re-opens its log files. As each child dies, the parent replaces it with a child from the new generation of the configuration, which begins serving new requests immediately.

Viewing the Apache Log Files

The following Apache log files are located in the `/var/log/apache2/` directory:

```
access_log
error_log
rcapache2.out
rewrite_log
ssl_request_log
```

You can also specify custom logs by adding the `CustomLog` directive to your virtual host configuration file. For information about formatting the custom log, see *Apache Module mod_log_config* (http://httpd.apache.org/docs/2.2/mod/mod_log_config.html).

Converting the Apache Cluster Resource

Before you convert the Apache Cluster Resource to run on Linux servers, ensure that your servers meet the Prerequisites for Reusing NetWare Apache Cluster Resources on Linux.

1. Configure the virtual hosts for your personalized websites on each Linux node in the cluster as described in "Using Apache HTTP Server on OES Servers" on page 44.
2. In iManager, offline the NSS pool cluster resource from a NetWare node.
3. In iManager, modify the load and unload scripts to remove the Apache start and stop commands.
4. In iManager, cluster migrate the cluster resource to a Linux node. The new load script applies when the resource loads.
5. Offline the Apache cluster resource.

   Leave the resource offline until all Linux nodes have been added and the cluster conversion has been finalized.
6. In iManager, set up the preferred nodes for the Apache cluster resource to include only Linux nodes in the cluster.
7. Finalize the steps to complete the cluster conversion, then commit the conversion.
8. Online the Apache cluster resource.

   ```
   cluster online <resource_name> [node_name]
   ```
9. In a web browser, access your website to ensure that the files are available.

   If you get permission errors, check the following:

   - The user `wwwrun` should be set as a file system trustee of the directory that is used as the `DocumentRoot` for the website. Assign Read and File Scan rights to the trustee.
   - The user `wwwrun` should be set as the file owner of the web content.

   See "Configuring Permissions for the Website DocumentRoot Directory" on page 52.
10. Cluster migrate the resource to each node in the cluster in turn, and access the website from a web browser to ensure the site is accessible from each of its preferred nodes.
11. Cluster migrate the resource to its most preferred node.

Troubleshooting the Apache HTTP Server

This section describes some issues you might experience with Apache HTTP Server and provides suggestions for resolving or avoiding them. For additional troubleshooting information, see the Novell Technical Support Knowledgebase (http://www.novell.com/support).

- "Apache Server Errors after Using the HTTP Server Option in YaST" on page 58
- "Files Downloaded from NetStorage Are 0 Bytes" on page 59

Apache Server Errors after Using the HTTP Server Option in YaST

If you use the **HTTP Server** option in YaST to manage Apache or virtual hosts, the option can overwrite essential OES settings and load the wrong modules, which breaks the default Apache HTTP Server setup. See TID 7002562 (http://www.novell.com/support/kb/doc.php?id=7002562) in the Novell Knowledgebase.

If you have used the **HTTP Server** option in YaST and Apache is no longer working, recover the OES default Apache HTTP Server setup by doing the following:

1. As the `root` user, open the `/etc/sysconfig/apache2` file in a text editor and modify the following directives:
   - **Proxy module:** In the `APACHE_MODULES=` line in the file, ensure that the `proxy` module is listed before the `proxy_ajp` module. For example (some modules are not listed for ease of reading the example):

     ```
     APACHE_MODULES="cgi dir rewrite ssl proxy proxy_ajp ssl"
     ```

   - **SSL module:** In the `APACHE_MODULES=` line in the file, ensure that the `ssl` module is listed. For example (some modules are not listed for ease of reading the example):

     ```
     APACHE_MODULES="cgi dir rewrite ssl proxy proxy_ajp ssl"
     ```

   - **Prefork mode:** Apache should run in `prefork` mode rather than `worker` mode. To force this, ensure that the `APACHE_MPM=""` line is set to `"prefork"`. For example:

     ```
     APACHE_MPM="prefork"
     ```

   - **SSL:** Ensure secure communications by enabling the SSL flag. For example:

     ```
     APACHE_SERVER_FLAGS="SSL"
     ```

2. Gracefully restart Apache to apply the changes. As the `root` user, enter the following command at a console prompt:

   ```
   rcapache2 graceful
   ```

Files Downloaded from NetStorage Are 0 Bytes

After you lock down ciphers for an Apache HTTP Server to use only the strongest SSL ciphers, all of the files downloaded from NetStorage are 0 bytes in size.

NetStorage might not work as expected if you lock down Apache HTTP Server to disallow low and medium SSL ciphers. Try allowing medium SSL cipher settings to see if that is sufficient, then add back low cipher settings if necessary.

For other SSL cipher configuration options, see *SSL/TLS Strong Encryption: How-To* (http://httpd.apache.org/docs/2.2/ssl/ssl_howto.html) at Apache.org.

Additional Information

The latest Apache documentation is available on the Apache HTTP Server Version 2.2 Documentation website (http://httpd.apache.org/docs-2.2/).

7 eDirectory Server Certificates

NetIQ Certificate Server provides two categories of services: Certificate Authority (CA) and eDirectory Server Certificates.

- The Certificate Authority services include the Enterprise CA and CRL (Certificate Revocation List). Only one server can host the CA, and normally that same server hosts the CRLs if they are enabled (although if you move the CA to a different server, the CRLs usually stay on the old server). The CA and CRL services are not cluster-enabled. There are no cluster-specific tasks for them.
- The eDirectory Server Certificates service is not clustered. However, clustered applications that use the server certificates must be able to use the same server certificates on whichever cluster node they happen to be running. You must set up Server Certificate objects in a clustered environment to ensure that your cryptography-enabled applications that use Server Certificate objects always have access to them.

The Server Certificates objects are created differently on Linux, and cannot be directly reused from the NetWare server. The differences and alternatives for setting up certificates for OES servers are described in the following sections:

- "Server Certificates Changes in OES 11 and Later" on page 61
- "Using Internal Certificates in a Cluster" on page 62
- "Using External Certificates in a Cluster" on page 62

Server Certificates Changes in OES 11 and Later

The Server Certificates service can create certificates for eDirectory services to use when you install the operating system. In addition, custom certificates can be created after the install by using Novell iManager or command line commands.

- "Using eDirectory Server Certificates in a Cluster" on page 61
- "Using eDirectory Server Certificates for HTTPS Services" on page 62

Using eDirectory Server Certificates in a Cluster

In a NetWare cluster, you might have copied the Server Certificate objects to all nodes in the cluster using backup and restore functions for Server Certificate objects. This functionality is also available for OES clusters. You can use the backup and restore feature for Server Certificate objects to duplicate the object's keying material from one node on the cluster to all nodes.

For information about setting up server certificates in a Novell Cluster Services cluster, see the following sections of the *NetIQ Certificate Server Administration Guide*:

- "Server Certificate Objects and Clustering"

- "Backing Up a Server Certificate Object"
- "Restoring a Server Certificate Object"

Using eDirectory Server Certificates for HTTPS Services

For NetWare, OES2 or later, all applications are integrated with eDirectory. This allows applications to automatically use the server certificates created by Certificate Server directly from eDirectory.

However, for OES1, many native Linux applications (such as Apache and Tomcat) are not integrated with eDirectory and therefore, cannot automatically use the certificates created by Certificate Server directly from eDirectory. By default, these services use the self-signed common server certificate created by YaST:

- **Certificate file:** `/etc/ssl/servercerts/servercert.pem`
- **Key file:** `/etc/ssl/servercerts/serverkey.pem`

Self-signed certificates provide minimal security and limited trust, and are not in compliance with the X.509 requirements as specified in RFC 2459 and RFC 3280. We recommend that you use eDirectory certificates instead.

When installing OES2 or later on Linux, the YaST installer provides a configuration screen that allows you to specify whether you want to automatically configure the server to export eDirectory Server Certificates to the file system, eliminating the need to manually configure the server through iManager. It's selected by default. If selected, it automatically replaces the existing server certificate and key files (YaST or third-party) with an eDirectory server certificate and key files.

For more information on how to manually configure OES1 servers to use eDirectory certificates, see NetIQ Certificate Server Administration Guide.

Using Internal Certificates in a Cluster

NetIQ Certificate Server can be used to create certificates that allow you to specify an alternative IP address or DNS address by adding it in the **Subject Alternative Name** extension. This requires that your DNS service be configured to reflect the cluster IP/DNS address as the default (or first) address. If the DNS service is set up correctly, the cluster applications can use the default certificates without needing any administration.

Ensure that the DNS service is configured to use the cluster IP/DNS address. During the OES install, select the **Use eDirectory Certificates** option so that NetIQ Certificate Server automatically creates the **SSL Certificate DNS** certificate with the correct IP/DNS address. By selecting the **Use eDirectory Certificates** option during the installation and using the cluster IP/DNS address, clustered applications should be able to access the certificates without needing further configuration for the Server Certificate object.

Using External Certificates in a Cluster

External (third-party) certificates create a Server Certificate object that includes the cluster's IP and/or DNS address. Create a backup of this certificate. For each server in the cluster, create a Server Certificate object with the same name by importing the previously created backup certificate and

key pair to a location on that server. This allows all of the servers in the cluster to use and share the same certificate and key pair. After all cluster nodes have the certificate, configure the cluster applications to use the server certificate.

IMPORTANT: This cluster task can also be used for sharing internal certificates on the cluster nodes. In early versions of Certificate Server, this was the only option available.

For information about exporting and using eDirectory Server Certificates for External Services, see "Using eDirectory Certificates with External Applications" in the *NetIQ Certificate Server Administration Guide*.

The external certificate method is more complicated than using internal certificates. You must create the certificate for each server in the cluster just as you did for NetWare. You must also create a configuration on the SAS:Service object for each server so that the common certificate is automatically exported to the file system where the non-eDirectory enabled applications can use it.

8 Novell CIFS

Novell CIFS for Linux is available for Open Enterprise Server (OES) 2015 SP1.

After you set up Novell CIFS on the Linux node and before you finalize the NetWare-to-Linux conversion, use the CIFS function in the Migration Tool to convert the configuration. See "Migrating CIFS to OES 2018 SP2" in the *OES 2018 SP2: Migration Tool Administration Guide*.

The commands in the scripts are also different. After the migration, you can view the revised load and unload scripts on the Linux server. See "Comparing File Access Protocol Commands in NSS Pool Resource Scripts" on page 26.

IMPORTANT: If the cluster resource goes comatose on the Linux server, there might be a timing issue for loading Novell CIFS. Add a `sleep` command of 5 or more seconds before the `novcifs --add` command. For example:

```
sleep 5
exit_on_error novcifs --add --vserver=.CN=NCS1_P1_SERVER.O=novell.T=TREE-188.
              --ip-addr=10.10.10.205
```

CIFS supports NCP cross-protocol file locking, which allows NCP, AFP, and CIFS users to access files on an NSS volume concurrently without data corruption by locking the files across protocols. On Linux, the cross-protocol file locking parameter for NCP Server is enabled by default. Verify that it is enabled on each node in the cluster if you plan to give both NCP users and CIFS users access to an NSS volume in the cluster. See "Configuring Cross-Protocol File Locks for NCP Server" in the *OES 2018 SP2: NCP Server for Linux Administration Guide*.

CIFS supports the merged view for Novell Dynamic Storage Technology (DST) shadow volumes built with NSS volumes. Wait until the cluster conversion is complete before attempting to set up DST shadow volumes in the OES cluster.

9 Novell Distributed File Services VLDB

The Novell Distributed File Services volume location database (VLDB) `.dat` file format is the same on both NetWare and Linux. The shared NSS volume that contains the `.dat` file can be cluster migrated to the Linux server.

Use one of these two methods for migrating the VLDB from NetWare to Linux:

- "Cluster Migrating the Shared NSS Volume for the VLDB" on page 67
- "Adding a Linux Server as a Replica Site" on page 68

Cluster Migrating the Shared NSS Volume for the VLDB

Use this method if you want to use the same shared disk where the VLDB is currently stored.

1. For each Linux node where you expect to run the VLDB service, install Novell Storage Services and any of its dependent services on the Linux node, then add it to the mixed cluster that you are converting.
2. For each of the Linux nodes, assign the node's nssadmin user as a trustee of the container that is configured as the Management Context for the VLDB, and give the user at least the `Read` and `Compare` rights to the `[All Attribute Rights]` property.

   IMPORTANT: If the Management Context is configured to use the container that contains a node's Server object, the nssadmin User object for that server is already a trustee of the container and has the `Supervisor` right. Do not modify the existing rights settings for this nssadmin User object when you add rights for the `[All Attribute Rights]` property.

   2a. In iManager, select **Rights > Modify Trustees**.

   2b. Select the container that is configured as the Management Context, then click **OK**.

   2c. Click **Add Trustee**, select the nssadmin User object, then click **OK**.

   The nssadmin User object is in the same container as its server. The user name format is *servname*admin.*context*. For example, if the server name is `server1.ou1.mycompany`, then *server1*admin.*ou1.mycompany* is the nssadmin user name.

   2d. Click **Assigned Rights** for the selected nssadmin User object.

   2e. Assign the **Read** and **Compare** rights to the **[All Attribute Rights]** property, then click **Done**.

   2f. Click **Apply** to save and apply the changes.

   2g. Repeat Step 2c through Step 2f for each of the Linux nodes where you expect to run the VLDB service.
3. Cluster migrate the DFS cluster resource from NetWare to Linux.
4. On the Linux node where the VLDB is active, offline the DFS cluster resource.
5. Remove the NetWare clusters from the cluster by using the `cluster leave` command, then finish the cluster conversion.

This automatically updates the basic cluster commands in the cluster resource scripts.

6 Using the **Clusters** plug-in in iManager, modify the load script of the DFS cluster resource to change the `vldb` command to the Linux format. For example, change it from

```
vldb /dir=vldbpath
```

to

```
vldb -dir /vldbpath
```

7 Online the cluster resource.

8 Run a VLDB repair to ensure that the database is correct.

Adding a Linux Server as a Replica Site

Use this method if you want to use a different shared disk for the VLDB on Linux. You can do this by adding a DFS replica site on Linux.

1 Install OES on the server that you want to add to the cluster. Ensure that Novell Storage Services and any of its dependent services are installed.

2 Assign the node's nssadmin user as a trustee of the container that is configured as the Management Context for the VLDB, and give the user at least the `Read` and `Compare` rights to the `[All Attribute Rights]` property.

IMPORTANT: If the Management Context is configured to use the container that contains a node's Server object, the nssadmin User object for that server is already a trustee of the container and has the `Supervisor` right. Do not modify the existing rights settings for this nssadmin User object when you add rights for the `[All Attribute Rights]` property.

2a In iManager, select **Rights > Modify Trustees**.

2b Select the container that is configured as the Management Context, then click **OK**.

2c Click **Add Trustee**, select the nssadmin User object, then click **OK**.

The nssadmin User object is in the same container as its server. The user name format is *servname*admin.*context*. For example, if the server name is `server1.ou1.mycompany`, then *server1*admin.*ou1.mycompany* is the nssadmin user name.

2d Click **Assigned Rights** for the selected nssadmin User object.

2e Assign the **Read** and **Compare** rights to the **[All Attribute Rights]** property, then click **Done**.

2f Click **Apply** to save and apply the changes.

3 Create a shared NSS pool and volume on the OES server, or create a shared Linux POSIX volume.

4 In iManager, add the Linux server as the second VLDB replica site for the DFS management context, and point to the shared NSS volume as the VLDB location.

5 Allow the VLDB data to synchronize between the NetWare replica and the Linux replica.

6 In iManager, remove the NetWare instance of the replica site.

7 Add the Linux server to the mixed-mode NetWare cluster.

8 Continue with the cluster conversion as described in "Converting NetWare Cluster Nodes to OES (Rolling Cluster Conversion)" on page 33.

10 DHCP Server

The Novell DHCP Server for Linux is based on a standards-compliant implementation from ISC that is distributed with SUSE Linux Enterprise Server. DHCP uses a different schema on Linux to store the configuration in eDirectory.

After you set up Novell DHCP Server on the Open Enterprise Server SP1 and before you complete the cluster conversion, you can use the DHCP option for the Migration Tool to convert the configuration from NetWare to OES. You cannot directly reuse the data. Migrate your DHCP server data, then perform the post-migration tasks to set up the configuration in the OES nodes of the cluster.

- "Setting Up Novell DHCP on OES" on page 69
- "Prerequisites for Migration" on page 69
- "Migrating the DHCP Configuration from NetWare to Linux Clusters in the Same Tree" on page 69
- "Post-Migration Tasks" on page 70

Setting Up Novell DHCP on OES

Novell DHCP Server for OES 11 and later supports using a shared Linux POSIX file system or a shared NSS file system for the cluster resource. Set up DHCP on the OES servers by using one of the following methods in the *OES 2018 SP2: DNS/DHCP Services for Linux Administration Guide*:

- "Configuring DHCP with OES Cluster Services for the NSS File System"
- "Configuring DHCP with OES Cluster Services for the Linux File System"

Prerequisites for Migration

For more information about prerequisites, see "Migration Requirements" for DHCP in the *OES 2018 SP2: Migration Tool Administration Guide*.

Migrating the DHCP Configuration from NetWare to Linux Clusters in the Same Tree

In this scenario, both the NetWare server and the OES server are in the same eDirectory tree. The NetWare source server must be running NetWare 6.5 SP8 with the latest patches applied. The Linux target server must be running OES 2015 SP1 on 64-bit hardware.

Run the DHCP function in the Migration Tool from one of the OES nodes. Perform the Tree Level Migration with the same Source server (tree to which NetWare clustered nodes are attached) and Target server (tree to which the Linux clustered nodes are attached). This ensures that the entire NetWare DHCP configuration data is available for OES DHCP.

See “Migrating DHCP ” in the *OES 2018 SP2: Migration Tool Administration Guide*, and follow the instructions for NetWare and Linux in the same eDirectory tree.

IMPORTANT: Before starting the DHCP server on the Linux cluster, stop the DHCP server on the NetWare cluster.

Post-Migration Tasks

1. Log in as the `root` user to the OES node where you ran the migration, then open a terminal console
2. Online the DHCP service cluster resource by entering

   ```
   cluster online resource_name
   ```

3. On the Linux node where you ran the migration:
   - **3a** Open the */mount_path*`/etc/dhcpd.conf` file in a text editor.

     Replace *mount_path* with the Linux path to the folder in the shared volume where DHCP-specific directories are created.
   - **3b** In the */mount_path*`/etc/dhcpd.conf` file, change the value for the `ldap-dhcp-server-cn` parameter to the `cn` of the migrated DHCP server, then save your changes.
   - **3c** Copy the `migrated_server.leases` file from `/var/opt/novell/dhcp/leases/` folder or to the lease path specified in the Migration Tool to the */mount_path*`/var/lib/dhcp/db/` folder, then rename it to `dhcpd.leases`.
4. Stop the DHCP server on the NetWare cluster by taking the NetWare DHCP cluster resource offline.
5. Start the DHCP server on the Linux cluster.

   ```
   rcnovell-dhcpd start
   ```

11 DNS Server

You can migrate the data from the Novell DNS Server on NetWare to a Novell DNS Server on Linux after you have installed and set up DNS services on an Open Enterprise Server (OES) 2015 SP1 node in the cluster. You cannot directly reuse the data.

- "Prerequisites for Migration" on page 71
- "Migrating the DNS Configuration from NetWare to Linux Clusters in the Same Tree" on page 71
- "Post-Migration Tasks" on page 71

Prerequisites for Migration

For information about prerequisites, see "Migrating DNS to OES 2018 SP2" in the *OES 2018 SP2: Migration Tool Administration Guide*.

Migrating the DNS Configuration from NetWare to Linux Clusters in the Same Tree

In this scenario, both the NetWare server and the OES server are in the same eDirectory tree. The NetWare source server must be running NetWare 5.1 SP8 or later versions. The Linux target server must be running OES 2015 SP1 on 64-bit hardware.

Use iManager to move the DNS server from a NetWare NCP server to an OES NCP server. For information see "Using Java Console to Migrate Servers within the Same eDirectory Tree" in the *OES 2018 SP2: Migration Tool Administration Guide*.

Post-Migration Tasks

See "Post-Migration Procedure" in the *OES 2018 SP2: Migration Tool Administration Guide*.

1. Use iManager or the Java Management Console to check for the existence of the following objects:
   - DNS-DHCP
   - DNSDHCP-GROUP
   - RootServerInfo
   - DNS Server object
2. Use the Clusters plug-in for iManager to verify the Cluster load script and unload script of the DNS cluster resources.

   See "DNS Load, Unload, and Monitor Scripts" in the *OES 2018 SP2: DNS/DHCP Services for Linux Administration Guide*.
3. Start the DNS server on the OES cluster.

12 Novell iPrint

This section describes how to convert the iPrint cluster resource from NetWare 6.5 SP8 to Open Enterprise Server (OES) 2015 SP1.

- "Installing iPrint on the OES Nodes" on page 73
- "Setting Up iPrint on the OES Nodes" on page 73
- "Migrating the iPrint Cluster Resource from NetWare to OES" on page 76
- "Finalizing the Cluster Conversion" on page 77
- "Additional Information" on page 77

Installing iPrint on the OES Nodes

Prepare the first OES server for use with iPrint in a cluster:

1. Install the following services on an OES server:
   - Novell iPrint
   - Novell Storage Services
   - Novell Cluster Services (but do not configure at install time)

   Select at least these services and any dependent services that each one requires.
2. After the install, add the server to the NetWare cluster:

   For instructions, see "Adding New OES Nodes to Your NetWare Cluster" on page 36.

Setting Up iPrint on the OES Nodes

Perform the steps in this section to set up iPrint and an iPrint cluster resource on the OES nodes in the mixed-mode cluster.

- "Preparing the OES Nodes for iPrint" on page 73
- "Setting Up iPrint on the OES iPrint Cluster Resource" on page 75
- "Setting Up Preferred Nodes for the OES iPrint Cluster Resource" on page 75
- "Editing the Load and Unload Scripts for the OES iPrint Cluster Resource" on page 75
- "Verifying the Status of the iPrint Setup" on page 76

Preparing the OES Nodes for iPrint

Because iPrint on NetWare and iPrint on Linux are different, cluster migrating the iPrint cluster resource from NetWare to Linux is not an option. You create a new pool cluster resource on an OES node that will be the iPrint cluster resource on Linux. To set up iPrint on each server, you move the

iPrint configuration information from the default Linux installation path on each node to the newly created shared NSS pool resource. Later, you will move the iPrint Driver Store and Print Manager information from the NetWare resource to the OES resource.

1. In a web browser, open iManager, then use the Storage role to create a new shared pool and volume on one of the OES servers where iPrint is installed.

   This is the iPrint cluster resource that will contain the iPrint data.

   For information about creating a clustered NSS pool and volume, see "Creating Cluster-Enabled Pools and Volumes" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

2. On the first OES node, set up clustering for iPrint on the shared NSS volume that you created in Step 1.

   2a Log in as the `root` user to the OES node where the shared pool resource is active, then open a terminal console.

   2b Go to the `/opt/novell/iprint/bin` directory, then run the `iprint_nss_relocate` script by entering

   ```
   ./iprint_nss_relocate -a admin_fdn -p admin_password -n
   nss_volume_path -l cluster [-c <Specify Container FDN where iPrint
   LUM object already
   exists or should be created>] [-w <Specify Container FDN where
   Apache LUM objects exist>]
   ```

   Replace *admin_fdn* with the comma-delimited fully distinguished name of the iPrint administrator user (such as `cn=admin,o=mycompany`). Replace *admin_password* with the actual password of the specified iPrint administrator user. Replace *nss_volume_path* with the Linux path (such as `/media/nss/NSSVOL1`) to the shared NSS volume where you want to relocate the iPrint configuration data.

   For information about the script options, see "Setting up iPrint on the NSS File System" in the *OES 2018 SP2: iPrint Administration Guide*.

   For example, enter

   ```
   ./iprint_nss_relocate -a cn=admin,o=mycompany -p password -n /media/
   nss/NSSVOL1 -l cluster -c o=mycompany,t=iPrint_Tree -w
   o=mycompany,t=iPrint_Tree
   ```

   2c Review the messages displayed on the screen to confirm the data migration from the local Linux path to the shared NSS path is completed.

3. For each remaining Linux node in the cluster where iPrint is installed, set up clustering for iPrint by doing the following:

   3a Log in as the `root` user to the OES node where the shared pool resource is active, then open a terminal console.

   3b Cluster migrate the shared NSS pool resource from the active OES node to this OES node by entering

   ```
   cluster migrate resource_name node_name
   ```

   3c Log in to the newly active OES node as the `root` user, then open a terminal console.

   3d Run the `iprint_nss_relocate` script as described in Step 2b, using the same values.

   3e Repeat Step 3a through Step 3d until all of the OES nodes are configured for iPrint.

Setting Up iPrint on the OES iPrint Cluster Resource

1 In iManager, select **iPrint > Create Driver Store**, then create a Driver Store on the OES node where the iPrint cluster resource is active.

See "Creating a Driver Store" in the *OES 2018 SP2: iPrint Administration Guide*.

Use the IP or DNS name of the shared NSS pool resource that you created in "Preparing the OES Nodes for iPrint" on page 73 as the **Target Server**. For the **eDirectory Server Name**, choose an eDirectory server that holds a copy of the replica where the Printer Agents will be created.

2 In iManager, select **iPrint > Create Print Manager**, then create a Print Manager on the OES node where the iPrint cluster resource is active.

See "Creating a Print Manager" in the *OES 2018 SP2: iPrint Administration Guide*.

Use the IP or DNS name of the shared NSS pool resource that you created in "Preparing the OES Nodes for iPrint" on page 73 as the **iPrint Service**. For the **eDirectory Server Name**, choose same server that you specified for the Driver Store. Deselect the **Start print manager after creation** option.

Setting Up Preferred Nodes for the OES iPrint Cluster Resource

Configure the Preferred Nodes list for the Linux shared NSS pool cluster resource to prevent an inadvertent failback of the resource to a NetWare server.

1 In iManager, click **Clusters > Cluster Manager**, then select the cluster where the Linux shared NSS pool resource is currently active.

2 Select the link for the OES shared NSS pool cluster resource to open its Properties page.

3 Go to the **Preferred Nodes** tab.

4 Move all of the NetWare nodes from the **Assigned Nodes** list to **Unassigned Nodes** list.

5 Click **OK** to save your changes.

Editing the Load and Unload Scripts for the OES iPrint Cluster Resource

Edit the load and unload scripts for the OES iPrint cluster resource.

1 Edit the load script. Add the following lines to the existing load script before the `exit 0` statement

```
ignore_error mv /media/nss/NSSVOL1/var/opt/novell/iprint/iprintgw.lpr /
media/nss/NSSVOL1/var/opt/novell/iprint/iprintgw.lpr.bak
```

NOTE: Replace `/media/nss/NSSVOL1` in the above command with your actual cluster volume mount point.

```
exit_on_error rcnovell-idsd start
exit_on_error rcnovell-ipsmd start
```

The daemons can also be started by using the file path `/etc/init.d/novell-idsd start` and `/etc/init.d/novell-ipsmd start`.

2 Edit the unload script. Add the following lines to the existing unload script after the `/opt/novell/ncs/lib/ncsfuncs` statement:

```
ignore_error rcnovell-ipsmd stop
ignore_error rcnovell-idsd stop
```

The daemons can also be stopped by using the file path `/etc/init.d/novell-ipsmd stop` and `/etc/init.d/novell-idsd stop`.

3 Activate the load and unload scripts by taking the resource offline, then bringing the resource online.

Verifying the Status of the iPrint Setup

Verify that the iPrint cluster resource is working by cluster migrating the OES iPrint cluster resource to each OES node in turn and performing the following checks:

1 Log in as the `root` user on the OES node where the iPrint cluster resource is active, then open a terminal console.

2 Check the status of the Print Manager and Driver Store.

```
rcnovell-ipsmd status
```

```
rcnovell-idsd status
```

3 Test the ability of `iprntman` to authenticate the admin user (or other user given with `miggui`).

```
iprntman psm -l -u admin
```

4 Cluster migrate the iPrint cluster resource to another OES node by entering

```
cluster migrate resource_name node_name
```

5 Repeat this check for each OES node in the mixed-mode cluster.

Migrating the iPrint Cluster Resource from NetWare to OES

After iPrint is configured for the OES nodes, you are ready to migrate the iPrint Driver Store and Print Manager information from the NetWare iPrint cluster resource to the OES iPrint cluster resource.

Perform the following steps in "Migrating an iPrint Cluster Resource" in the *OES 2018 SP2: Migration Tool Administration Guide*.

1 Perform the pre-migration checks as described in "Pre-Migration iPrint Configuration" in the *OES 2018 SP2: Migration Tool Administration Guide*.

2 Perform a consolidated migration of the iPrint service as described in "iPrint Consolidate Migration" in the *OES 2018 SP2: Migration Tool Administration Guide*.

Start the Migration Tool from the target server (the OES node where the iPrint cluster resource is active).

For the source server, authenticate by using the IP address or DNS name of the NetWare iPrint cluster resource.

For the target server, authenticate by using the IP address or DNS name of the Linux iPrint cluster resource.

3 Verify that the migration was successful as described in "Verifying the Result of the iPrint Migration" in the *OES 2018 SP2: Migration Tool Administration Guide*.

4 Transition the Transition end-user printing from NetWare to Linux.

- Offline the NetWare iPrint cluster resource.
- View the NetWare iPrint cluster load script's /DNSNAME value.
- Configure DNS to resolve the /DNSNAME value to the IP address of the target Linux cluster resource hosting the Print Manager.

  NOTE: The propagation of the DNS change might take time, depending on your network.

  DNSNAME is the address that the clients use to find the NetWare Print Manager. The same DNSNAME is used to find the Linux Print Manager.
- Update each of the Linux node `/etc/hosts` files to resolve to the Linux iPrint cluster IP address.
- Update the `/etc/opt/novell/iprint/conf/ipsmd.conf` PSMHostAddress value to the /DNSNAME.
- Restart the Print Manager.

5 (Optional) Perform the post-migration steps as described in "Transfer ID" and "Migrating an iPrint Cluster Resource" in the *OES 2018 SP2: Migration Tool Administration Guide*.

For detailed information about iPrint migration requirements, pre-migration configuration, migration procedures, post-migration tasks, and troubleshooting, see "Migrating iPrint to OES 2018 SP2" in the *OES 2018 SP2: Migration Tool Administration Guide*.

Finalizing the Cluster Conversion

After your OES iPrint setup is working as expected, finalize the cluster conversion, as described in "Finalizing the Cluster Conversion" on page 39.

Additional Information

See the following Novell Support Technical Information Documents (TIDs) in the Novell Knowledgebase for more information about migrating iPrint from NetWare to OES:

- *TID 7005448: Migrating an iPrint Cluster from NetWare to OES 2* (http://www.novell.com/support/)
- *TID 7004455:* iPrint Migration Best Practices (http://www.novell.com/support/)

13 MySQL

SUSE Linux Enterprise Server (SLES) 11 Service Pack 4 (SP4) and Novell Open Enterprise Server 2015 SP1 provide an open source version of the MySQL 5.5.*x* software that is offered under the GNU General Public License (GPL) Version 2. Version 5.0.*x* is available on SLES 11 SP2 and OES 11 SP1, and earlier versions. MySQL can be used with Novell Cluster Services to provide high availability support to the customers you service with MySQL. This helps prevent interruptions of access for the MySQL database.

IMPORTANT: As stated in the *Release Notes for SUSE Linux Enterprise Server 11* SP4 and earlier (http://www.novell.com/linux/releasenotes/x86_64/SUSE-SLES/11-SP4/), the open source MySQL packages require additional support contracts to be obtained by the customer in order to receive full support.

The MySQL database format is upgraded from version 5.0 to version 5.5 in SUSE Linux Enterprise Server 11 SP3 and OES 11 SP2 and later versions. For information about upgrading the database format, see "Upgrading from MySQL 5.0 to MySQL 5.5 Introduces a New Database Format" in the *OES 2015 SP1: Web Services and Applications Guide*.

MySQL is installed on all nodes where you want it to run, but a database runs on only one node in the cluster at a time. The MySQL configuration files are modified on each node to point to a path on a Linux Logical Volume Manager (LVM) volume group cluster resource that contains the MySQL database files. You cluster-enable the volume group by using the MySQL template, then configure its resource load, unload, and monitoring scripts, set its resource failover and failback modes, and assign the resource to specific nodes in the cluster. When a node fails where the resource is online, the resource fails over to the next preferred node in the cluster.

IMPORTANT: Refer to the official MySQL 5.5 documentation for information about configuring, managing, and using MySQL. For information, see the MySQL Documentation Library: MySQL Reference Manuals (http://dev.mysql.com/doc/).

The instructions in this section describes how to set up MySQL in a Novell Cluster Services cluster.

- "Prerequisites for Clustering MySQL" on page 80
- "Installing and Enabling MySQL" on page 80
- "Creating an LVM Volume Group and Logical Volume" on page 83
- "Configuring MySQL on the LVM Logical Volume" on page 88
- "Cluster-Enabling MySQL on the Logical Volume" on page 90
- "File Location" on page 93
- "Security Considerations for the MySQL Configuration" on page 94
- "Additional Information" on page 95

Prerequisites for Clustering MySQL

The following setup is required for clustering the MySQL database files with Novell Cluster Services:

- ❒ Novell Cluster Services must be installed and configured as described in "Installing, Configuring, and Repairing OES Cluster Services" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.
- ❒ MySQL must be installed on every node in the cluster where you want MySQL to run. The installation is described in "Installing and Enabling MySQL" on page 80.
- ❒ The SAN device that you want to use for the MySQL database must be accessible to all nodes in the cluster. It will be activated on only one node at a time.
- ❒ You must create a shared Linux Logical Volume Management (LVM) volume group where you will store the MySQL database and configuration file. This setup is described in "Creating an LVM Volume Group and Logical Volume" on page 83.

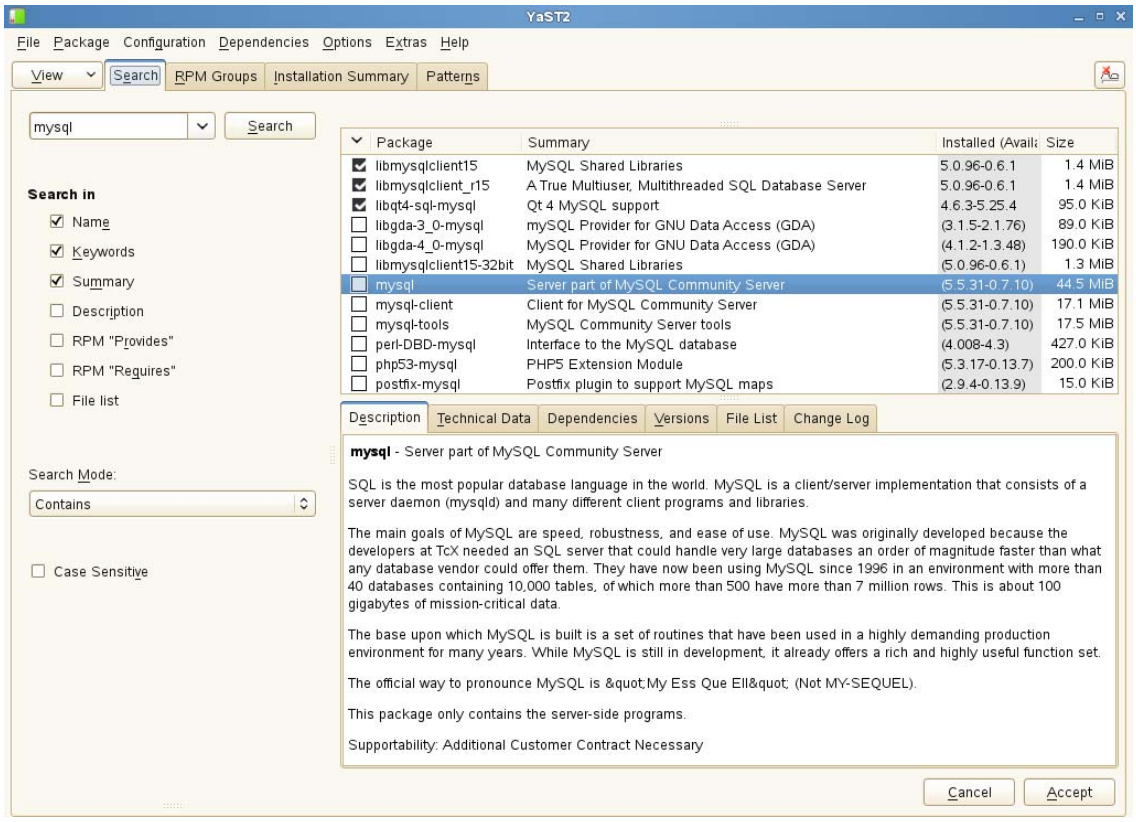
Installing and Enabling MySQL

Before you configure MySQL with Novell Cluster Services, MySQL must be installed and configured properly on all servers in the cluster where you intend to run it. You can use the YaST Software Management tool to install the MySQL and the MySQL Client packages. Other MySQL packages are available that allow you to use MySQL with Perl, PHP, Postfix, or Python, but this guide does not cover their installation or use.

Package	Description
`mysql`	Provides the MySQL software and database.
`mysql-client`	Provides the MySQL client command line program that acts as a text-based front end for the MySQL Server. It is used for issuing queries and viewing the results interactively from a terminal window
`msql-Max`	Provides the MySQL software, database, and the following features for users that require transaction support: ◆ Berkeley database (BDB) tables ◆ InnoDB tables These features provide transaction-safe tables to which locks are applied while a series of SQL queries is made. The series of queries is referred to as a transaction.
`perl-DBD-mysql`	Provides a MySQL database driver (DBD) to support a database-independent interface (DBI) for the Perl programming language.
`php5-mysql`	Provides a PHP plug-in that allows an Apache HTTP server to access a MySQL database.
`postfix-mysql`	Provides a Postfix plug-in that allows a Postfix mail system to access a MySQL database.
`python-mysql`	Provides a Python plug-in that allows you to execute SQL queries on a MySQL database through your Python application.

Use the following procedure to install the `mysql` and `mysql-client` packages, and enable MySQL on each node in the cluster:

1. Log in to the server as the Linux `root` user, then open YaST.
2. Ensure that the SUSE Linux Enterprise Server 11 SP*x* installation CD is mounted on the server.
3. In YaST, select **Software > Software Management**, then click the **Search** tab.
4. To find the components, type `mysql` in the **Search** field, then click **Search**.
5. In the **Package** list, select `mysql` and `mysql-client`.



6. Click **Accept**, then click **Continue** for each component to confirm that you want to install it.

   YaST does the following:

   - Installs the MySQL Server and MySQL Client software.

     The software is not enabled by default, and the MySQL daemon is not running at this time. No run levels are set.

   - Creates the MySQL root user (a user internal to the MySQL system) as a superuser that has access rights to perform any function in MySQL. Initially, this user has no password assigned.
   - Creates a default path `/var/lib/mysql` for storing databases that you create later. Initially, this directory is empty. It is populated later when you enable the MySQL service.
   - Creates the `mysql` user and group on the server and makes them the owners of the default data directory `/var/lib/mysql` and its contents.

- Creates a default mount point `/mnt/mysql` for the database. This is where you will mount the LVM logical volume that you create for the database in "Creating an LVM Volume Group and Logical Volume" on page 83.
- Creates the default MySQL configuration file (`/etc/my.cnf`).

7 In YaST, enable the MySQL service:

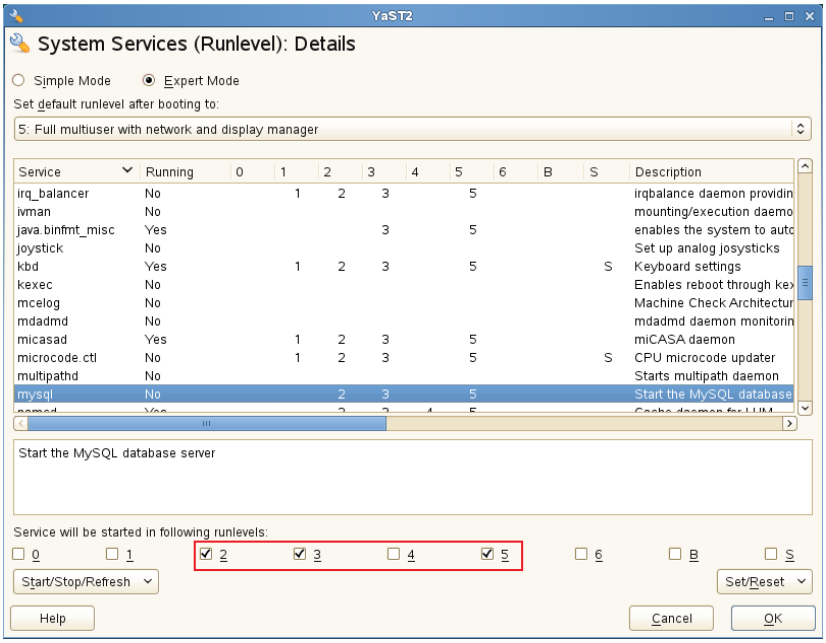
7a Select **System > System Services (Runlevel)**.

7b Select **Expert Mode**.

7c In the **Service** list, select the `mysql` daemon.

7d Click **Set/Reset > Enable the Service**.

Under **Service will be started in the following runlevels**, notice that the 2, 3, and 5 check boxes are selected by default. You don't want the service to start on system boot because it starts when the cluster resource is brought online on a cluster node.



7e In the lower right corner, click **OK**.

7f When you are prompted to confirm the changes, click **Yes** to save them.

7g Exit YaST.

8 Stop the MySQL daemon from running. In a terminal console, enter the following as the Linux `root` user:

```
/etc/init.d/mysql stop
```

Alternatively, you can use the `rcmysql stop` command.

9 Repeat Step 1 through Step 8 on each node in the cluster to install and enable MySQL.

10 After you have installed and enabled MySQL on all servers in the cluster, continue with "Creating an LVM Volume Group and Logical Volume" on page 83.

Creating an LVM Volume Group and Logical Volume

After you have installed MySQL, you are ready to set up the LVM volume group and logical volume where you will store a MySQL database. Sample values are used in the procedures in this section to help you understand what is required at each step. The overview provides only the Linux commands that you need to create and prepare the volume group for use by MySQL. The detailed description provides more information about the process, including the syntax and sample commands.

- "Sample Values" on page 83
- "Setting Up the VG and LV (Overview)" on page 83
- "Setting up the VG and LV (Detailed)" on page 84

Sample Values

The procedures in this section use the following parameters. Ensure that you replace the sample values with your values. The first node in the cluster is where you configure MySQL and the cluster resource.

Parameter	Sample Value
LVM physical volume	`/dev/sdd`
LVM volume group name	`mysqlvg`
LVM logical volume	`msqllv`
File system type	`ext3` This is the file system type that you make on the LVM logical volume, such as `btrfs`, `ext2`, `ext3`, `reiserfs`, or `xfs`.
Logical volume path	`/dev/mysqlvg/mysqllv`
Mount point for the logical volume	`/mnt/mysql`
Default MySQL root path	`/var/lib/mysql`
New MySQL root path	`/mnt/mysql/var/lib/mysql`

Setting Up the VG and LV (Overview)

You can create the volume group and logical volume by issuing the following LVM commands as the `root` user on the cluster node. This overview of the process uses the sample values. Ensure that you substitute your own values in the commands. For details, see "Setting up the VG and LV (Detailed)" on page 84.

Command Action	Command
1. Create the LVM physical volume.	`pvcreate /dev/sdd`
2. Create the clustered LVM volume group.	`vgcreate -c y mysqlvg /dev/sdd`

Command Action	Command
3. Activate the volume group exclusively on the node.	`vgchange -a ey mysqlvg`
4. Create the LVM logical volume.	`lvcreate -n mysqllv -L size mysqlvg`
5. Add a file system to the LVM logical volume.	`mkfs -t ext3 /dev/mysqlvg/mysqllv [fs_options]`
6. Create a mount point for the logical volume.	`mkdir /mnt/mysql` You must also create this path on each node in the cluster.
7. Mount the LVM logical volume.	`mount -t ext3 /dev/mysqlvg/mysqllv / mnt/mysql`

8. Create the directory structure for the MySQL database files on the mounted logical volume.	`cd /mnt/mysql`
	`mkdir /mnt/mysql/var`
	`mkdir /mnt/mysql/var/lib`
	`mkdir /mnt/mysql/var/lib/mysql`

9. Modify the file ownership of the mount point and subdirectories.	`chown -R mysql:mysql /mnt/mysql`
10. Deactivate the LVM logical volume.	`vgchange -a n mysqlvg`

Setting up the VG and LV (Detailed)

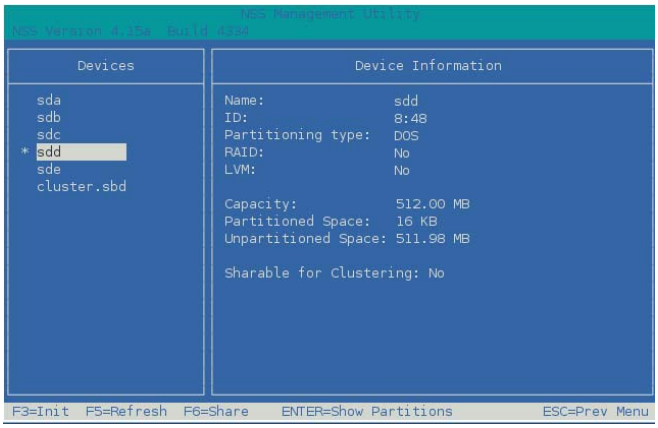
The following procedure provides detailed instructions for creating the LVM volume group and logical volume:

1. Log in as the Linux `root` user to the first node of the cluster, then open a terminal console.
2. In NSSMU, initialize the SAN device that you want to use for the MySQL database, but do not mark it as shareable for clustering:
   - **2a** At the console prompt, launch NSSMU by entering:

     `nssmu`
   - **2b** Select **Devices**, then press Enter.
   - **2c** In the **Devices** list, select the unpartitioned device that you want to use, then press F3 to initialize it.
   - **2d** Read the advisory, then press Y to confirm that you want to initialize the device.
   - **2e** Specify the Master Boot Record (MBR) type as DOS or GPT, then press Enter.

     Typically, you use DOS format for devices up to 2 TB. You use GPT for devices greater than 2 TB.

2f Verify that the device is initialized and that it is unshared (that is, **Shareable for Clustering** is set to **No**).



2g Exit NSSMU to return to the command prompt.

3 Create an LVM physical volume on the device (such as `/dev/sdd`) by entering:

```
pvcreate <device>
```

For example:

```
pvcreate /dev/sdd
  No physical volume label read from /dev/sdd
  Physical volume "/dev/sdd" successfully created
```

4 Create an LVM volume group (such as `mysqlvg`) on the physical volume by entering:

```
vgcreate -c y <vg_name> <device>
```

For example:

```
vgcreate -c y "mysqlvg" /dev/sdd
  Clustered volume group "mysqlvg" successfully created
```

The volume group is automatically activated.

5 Activate the volume group exclusively on the current server by entering:

```
vgchange -a ey <vg_name>
```

The `-a` option activates the volume. The `ey` parameter specifies the values `exclusively` and `yes`.

For example:

```
vgchange -a ey mysqlvg
```

6 View information about the volume group by using the `vgdisplay` command:

```
vgdisplay <vg_name>
```

Notice that 4 MB of the device are used for the volume group's Physical Extent (PE) table. You must consider this reduction in available space on the volume group when you specify the size of the LVM logical volume in the next step (Step 7).

For example:

```
vgdisplay mysqlvg
  --- Volume group ---
  VG Name               mysqlvg
  System ID
  Format                lvm2
  Metadata Areas        1
  Metadata Sequence No  1
  VG Access             read/write
  VG Status             resizable
  MAX LV                0
  Cur LV                0
  Open LV               0
  Max PV                0
  Cur PV                1
  Act PV                1
  VG Size               508.00 MB
  PE Size               4.00 MB
  Total PE              127
  Alloc PE / Size       0 / 0
  Free  PE / Size       127 / 508.00 MB
  VG UUID               rqyAd3-U2dg-HYLw-0SyN-loO7-jBH3-qHvySe
```

7 Create an LVM logical volume (such as `mysqllv`) on the volume group by entering:

`lvcreate -n <lv_name> -L size <vg_name>`

Specify the logical volume name, size, and the name of the volume group where you want to create it. The size is specified in megabytes by default.

The logical volume full path name is `/dev/<vg_name>/<lv_name>`.

For example:

```
lvcreate -n "mysqllv" -L 500 "mysqlvg"
  Logical volume "mysqllv" created
```

This volume's full path name is `/dev/mysqlvg/mysqllv`.

8 View information about the logical volume by entering:

`lvdisplay -v <lv_path_name>`

For example:

```
lvdisplay -v /dev/mysqlvg/mysqllv
    Using logical volume(s) on command line
  --- Logical volume ---
  LV Name                /dev/mysqlvg/mysqllv
  VG Name                mysqlvg
  LV UUID                nIfsMp-alRR-i4Lw-Wwdt-v5io-2hDN-qrWTLH
  LV Write Access        read/write
  LV Status              available
  # open                 0
  LV Size                500.00 MB
  Current LE             125
  Segments               1
  Allocation             inherit
  Read ahead sectors     auto
  - currently set to     1024
  Block device           253:1
```

9 Create a file system (such as BtrFS, Ext2, Ext3, ReiserFS, or XFS) on the LVM logical volume by entering:

```
mkfs -t <fs_type> <lv_path_name> [fs_options]
```

You can specify file system options according to the type of file system you are making. For information, see the `mkfs(8)` man page and the related man page for the file system type, such as `mkfs.btrfs(8)`, `mkfs.ext2(8)`, `mkfs.ext3(8)`, `mkfs.reiserfs(8)`, or `mkfs.xfs(8)`.

For example:

```
mkfs -t ext3 /dev/mysqlvg/mysqllv
  mke2fs 1.41.9 (22-Aug-2009)
  Filesystem label=
  OS type: Linux
  Block size=1024 (log=0)
  Fragment size=1024 (log=0)
  128016 inodes, 512000 blocks
  25600 blocks (5.00%) reserved for the super user
  First data block=1
  Maximum filesystem blocks=67633152
  63 block groups
  8192 blocks per group, 8192 fragments per group
  2032 inodes per group
  Superblock backups stored on blocks:
    8193, 24577, 40961, 57345, 73729, 204801, 221185, 401409
  Writing inode tables: done
  Creating journal (8192 blocks): done
  Writing superblocks and filesystem accounting information: done

  This filesystem will be automatically checked every 29 mounts or
    180 days, whichever comes first.  Use tune2fs -c or -i to override.
```

10 Create a mount point for the logical volume by entering:

```
mkdir /mnt/mysql
```

11 Mount the logical volume on the MySQL mount point by entering:

```
mount -t <fs_type> <lv_path_name> <mount_point>
```

For example:

```
mount -t ext3 /dev/mysqlvg/mysqllv /mnt/mysql
```

12 Go to the mount point location (`/mnt/mysql`), then create the `/var/lib/mysql` subdirectory structure by entering:

```
cd /mnt/mysql
mkdir /mnt/mysql/var
mkdir /mnt/mysql/var/lib
mkdir /mnt/mysql/var/lib/mysql
```

13 Change the owner and group owner of the `/mnt/mysql` directory and its contents to use the `mysql` user and group. Enter the `chown` command with the recursive (`-R`) option:

```
cd /mnt
chown -R mysql:mysql mysql
```

Another way to do this is to explicitly specify the directory path:

```
chown -R mysql:mysql /mnt/mysql
```

14 Continue with "Configuring MySQL on the LVM Logical Volume" on page 88.

Configuring MySQL on the LVM Logical Volume

MySQL databases are usually located in a subdirectory of the `/var/lib/mysql/` directory. If you create a database named `test`, the database files are located in the `/var/lib/mysql/test` directory.

In order for MySQL to take advantage of the benefits provided by Novell Cluster Services, you must make some configuration changes to MySQL. On the first server, you copy the default MySQL configuration file (`/etc/my.cnf`) to the LVM logical volume, modify `/mnt/mysql/var/lib/mysql/my.cnf` file so that all `datadir` entries are commented out, then create a MySQL database on the LVM Logical volume.

The following instructions assume that you have not created a database on the server at this time. If a MySQL database currently exists in the default `/var/lib/mysql` location, the database's directory and its contents must be relocated to the new `/mnt/mysql/var/lib/mysql` path, rather than creating it as described in Step 6 on page 89 of the following procedure. Afterwards, ensure that you modify the ownership of the folder and files to the `mysql` user and group by using the `chown` command as illustrated in Step 13 of "Creating an LVM Volume Group and Logical Volume" on page 83.

IMPORTANT: After you have modified the MySQL configuration file to use the LVM logical volume path, you should always exclusively activate the volume group on the server before attempting to start the MySQL daemon. The cluster resource does this automatically in the load script.

To configure a MySQL database on the LVM logical volume:

1. Log in as the Linux `root` user on the first node, then open a file browser or terminal console.
2. Copy the default `/etc/my.cnf` configuration file to the `/mnt/mysql/var/lib/mysql` directory:

   ```
   cp /etc/my.cnf /mnt/mysql/var/lib/mysql
   ```

3. In a text editor, modify the `/mnt/mysql/var/lib/mysql/my.cnf` file and comment out any data directory entries, then save your changes. For example:

   ```
   # datadir=
   ```

4. Change the permissions on the `/mnt/mysql/var/lib/mysql/my.cnf` file to Read and Execute for each permission level, and change the ownership to the `mysql` user and group:

   ```
   chmod 555 /mnt/mysql/var/lib/mysql/my.cnf
   ```

   ```
   chown mysql:mysql /mnt/mysql/var/lib/mysql/my.cnf
   ```

   You can view these settings by using the `ll` *<filepath>* command. For example:

   ```
   ll /mnt/mysql/var/lib/mysql/my.cnf
     -r-xr-xr-x 1 mysql mysql 6297 2011-07-08 14:19 /mnt/mysql/var/lib/
   mysql/my.cnf
   ```

5. Open a terminal console as the Linux `root` user, then start MySQL:

   ```
   /etc/init.d/mysql start
   ```

   Another option is to use the `rcmysql start` command.

6. Create a database named `data` on the LVM logical volume:

   ```
   mysql_install_db --datadir=/mnt/mysql/var/lib/mysql/data --user=mysql
   ```

7. Set the ownership of the `data` database to be the `mysql` user and group:

   ```
   chown -R mysql:mysql /mnt/mysql/var/lib/mysql/data
   ```

8. Stop the MySQL daemon from running:

   ```
   /etc/init.d/mysql stop
   ```

   Another option is to use the `rcmysql stop` command.

9. Deactivate the LVM volume group:

   ```
   vgchange -a n <vg_name>
   ```

   For example:

   ```
   vgchange -a n mysqlvg
   ```

10. Continue with “Cluster-Enabling MySQL on the Logical Volume” on page 90.

Cluster-Enabling MySQL on the Logical Volume

Now that you have configured MySQL for the LVM logical volume, you are ready to cluster-enable MySQL. In iManager, you use the Novell Cluster Services MySQL template to create a cluster resource for the LVM volume group that contains the MySQL database. The resource's load script starts the MySQL daemon when the resource is brought online, and the unload script stops it when the resource is taken offline.

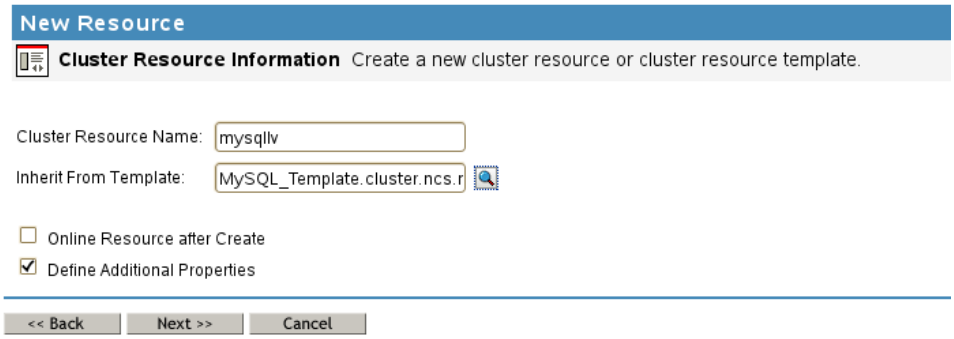
The sample scripts in this section use the following sample parameters. Ensure that you replace the sample values with your values.

Parameter	Sample Value
Resource IP Address	10.10.10.44
MOUNT_FS	`ext3` This is the file system you created on the LVM volume group, such as `btrfs`, `ext2`, `ext3`, `reiserfs`, or `xfs`.
VOLGROUP_NAME	`mysqlvg`
MOUNT_DEV	`/dev/$VOLGROUP_NAME/mysqllv`
MOUNT_POINT	`/mnt/mysql`
MySQL_ROOT	`$MOUNT_POINT/var/lib/mysql`

Use the following procedure to create the MySQL cluster resource for the LVM volume group:

1. In iManager, select **Clusters > Cluster Options**, then browse to select the cluster.
2. Under the **Cluster Objects** title, click **New**.
3. On the **New Resource > Resource Type** page, specify **Resource** as the type, then click **Next**.
4. On the **New Resource > Cluster Resource Information** page, specify a cluster resource name, browse to select the **MySQL_Template,** then click **Next**.

   Do not select **Online Resource after Create**. You must configure the resource scripts and settings before bringing the resource online.



5 On the Load Script page, modify the definition fields for your MySQL resource, file system type, volume group name, logical volume name, and mount point, then click **Next**.

The following load script uses the sample values from the MySQL setup:

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs

# define the IP address
RESOURCE_IP=10.10.10.44
# define the file system type
MOUNT_FS=ext3
#define the volume group name
VOLGROUP_NAME=mysqlvg
# define the device
MOUNT_DEV=/dev/$VOLGROUP_NAME/mysqllv
# define the mount point
MOUNT_POINT=/mnt/mysql

# define MySQL database root
MySQL_ROOT=$MOUNT_POINT/var/lib/mysql

#activate the volume group
exit_on_error vgchange -a ey $VOLGROUP_NAME

# mount the file system
exit_on_error mount_fs $MOUNT_DEV $MOUNT_POINT $MOUNT_FS

# add the IP address
exit_on_error add_secondary_ipaddress $RESOURCE_IP

# start MySQL
/usr/bin/mysqld_safe --user=mysql --pid-file=$MySQL_ROOT/mysql.pid --
socket=$MySQL_ROOT/mysql.sock --datadir=$MySQL_ROOT --bind-
address=$RESOURCE_IP &>/dev/null &

# return status
exit 0
```

6 On the Unload Script page, modify the definition fields for your MySQL resource, file system type, volume group name, logical volume name, and mount point, then click **Next**.

The following unload script uses the sample values from the MySQL setup:

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs

# define the IP address
RESOURCE_IP=10.10.10.44
# define the file system type
MOUNT_FS=ext3
#define the volume group name
VOLGROUP_NAME=mysqlvg
# define the device
MOUNT_DEV=/dev/$VOLGROUP_NAME/mysqllv
# define the mount point
MOUNT_POINT=/mnt/mysql

# define MySQL database root
MySQL_ROOT=$MOUNT_POINT/var/lib/mysql

# request MySQL stop
ignore_error killproc -p $MySQL_ROOT/mysql.pid -TERM /usr/sbin/mysqld

# del the IP address
ignore_error del_secondary_ipaddress $RESOURCE_IP

# umount the file system
sleep 10 # if not using SMS for backup, please comment out this line
exit_on_error umount_fs $MOUNT_DEV $MOUNT_POINT $MOUNT_FS

#deactivate the volume group
exit_on_error vgchange -a n $VOLGROUP_NAME

# return status
exit 0
```

7 On the Monitoring Script page, modify the definition fields for your MySQL resource, file system type, volume group name, logical volume name, and mount point, then click **Next**.

The following monitoring script uses the sample values from the MySQL setup:

```
#!/bin/bash
. /opt/novell/ncs/lib/ncsfuncs

# define the IP address
RESOURCE_IP=10.10.10.44
# define the file system type
MOUNT_FS=ext3
#define the volume group name
VOLGROUP_NAME=mysqlvg
# define the device
MOUNT_DEV=/dev/$VOLGROUP_NAME/mysqllv
# define the mount point
MOUNT_POINT=/mnt/mysql
```

```
# define MySQL database root
MySQL_ROOT=$MOUNT_POINT/var/lib/mysql

#check the logical volume
exit_on_error status_lv $MOUNT_DEV

# check the file system
exit_on_error status_fs $MOUNT_DEV $MOUNT_POINT $MOUNT_FS

# check the IP address
exit_on_error add_secondary_ipaddress $RESOURCE_IP

# check MySQL
exit_on_error checkproc -p $MySQL_ROOT/mysql.pid /usr/sbin/mysqld


# return status
exit 0
```

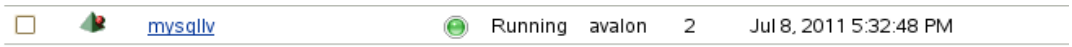
8 On the Resource Policies page, specify the **Resource Behavior**, **Start Mode**, **Failover Mode**, and **Failback Mode**, then click **Next**.

   For information about these fields, see "Configuring the Start, Failover, and Failback Modes for Cluster Resources" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

9 On the Resource Preferred Nodes page, assign the nodes where MySQL is installed, then click **Finish**.

   The resource appears in the Cluster Objects list:

10 Bring the MySQL resource online. Select **Clusters** > **Cluster Manager**, select the MySQL resource check box, then click **Online**.



   If the resource goes comatose, offline the resource, then open its properties page and re-verify the scripts.

File Location

During the MySQL installation, the following files are unpacked or created by YaST:

MySQL Component	Default Location in OES
MySQL daemon for start, stop, and restart commands	`/etc/init.d/mysql`
Configuration files	`/etc/my.cnf` `/etc/mysqlaccess.conf`
Database files	`/var/lib/mysql`
Man pages	`/usr/share/man/man1`
Documentation (*MySQL Readme*)	`/usr/share/doc/packages/mysql`

MySQL Component	Default Location in OES
Log file	`/var/lib/mysql/mysqld.log` The MySQL log file can also be accessed via a hard link from `/var/log/mysqld.log`.

Software	Some of the software components might not appear in this location until after you enable the service.
	
	`/usr/bin/mysql`
	`/usr/bin/mysqladmin`
	`/usr/bin/mysqlbinlog`
	`/usr/bin/mysqlbug`
	`/usr/bin/mysqlcheck`
	`/usr/bin/mysqld_multi`
	`/usr/bin/mysqld_safe`
	`/usr/bin/mysqldump`
	`/usr/bin/mysqldumpslow`
	`/usr/bin/mysql_fix_extensions`
	`/usr/bin/mysql_fix/privilege_tables`
	`/usr/bin/mysqlimport`
	`/usr/bin/mysql_install_db`
	`/usr/bin/mysql_secure_installation`
	`/usr/bin/mysqlshow`
	`/usr/bin/mysqlupgrade`
	`/usr/bin/my_print_defaults`
	`/usr/bin/myisamcheck`
	`/usr/bin/myisam_ftdump`
	`/usr/bin/myisamlog`
	`/usr/bin/myisampack`

Security Considerations for the MySQL Configuration

Consider the security measures in this section when working with MySQL.

- "MySQL Ports" on page 94
- "Securing MySQL" on page 94

MySQL Ports

MySQL uses port 3306 by default. Additional ports are assigned sequentially as 3307, 3308, and so on. These ports must be open in the firewall in order to allow remote access to the MySQL database.

Securing MySQL

The default installation of MySQL provides some configuration settings, an anonymous user, and the `test` database that can possibly compromise security in a production environment:

- The root user can connect from the local host or remotely.
- An anonymous user is also created and can connect from the local host or remotely.

- Any local user on the server can connect to the `test` database without a password and be treated as the anonymous user.
- The anonymous user can perform any function on any databases named `test` or with a name that begins with `test_`.

For production servers, we recommend that you secure your MySQL service by setting a password for the MySQL root user. This is a password for the MySQL administrator user, which is a root user within the MySQL system. It is not the Linux `root` user.

1 To set the password and log in to MySQL on the server, enter the following commands:

```
/usr/bin/mysqladmin -u root password <new_password>
/usr/bin/mysqladmin -u root -h <server_fdn_name> password
<new_password>
```

For example:

```
/usr/bin/mysqladmin -u root password novell
/usr/bin/mysqladmin -u root -h myserver1.europe.example.com password
novell
```

Alternatively, you can run the `mysql_secure_installation` command as the Linux `root` user, complete the fields that make sense for your MySQL configuration, then use:

```
/usr/bin/mysql_secure_installation
```

We recommend that you configure the following secure settings:

- Set a password for the MySQL root user.
- Remove MySQL anonymous users.
- Disallow remote login for the MySQL root user.

  The MySQL root user is allowed to connect to the database, but only from the local host.
- Remove the `test` database.
- Reload the Privileges table.

Additional Information

The following resources are available to help you manage and use MySQL:

- *MySQL 5.5 Reference Manual* (http://dev.mysql.com/doc/refman/5.5/en/index.html) from the MySQL Documentation Library (http://dev.mysql.com/doc/)
- After you have installed MySQL and the MySQL client on the server, the following man pages are available for MySQL utilities by entering the `man <mysql_utility>` command:
  - `mysql(1)`
  - `mysqladmin(1)`
  - `mysqlbinlog(1)`
  - `mysqlbug(1)`
  - `mysqlcheck(1)`
  - `mysqld_multi(1)`

- mysqld_safe(1)
- mysqldump(1)
- mysql_fix_extensions(1)
- mysql_fix_privileg_tables(1)
- mysqlimport(1)
- mysql_install_db(1)
- mysqlsecure_installation(1)
- mysqlshow(1)
- mysqlupgrade(1)

14 Novell Storage Services Pools

Consider the guidelines in this section when converting Novell Storage Services (NSS) pool cluster resources from NetWare 6.5 SP8 to Open Enterprise Server (OES) 2015 SP1.

- "NSS Pool Cluster Migration" on page 97
- "NSS File System Migration to NCP Volumes or Linux POSIX File Systems" on page 97
- "Estimated Time Taken to Build the Trustee File on Linux" on page 97
- "Using Antivirus Software for NSS and NCP Volumes on Linux" on page 98

NSS Pool Cluster Migration

In the mixed-mode cluster, NSS pool cluster resources created on NetWare can be failed over or cluster migrated to nodes that are running OES where NSS is installed and running.

For information about NSS differences in OES 11 and later, see "NSS Pools (Storage Manager)" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.

Some NSS features are not available or work differently on Linux. See "Cross-Platform Issues for NSS" in the *OES 2018 SP2: NSS File System Administration Guide for Linux*.

Pool snapshots use different technologies on NetWare and Linux. Pool snapshots are not supported for shared pools on Linux.

IMPORTANT: Ensure that you delete pool snapshots for all clustered pools before you begin the cluster conversion.

NSS File System Migration to NCP Volumes or Linux POSIX File Systems

To move data from NSS file systems on NetWare to NCP volumes or to Linux POSIX file systems on Linux, you must use the Migration tool. See "Migrating File Systems to OES 2018 SP2" in the *OES 2018 SP2: Migration Tool Administration Guide*.

Estimated Time Taken to Build the Trustee File on Linux

On Linux, NCP Server stores file system trustees and rights information in the `._NetWare/.trustee_database.xml` file at the root of each NSS volume or NCP volume. The NSS file system also stores this information in its file system metadata as it does on NetWare. This database file is updated when you:

- Add file system trustees and rights

- Delete file system trustees and rights
- Modify file system trustees and rights

When you migrate an NSS volume from NetWare to Linux, the trustee database file does not exist. NCP Server reads the trustee and rights information from the NSS file system metadata, validates the User object, and stores the settings in a `._NetWare/.trustee_database.xml` file at the root of the volume. The information collection process begins automatically when the NSS volume is mounted on the OES server.

Testing found that building the initial database on Linux for an existing volume takes about one minute per 50,000 storage objects. Testing was done on the following configuration for the target server:

HP DL380 G5

2 Quad-Core Intel Xeon CPU E5345 @ 2.33 GHz

12 GB RAM

1 Gigabit NIC

2 HBAs with 4 paths to the EMC DMX Symmetrix Storage with 4 gigabits per second (Gbps) bandwidth

To follow the synchronization between the file system and the trustee file, look for output in the `/var/opt/novell/log/ncp2nss.log` file.

Using Antivirus Software for NSS and NCP Volumes on Linux

For information about using antivirus software for NSS volumes and NCP volumes on your OES servers, see "McAfee Antivirus Requires Additional Configuration" in the *OES 2018 SP2: Planning and Implementation Guide*.

A Comparing Novell Cluster Services for Linux and NetWare

Table A-1 compares the features and capabilities of Novell Cluster Services on Open Enterprise Server (OES) 2015 SP1 and NetWare 6.5 SP8.

Table A-1 *Comparison of Novell Cluster Services for Linux and NetWare*

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
Operating system	OES 2015 SP1	NetWare 6.5 SP8
Two-node cluster with OES license	Yes	Yes
Up to 32 nodes in a single cluster with additional license	Yes	Yes
Guest servers on Xen VMs as cluster nodes	Yes	Yes
Guest servers on KVM VMs as cluster nodes	Yes	Yes
Guest servers on VMware as cluster nodes	Yes See *OES 2015 SP1: Novell Cluster Services Implementation Guide for VMware*.	Yes, where NetWare is supported by the VMware product
Novell Business Continuity Clustering support	BCC 2.0 for OES 11 SP1	BCC 1.1 SP2 for NetWare 6.5 SP8
Administrator users	The administrator user whose credentials you provide during the installation is the cluster administrator. The tree administrator user is not automatically given rights. Rights must be granted manually. See "Configuring Additional Administrators" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.	The administrator user whose credentials you provide during the installation is the cluster administrator. For NetWare, rights are automatically extended to the tree administrator user.
OES Common Proxy User	Supported	Not applicable
NCS_Management Group	Yes	Not applicable
Preferred list for LDAP servers	Yes; in the `/etc/opt/novell/ncs/clstrlib.conf` file	No

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
Directory-based cluster configuration	Yes; common schema for NetWare and Linux	Yes; common schema for NetWare and Linux
Directory schema extension during the first Novell Cluster Services installation in a tree	The user who installs the fist instance of Novell Cluster Services in a tree must have schema extension rights. The schema extension can be performed separately from the Novell Cluster Services installation by a user with schema extension rights. See "Extending the eDirectory Schema to Add Cluster Objects" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*. Afterwards, any administrator with sufficient rights can install Novell Cluster Services. See. "Assigning Install Rights for Container Administrators or Non-Administrator Users" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.	The user who installs the fist instance of Novell Cluster Services in a tree must have schema extension rights.
Forward migration for Novell Cluster Services	**OES 11 SP2 to OES 2015 SP1:** Down cluster and rolling cluster upgrade are supported. See "Upgrading OES Clusters" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*. **OES 2 SP3 to OES 2015 SP1:** Down cluster and rolling cluster upgrade are supported. Special handling is required for Linux POSIX file system cluster resources. See "Upgrading Clusters from OES 2 SP3 to OES 2018" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*.	**NetWare 6.5 SP7 to NetWare 6.5 SP8:** Down cluster and rolling cluster upgrade are supported. **NetWare 6.0 to NetWare 6.5 SP7 or later:** Down cluster and rolling cluster upgrade are supported. **NetWare 5.1 to NetWare 6.5 SP7 or later:** Only the down cluster upgrade is supported.
Cluster conversion from NetWare to Linux	**NetWare 6.5 SP8 to OES 2015 SP1:** Down cluster and rolling cluster conversion are supported. After all nodes have been converted, use the `cluster commit` command to finalize the conversion.	Not applicable

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
mixed-mode Linux and NetWare clusters	Supported only for rolling cluster conversions from NetWare to Linux.	Supported only for rolling cluster conversions from NetWare to Linux.
SBD (split-brain detector)	Yes; during the install on the first server in the cluster, or by using the sbdutil after the install and before adding a second node to the cluster.	Yes; during the install on the first server in the cluster.
Mirrored SBD	During the install. After the install and before adding a second node to the cluster by using the sbdutil and specifying two devices. Mirroring an existing SBD by using NLVM.	During the install on the first server in the cluster, or by using the sbdutil after the install.
Shared disks	Fibre Channel SAN LUNs iSCSI SAN LUNs SCSI disks (shared external drive arrays)	Fibre Channel SAN LUNs iSCSI SAN LUNs SCSI disks (shared external drive arrays)
Cluster-aware shared devices	Share devices by using NLVM, NSSMU, or the Storage plug-in to iManager.	Share devices by using NSSMU or the Storage plug-in to iManager.
Requires Novell Storage Services (NSS)	Required to use NLVM and NSSMU to manage devices, and to create NSS pools as cluster resources.	NSS is the default file system on NetWare. Novell Cluster Services is not supported on NetWare traditional volumes.
Volume manager for NSS pools	Novell Linux Volume Manager NLVM	NetWare Segment Manager
Volume manager for Linux POSIX file systems	Novell Linux Volume Manager NLVM	NetWare Segment Manager
Requires NCP (NetWare Core Protocol)	NCP Server is required for all storage resources that use NCP, including NSS pools, NCP volumes, and Dynamic Storage Technology shadow volume pairs. NCP is optional for clustered Linux LVM volume groups and volumes.	NCP is the default file access protocol on NetWare.

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
NSS pools as cluster resources	Yes See "Configuring and Managing Cluster Resources for Shared NSS Pools and Volumes" in the *OES 2018 SP2: OES Cluster Services for Linux Administration Guide*. Shareable for Clustering Multiple-Server Activation Prevention (MSAP) Cluster volume broker; Linux kernel module handles NSS pool events.	Yes See "Setting Up Cluster Resources for Novell Cluster Services" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Administration Guide*. Shareable for Clustering Multiple-Server Activation Prevention (MSAP) Cluster volume broker
Linux POSIX file systems as cluster resources	Yes See "Configuring and Managing Cluster Resources for Shared LVM Volume Groups". For information about managing resources migrated from OES 2 SP3 to OES 11 or later, see "Upgrading and Managing Cluster Resources for Linux POSIX Volumes with CSM Containers".	Not applicable
NCP volumes on Linux POSIX file systems as cluster resources	Yes See "Configuring NCP Volumes with OES Cluster Services" in the *OES 2018 SP2: NCP Server for Linux Administration Guide*.	Not applicable
Dynamic Storage Technology shadow volume pairs as cluster resources	Yes; by combining the load and unload scripts for shared NSS pools and managing the pair as a single cluster resource. See "Configuring DST Shadow Volume Pairs with OES Cluster Services" in the *OES 2018 SP2: Dynamic Storage Technology Administration Guide*.	Not supported by Dynamic Storage Technology.
Xen virtual machines as cluster resources	Yes See "Configuring OES Cluster Services in a Virtualization Environment".	Not applicable
iManager	Yes	Yes

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
Clusters plug-in and Storage Management plug-in for iManager	Yes	Yes
My Clusters and My Resources feature of the Clusters plug-in	Yes	Can be used to manage NetWare 6.5 SP8 servers, but cannot be run on NetWare servers.
Cluster-enabling NSS pools by using the Storage plug-in for iManager	Yes	Yes
Cluster-enabling NSS pools by using the NSS Management Utility (NSSMU)	Yes	Yes
Creating cluster enabled NSS pools by using NLVM commands	Yes	Not applicable
Creating cluster enabled LVM volume groups by using NSSMU	Yes	Not applicable
Creating cluster enabled LVM volume groups by using NLVM commands	Yes	Not applicable
Command line interface	Yes; using the terminal console as the `root` user	Yes; using the terminal console
XML-based API	Yes; same as NetWare except that it uses the `/_adminfs` path on Linux.	Yes; same as for Linux except that it uses the `_admin` volume on NetWare.
Load, unload, and monitor scripts	Yes Script commands differ. Scripts are automatically translated from NetWare commands to Linux commands during the cluster conversion from NetWare to Linux. For a comparison of script commands, see "Planning the Conversion of Load and Unload Scripts" in the *OES 2015 SP1: Novell Cluster Services NetWare to Linux Conversion Guide*.	Load and unload scripts; no monitoring
NCP support for accessing files on shared NSS pools	Yes	Yes
NCP support for accessing files on shared NCP volumes on Linux POSIX file systems	Yes	Not applicable
NCP support for accessing files on Dynamic Storage Technology volumes made up of two NSS volumes	Yes	DST not available

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
Novell AFP support for accessing files on shared NSS pools	Yes; cross-protocol file locking available with NCP and Novell CIFS, or with NCP and Novell Samba	Yes; with cross-protocol file locking
Novell CIFS support for accessing files on shared NSS pools	Yes; cross-protocol file locking available with NCP and Novell AFP, or with NCP and Novell Samba	Yes; with cross-protocol file locking
Novell CIFS support for accessing files on Dynamic Storage Technology volumes made up of two NSS volumes	Yes; cross-protocol file locking available in NCP	DST not available
Linux Samba/CIFS support for accessing files on shared NSS pools on Linux	Yes; with cross-protocol file locking available in NCP Requires users to be Linux-enabled with Linux User Management. Requires Universal Password.	Not applicable
Linux Samba/CIFS support for accessing files on shared Linux POSIX file systems	Yes Requires users to be enabled with Linux User Management. Requires Universal Password.	Not applicable
Leverage Heartbeat 2 resource agents	Yes	Not applicable
LAN fault tolerance	Channel bonding See `/usr/src/linux/Documentation/bonding.txt`	NIC teaming See "NIC Teaming" in the *NW 6.5 SP8: TCP/ IP Administration Guide*
Multipath I/O	Device Mapper - Multipath I/O, or third-party MPIO solutions See "Managing Multipath I/O for Devices" (http://www.suse.com/documentation/sles11/stor_admin/data/multipathing.html) in the *SLES 11 SP3: Storage Administration Guide.* (http://www.suse.com/documentation/sles11/stor_admin/data/bookinfo.html)	Media Manager Multipath I/O, or third-party MPIO solutions See "Managing Multipath I/O to Devices (NetWare)" in the *NW 6.5 SP8: NSS File System Administration Guide*.
Cascade failover prevention	Yes	Yes
Master node election process	New master election process as described in "Electing a Master Node".	Old master election process
Monitor script	Yes	No

Feature or Capability	Cluster Services for Linux	Cluster Services for NetWare
Resource Mutual Exclusion Groups	Yes	No
NCS-level monitoring of the NDSD daemon	Yes, OES 11 SP2 or later	No
STONITH	Yes	No
VLAN support	Yes	No

B Comparing Resources Support for Linux and NetWare

Table B-1 compares clustering support for using Novell Cluster Services on Open Enterprise Server 2015 SP1 and on NetWare 6.5 SP8.

NSS pool cluster resources can be cluster migrated from NetWare to Linux as part of a cluster conversion. If the resource contains data only, no additional steps are required. However, clustered services can require special handling. See the *OES 2015 SP1: Novell Cluster Services NetWare to Linux Conversion Guide*.

Table B-1 *Comparison of Clustering Support for Services on Linux and NetWare*

Service	NetWare 6.5 SP8	OES 2015	For conversion information, see
AFP (Apple Filing Protocol)	Yes See "Setting Up for Macintosh" in the *NW 6.5 SP8: AFP, CIFS, and NFS (NFAP) Administration Guide*.	Yes See "Configuring AFP with OES Cluster Services for an NSS File System" in the *OES 2018 SP2: OES AFP for Linux Administration Guide*.	See Chapter 5, "Novell AFP," on page 41.
Apache Web Server	Yes See "Apache with Novell Cluster Services" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Resource Configuration Guide*.	Yes; use the standard Apache Web Server for Linux.	See Chapter 6, "Apache HTTP Server," on page 43.
CIFS (Windows File Services)	Yes; Novell CIFS See "Setting Up for Windows" in the *NW 6.5 SP8: AFP, CIFS, and NFS (NFAP) Administration Guide*.	Yes; Novell CIFS See "Configuring CIFS with Cluster Services for an NSS File System" in the *OES 2018 SP2: OES CIFS for Linux Administration Guide*.	See Chapter 8, "Novell CIFS," on page 65.
DFS (Novell Distributed File Services) Volume location database (VLDB)	Yes See "Clustering Novell Distributed File Services" in the *NW 6.5 SP8: Novell Distributed File Services Administration Guide*.	Yes See "Clustering Distributed File Services" in the *OES 2015 SP1: Novell Distributed File Services Administration Guide for Linux*.	See Chapter 9, "Novell Distributed File Services VLDB," on page 67.

Service	NetWare 6.5 SP8	OES 2015	For conversion information, see
DHCP	Yes See "Clustering in NetWare 6.5" in the *NW 6.5 SP8: Novell DNS/DHCP Services Administration Guide*.	Yes DHCP for Linux supports using a shared Linux POSIX file system or a shared NSS pool for the cluster resource. See "Configuring DHCP with OES Cluster Services for the Linux File System" in the *OES 2018 SP2: DNS/DHCP Services for Linux Administration Guide*.	See Chapter 10, "DHCP Server," on page 69.
DNS	Yes See "Creating a Cluster-Enabled DNS Server" in the *NW 6.5 SP8: Novell DNS/DHCP Services Administration Guide*.	Yes See "Configuring DNS with OES Cluster Services" in the *OES 2018 SP2: DNS/DHCP Services for Linux Administration Guide*.	See Chapter 11, "DNS Server," on page 71.
Dynamic Storage Technology service	Not available	Can be used in a cluster, but the service is not clustered. See also Storage, DST shadow volume pairs.	DST runs on each OES node and you set the global server-level parameters to be the same on each one.
eDirectory 8.8*x*	No	No	eDirectory has its own redundancy built in (multiple replicas) and would not benefit from being clustered.
Certificate Server	Yes See "Server Certificate Objects and Clustering" in the *Novell Certificate Server 3.3.1 Administration Guide* (http://www.novell.com/documentation/crt33/).	Yes See "Server Certificate Objects and Clustering" in the *NetIQ Certificate Server Administration Guide*.	See Chapter 7, "eDirectory Server Certificates," on page 61.

Service	NetWare 6.5 SP8	OES 2015	For conversion information, see
exteNd Application Server and MySQL	Yes; NetWare 6.5 SP2 or earlier. See "Configuring Novell exteNd Application Server and MySQL with Novell Cluster Services" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Resource Configuration Guide*.	Not available on Linux.	This install option was discontinued beginning in NetWare 6.5 SP3. See also MySQL.
FTP Server	Yes See "Cluster-Enabling NetWare FTP Server" in the *NW 6.5 SP8: Novell FTP Administration Guide*.	No; use the Novell FTP (Pure-FTPd) solution. See "Cluster Enabling Pure-FTPd in an OES Environment" in the *OES 2018 SP2: Planning and Implementation Guide*.	Not applicable
Identity Manager Bundle Edition	Can be used in a cluster, but is not clustered. Requires Identity Manager 3.5.	Can be used in a cluster, but is not clustered. Requires Identity Manager 4.0.2. See the *Identity Manager 4.0.2 Overview Guide*.	
iPrint	Yes See the *NW 6.5 SP8: iPrint Administration Guide*.	Yes See "Configuring iPrint with Novell Cluster Services" in the *OES 2018 SP2: iPrint Administration Guide*.	See Chapter 12, "Novell iPrint," on page 73.
MySQL	Yes See "Configuring MySQL on Novell Clustering Services" in the *NW 6.5 SP8: Novell MySQL Administration Guide*.	Yes; use the standard MySQL service for Linux. See Chapter 13, "MySQL," on page 79.	
NCP Server	Can be used in a cluster, but is not clustered.	Can be used in a cluster, but is not clustered. See also Storage, NCP volumes on Linux POSIX file systems.	NCP Server runs on each server node in the cluster. It should have the same configuration on each node of the cluster.

Service	NetWare 6.5 SP8	OES 2015	For conversion information, see
NetStorage	Yes See "Configuring NetStorage with Novell Cluster Services" in the *NW 6.5 SP8: NetStorage Administration Guide*.	Yes See "Configuring NetStorage with OES Cluster Services" in the *OES 2018 SP2: NetStorage Administration Guide for Linux*.	No known issues.
NFS	Yes See "Cluster-Enabling Native File Access for UNIX" in the *NW 6.5 SP8: AFP, CIFS, and NFS (NFAP) Administration Guide*.	No; use the standard Linux solution for NFS.	
Novell iFolder 2.1.*x*	Yes	Not applicable	iFolder 2.1x is replaced by Novell iFolder 3.9.
Novell iFolder 3.9	Not applicable	Yes See "Clustering iFolder Servers with Novell Cluster Services for Linux" in the *Novell iFolder 3.9.2 Administration Guide*.	See "Migration" in the *OES 2018 SP2: Migration Tool Administration Guide*.
Printing	Yes	Yes	See iPrint.
Storage, DST shadow volume pairs	Not applicable	Yes See "Configuring DST Shadow Volume Pairs with OES Cluster Services" in the *OES 2018 SP2: Dynamic Storage Technology Administration Guide*.	DST shadow volumes are on shared NSS pools that are created separately, then managed in the same load/unload scripts.
Storage, NCP volumes on Linux POSIX file systems	Not applicable	Yes See "Configuring NCP Volumes with OES Cluster Services" in the *OES 2018 SP2: NCP Server for Linux Administration Guide*.	The NCP Server service is not clustered; its volumes can be clustered.
Storage, NetWare Traditional volumes	No	Not applicable	

Service	NetWare 6.5 SP8	OES 2015	For conversion information, see
Storage, NSS pools and volumes	Yes See "Setting Up Cluster Resources for Novell Cluster Services" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Administration Guide*.	Yes See "Configuring and Managing Cluster Resources for Shared NSS Pools and Volumes". For a feature comparison, see "Cross-Platform Issues for NSS" in the *OES 2018 SP2: NSS File System Administration Guide for Linux*.	See Chapter 14, "Novell Storage Services Pools," on page 97.
Tomcat	Yes See "Configuring Tomcat and Novell Cluster Services" in the *NW6.5 SP8: Novell Cluster Services 1.8.5 Resource Configuration Guide*.	Yes; native to Linux Use a similar procedure to the one outlined for Tomcat on NetWare, but use the Linux locations and files.	You cannot convert the NetWare Tomcat configuration for a Linux server.
Xen guest servers as nodes in a cluster	Virtualized NetWare nodes can be used in NetWare clusters. Nodes can be any combination of virtual and physical servers.	Virtualized OES nodes can be used in OES clusters. Nodes can be any combination of virtual and physical servers.	See "Configuring OES Cluster Services in a Virtualization Environment".
Xen virtual machines on the host server	Not applicable	Yes; use the Xen and XenLive templates.	See "Virtual Machines as Cluster Resources".
VMware guest servers as nodes in a cluster	For VMware products that support NetWare, virtualized NetWare nodes can be used in NetWare clusters. Nodes can be any combination of virtual and physical servers.	Virtualized OES nodes can be used in OES clusters. Nodes can be any combination of virtual and physical servers. See *OES 2015 SP1: Novell Cluster Services Implementation Guide for VMware*.	