IBM zSystems and LinuxONE

Dynamic Partition Manager (DPM) Guide

SB10-7182-02

Note:

Before you use this information and the product it supports, read the information in "Safety" on page xiii, Appendix D, "Notices," on page 191 and *IBM Systems Environmental Notices and User Guide*, Z125–5823.

This edition, SB10-7182-02, applies to IBM Z and IBM LinuxONE servers. This edition replaces SB10-7182-01.

There might be a newer version of this document in a **PDF** file available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.

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Safety notices

Safety notices may be printed throughout this guide. **DANGER** notices warn you of conditions or procedures that can result in death or severe personal injury. **CAUTION** notices warn you of conditions or procedures that can cause personal injury that is neither lethal nor extremely hazardous. **Attention** notices warn you of conditions or procedures that can cause damage to machines, equipment, or programs.

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Laser safety information

All IBM Z® and IBM LinuxONE (LinuxONE) models can use I/O cards such as FICON®, Open Systems Adapter (OSA), RoCE Express, Integrated Coupling Adapter (ICA SR, ICA SR1.1), zHyperLink Express, or other I/O features which are fiber optic based and utilize lasers (short wavelength or long wavelength lasers).

Laser compliance

All lasers are certified in the US to conform to the requirements of DHHS 21 CFR Subchapter J for Class 1 or Class 1M laser products. Outside the US, they are certified to be in compliance with IEC 60825 as a Class 1 or Class 1M laser product. Consult the label on each part for laser certification numbers and approval information.

Laser Notice: U.S. FDA CDRH NOTICE if low power lasers are utilized, integrated, or offered with end product systems as applicable. Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019.

CAUTION: This product might contain one or more of the following devices: CD-ROM drive, DVDROM drive, DVD-RAM drive, or laser module, which are Class 1 laser products. Note the following information:

- **Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.**
- **Use of the controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure. (C026)**

CAUTION: Data processing environments can contain equipment transmitting on system links with laser modules that operate at greater than Class 1 power levels. For this reason, never look into the end of an optical fiber cable or open receptacle. (C027)

About this publication

This book contains general concepts, planning guidelines, instructions, and reference information for creating and managing partitions on systems that are running in Dynamic Partition Manager (DPM) mode.

DPM is a feature of the following IBM Z and IBM LinuxONE (LinuxONE) systems:

- IBM z16™: machine types 3931 and 3932
- IBM z15®: machine types 8561 and 8562
- IBM z14®: machine types 3906 and 3907
- IBM LinuxONE Emperor 4: machine type 3931
- IBM LinuxONE Rockhopper 4: machine type 3932
- IBM LinuxONE III: machine types 8561 and 8562
- IBM LinuxONE Emperor II (Emperor II): machine type 3906
- IBM LinuxONE Rockhopper II (Rockhopper II): machine type 3907

This book describes DPM Version 5, which is available starting with Hardware Management Console / Support Element (HMC/SE) Version 2.16.0. For a list of prerequisites and functions introduced with DPM Version 5, see Chapter 10, “Prerequisites for using Dynamic Partition Manager,” on page 91.

Partitions on a DPM-enabled system support the following operating systems and hypervisors:

- Various Linux® distributions, which are listed on the IBM tested platforms page for Linux environments: https://www.ibm.com/support/pages/linux-ibm-z-tested-platforms. These distributions include supported versions of Red Hat® Enterprise Linux (RHEL), SUSE Linux Enterprise Server (SLES), and Ubuntu Server (KVM or LPAR DPM).
- z/VM® 7.1 or later. z/VM is supported as a virtualization hypervisor on which you can run multiple Linux images.

DPM also supports IBM Secure Service Container partitions.

Figures included in this document illustrate concepts and are not necessarily accurate in content, appearance, or specific behavior.

Intended audience

The primary audience for this book is system administrators with knowledge of virtualization concepts but limited mainframe or LinuxONE system skills. These administrators are responsible for creating and managing partitions on a DPM-enabled system, to support business applications.

Other IT personnel who might benefit from using this book include mainframe or LinuxONE system operators, automation engineers, and experienced system administrators who need to learn how to use DPM tasks.

Prerequisite and related information

This book describes how to plan for, create, and manage partitions on DPM-enabled systems. To create and manage partitions and their resources, system administrators use specific tasks on the HMC. These tasks can be accomplished through a program as well, with the HMC Web Services application programming interfaces (APIs) for DPM.

- For more information about a specific system, see the appropriate system technical guide on the IBM Redbooks® web site at http://www.redbooks.ibm.com/. For example, for the IBM z16, see the *IBM z16™ Technical Introduction*, SG24-8950.
- For information about the DPM APIs, see the appropriate edition of *Hardware Management Console Web Services API*, which is available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-

hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.

HMC users also can monitor and manage systems and partitions through the IBM HMC Mobile for Z and LinuxONE app for iOS and Android. The systems can either run in standard mode (that is, with Processor Resource/System Manager or PR/SM), or run with DPM enabled. The HMC Mobile app provides system and partition views, status monitoring, hardware messages, operating system messages, and the ability to receive push notifications from the HMC, using the existing support server connection. For more information, see the HMC online help for the **HMC Mobile Settings** task.

Related HMC and SE console information

Hardware Management Console (HMC) and Support Element (SE) information can be found on the console help system.

Related information for Linux on IBM Z and LinuxONE

For information about installing and running a Linux distribution on an IBM Z or LinuxONE server, see the Linux on IBM Systems topics in IBM Documentation, at: https://www.ibm.com/docs/en/linux-on-systems?topic=linuxone-library-overview

Another useful source of information is the IBM Developer site for Linux at https://developer.ibm.com/technologies/linux/

Related information for z/VM

For information about installing and running z/VM as a hypervisor for Linux guests on an IBM Z or LinuxONE server, see the documentation for the version of z/VM that you are installing. The z/VM library is available in IBM Documentation at https://www.ibm.com/docs/en/zvm

Related information for IBM Secure Service Container

For information about working with Secure Service Container partitions and the appliances they support, see the appropriate edition of the *Secure Service Container User's Guide*, which is available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.

How to use this publication

This book provides an overview of DPM, lists the system requirements for its use, and contains step-by-step instructions for system administrators who create, start, and manage partitions on a DPM-enabled system.

Topics are organized in parts, for the audience who is most likely to use the information:

Part 1: Introduction to the IBM Dynamic Partition Manager (DPM)

Topics in this part describe DPM, explain the benefits of using it, and provide a basic set of instructions for creating and starting a new partition on a DPM-enabled system. These topics are appropriate for readers who need a quick introduction to DPM.

Part 2, “Basic concepts and terms for Linux administrators,” on page 9

Topics in this part explain concepts and terms that might be unfamiliar to system administrators who have little or no experience working on a mainframe or LinuxONE system.

Part 3, “Basic tasks for Linux administrators,” on page 39

Topics in this part provide a planning checklist and step-by-step instructions for creating and starting a partition, and its operating system or hypervisor, on a DPM-enabled system. Also included is a summary of HMC tasks for monitoring and managing partitions, adapters, and other resources on

a DPM system. These topics are appropriate for any administrator who creates or manages DPM partitions.

Part 4, "Topics for system planners," on page 89

Topics in this part provide the prerequisites for enabling DPM on a mainframe or LinuxONE system, information about supported functions, and the engineering changes (ECs) or machine change levels (MCLs) for upgrading to the latest DPM version. This part also includes migration instructions and information about I/O adapter configuration. These topics are appropriate for experienced system planners and other administrators who are familiar with mainframe or LinuxONE systems.

Part 5, "Topics for network administrators," on page 125

Topics in this part provide information about network-related concepts and tasks that are specific to working with DPM-enabled systems.

Part 6, "Topics for storage administrators," on page 139

Topics in this part provide information about storage-related concepts and tasks that are specific to working with DPM-enabled systems. These topics apply to supported types of Fibre Connection (FICON) extended count key data (ECKD) direct-access storage devices (DASD), and Fibre Channel Protocol (FCP) Small Computer System Interface (SCSI) disk storage devices and FCP tape storage devices.

Appendixes

Topics in this part include the default task roles for DPM tasks on the HMC or SE; a sample system cabling plan; a sample Non-Volatile Memory Express® (NVMe) adapter plan; instructions for configuring and accessing FCP tape storage drives; and trademark information.

Accessibility features

Accessibility features help users who have physical disabilities such as restricted mobility or limited vision use software products successfully. The accessibility features can help users do the following tasks:

- Run assistive technology such as screen readers and screen magnifier software.
- Operate specific or equivalent features by using the keyboard.
- Customize display attributes such as color, contrast, and font size.

Consult assistive technologies

Assistive technology products, such as screen readers, function with the user interfaces found in this product. Consult the product information for the specific assistive technology product that is used to access our product information.

Keyboard navigation

This product uses standard Microsoft Windows navigation keys.

IBM and accessibility

See http://www.ibm.com/able for more information about the commitment that IBM has to accessibility.

How to provide feedback to IBM

We welcome any feedback that you have, including comments on the clarity, accuracy, or completeness of the information.

For additional information use the following link that corresponds to your configuration:

Configuration	Link
IBM z16 Model A02	How to send feedback to IBM

Configuration	Link
IBM z16 Rack Mount Bundle	How to send feedback to IBM
IBM LinuxONE Rockhopper 4 Model LA2	How to send feedback to IBM
IBM LinuxONE Rockhopper 4 Rack Mount Bundle	How to send feedback to IBM

Summary of changes

For the most recent edition only, technical changes to the text are indicated by a thick vertical line to the left of the change.

January 2024: SB10-7182-02

This edition contains updates for DPM R5.2, which introduces two new types of partition links: FICON CTC and HiperSockets. The primary topics include the following:

- "Partition links" on page 25, which introduces the different types of partition link, with details about each type.
- Chapter 9, "Summary of tasks for managing systems, adapters, and partitions," on page 83 and Appendix A, "DPM task and resource roles," on page 183, which list changes or additions to tasks through which administrators can create and manage partition links.
- Chapter 10, "Prerequisites for using Dynamic Partition Manager," on page 91, which lists the DPM R5.2 updates and associated driver bundle numbers.
- Chapter 16, "The HiperSockets user experience with DPM R5.2," on page 123, which briefly describes the simplified user experience for creating and managing HiperSockets connections.
- "Migration instructions for a system replacement" on page 105, which provides information about the conversion of HiperSockets adapters to HiperSockets partition links during an upgrade to DPM R5.2, along with potential migration actions.
- Chapter 17, "Configuring FICON connections for use with FICON CTC partition links," on page 127, which provides an overview of the user interface changes to the **Configure Storage** task, through which administrators can view, create, and modify FICON connections for storage and network access.

Various other topics throughout this edition are also updated to include information about partition links.

May 2023: SB10-7182-01

This edition contains the following updates for DPM R5.1 and the new IBM Z and LinuxONE systems (machine type 3932).

- This edition adds the IBM z16 and IBM LinuxONE Rockhopper 4 (machine type 3932) to the list of supported servers, in the following topics.
  - "About this publication" on page xv
  - Chapter 1, "Dynamic Partition Manager: A quicker and easier way to deploy Linux servers," on page 3
  - Chapter 10, "Prerequisites for using Dynamic Partition Manager," on page 91

  The rack mount configurations introduce a new default naming convention for installed adapters, as noted in Chapter 12, "Adapter configuration," on page 113.
- With DPM R5.1, system administrators and programmers can specify options to enable DPM to validate that the Linux operating system executables on a boot volume originate from a trusted source, and have not been altered without authorization. For more information, see Chapter 14, "Validating boot images of operating systems," on page 119.

March 2023: SB10-7182-00b

This edition contains updates to the topic, "Migration instructions for a system replacement" on page 105.

September 2022: SB10-7182-00a

This edition adds the IBM LinuxONE Emperor 4 to the list of supported servers, in the following topics.

- “About this publication” on page xv
- Chapter 1, “Dynamic Partition Manager: A quicker and easier way to deploy Linux servers,” on page 3
- Chapter 10, “Prerequisites for using Dynamic Partition Manager,” on page 91

Part 1. Introduction to Dynamic Partition Manager

Topics in this part describe DPM, explain the benefits of using it, and provide a basic set of instructions for creating and starting a new partition on a DPM-enabled system. These topics are appropriate for readers who need a quick introduction to DPM.

Topics covered in this part are:

Chapter 1. Dynamic Partition Manager: A quicker and easier way to deploy Linux servers

Linux servers and applications have run on mainframes and LinuxONE systems for years, but configuration and setup are fairly complicated and requires the use of several specific tools. However, with IBM Dynamic Partition Manager (DPM), system administrators now have a quicker and easier way to deploy Linux servers, using only the Hardware Management Console (HMC). The HMC is the user interface for managing mainframes and LinuxONE systems, along with their resources.

DPM is a configuration manager that is designed for setting up and managing Linux servers that run on a mainframe or LinuxONE system. On a DPM-enabled system, the runtime environment for your Linux server is called a *partition*. A partition is also the runtime environment for a hypervisor and its guest operating-system images. On other platforms, a partition is a portion of the system hard disk that you create to run different operating systems on the same disk, or to give the appearance of separate hard disks for multiple users or other purposes. On a mainframe or LinuxONE system, a partition is a virtual representation of all of the physical hardware resources, which include processors, memory, and input/output (I/O) adapters, that are available to an operating system or hypervisor. On mainframe and LinuxONE systems, as on other platforms, an *adapter* is a physical device that connects the system to other computers or devices. In contrast to other platforms, adapters on a mainframe or LinuxONE system can be shared between partitions, which reduces the amount of adapters that might be required to handle a specific workload.

To make use of DPM, system administrators select specific tasks in the HMC; the user interface of these tasks has a design that is similar to the tools that system administrators use on other platforms. These specific HMC tasks are available only on a DPM-enabled system. Figure 1 on page 4 shows the **HMC Welcome** page, which provides a visual summary of the number and status of elements that are managed through the HMC: systems, the partitions that run on those systems, and the adapters that are configured for those systems.

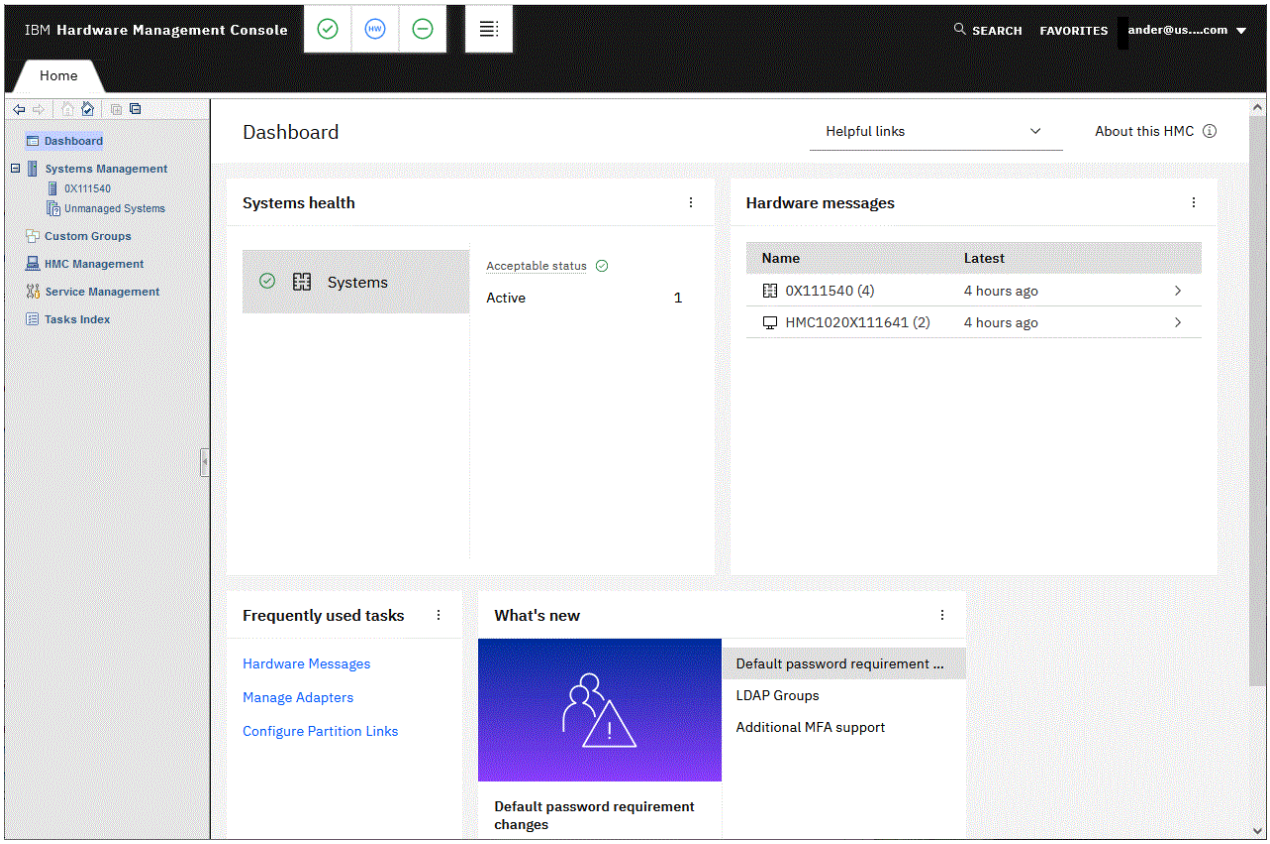

Figure 1. The HMC Welcome page

When your company orders a mainframe or LinuxONEsystem with the required DPM features, IBM service representatives install the system and enable DPM, so it is ready for use when the system is powered on. DPM is available on the following systems.

- IBM z16: machine types 3931 and 3932
- IBM z15: machine types 8561 and 8562
- IBM z14: machine types 3906 and 3907
- IBM LinuxONE Emperor 4: machine type 3931
- IBM LinuxONE Rockhopper 4: machine type 3932
- IBM LinuxONE III: machine types 8561 and 8562
- IBM LinuxONE Emperor II (Emperor II): machine type 3906
- IBM LinuxONE Rockhopper II (Rockhopper II): machine type 3907

When you use the HMC to configure the running environment for your Linux server, DPM automatically discovers and displays the system resources that are available for your use, and indicates how your selections might affect other servers and applications that are already defined or running on the same system. After your Linux server is up and running, you can use DPM to:

- Modify system resources without disrupting running workloads.
- Monitor sources of system failure incidents and conditions or events that might lead to workload degradation.
- Create alarms so that you can be notified of specific events, conditions, and changes to the state of system resources.
- Update individual partition resources to adjust capacity, redundancy, availability, or isolation.

Chapter 2. Getting started: Creating a new partition and starting your Linux server

This topic provides a quick review of the procedure for creating and starting a new partition to host a single image of the Linux operating system. Links to more detailed information are included in the procedure steps.

Before you begin

- Verify the intended use of DPM-enabled systems with your system planner, so you know which system is the appropriate one for you to use for your Linux server and the business applications that it will support. You also need to know which of the system features and resources (adapters, processors, memory, and so on) that your server and its business applications require.
- After you know which system to use, and complete capacity planning for the applications that you intend to run on the Linux server, you can list the system resources that you need to assign to your partition. Depending on the IT roles and operating procedures at your installation, you might have to work with the network administrator, storage administrator, or security administrator before you create the partition.

Procedure

1. Log in to the Hardware Management Console (HMC), using a customized user ID with the predefined System Programmer Tasks role.
2. On the main HMC page, expand the **Systems Management** node to view managed systems, and select the DPM-enabled system on which you want to create a partition for your Linux server.

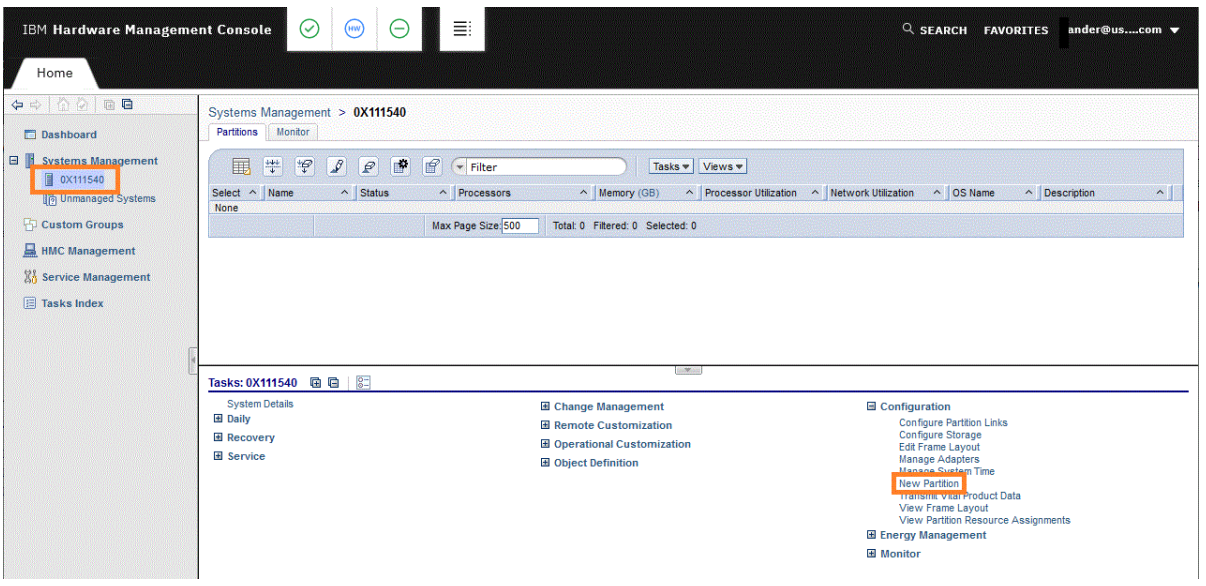

Figure 2. Portion of the main HMC page, with the Systems Management node expanded, and a system and the New Partition task highlighted

3. Use the **New Partition** wizard to create a partition.

   You can access this task from the main HMC page by selecting the Systems Management node and expanding the Configuration task group; by selecting a specific DPM-enabled system; or by selecting the task in the Tasks index.

   For more detailed guidance and instructions, see the following topics:

- Chapter 6, “Planning checklist for creating a partition,” on page 41
- “Creating a new partition” on page 49

a) Open the **New Partition** task.

This action opens the **New Partition** window, which is shown in Figure 3 on page 6.

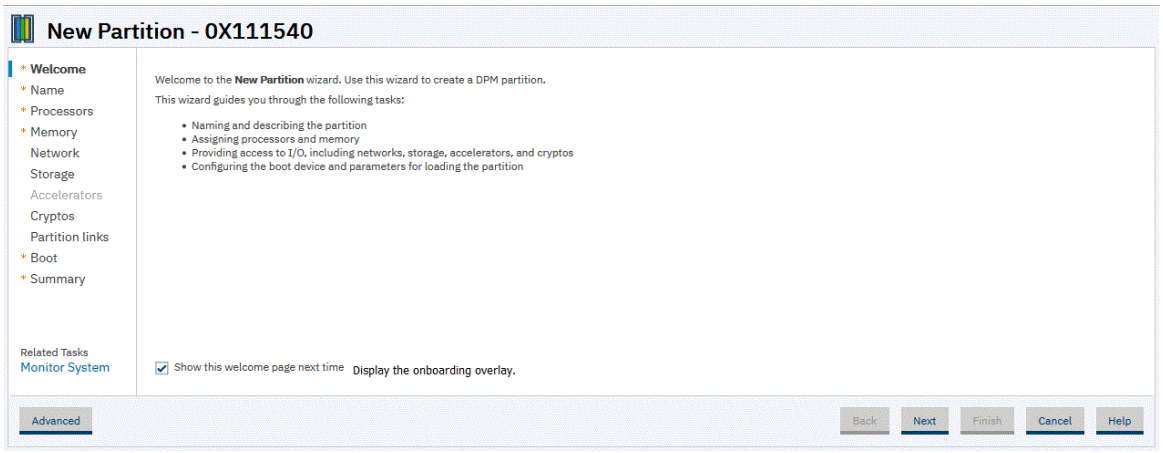

Figure 3. Welcome page of the New Partition task in basic mode

The **New Partition** task offers two modes through which you can create a partition: basic and advanced. For a comparison of the two modes and the implications of switching between them, see “Selecting which New Partition task mode to use” on page 47.

b) Complete the required fields on the task pages to create the new partition, depending on the requirements of the applications that your Linux server will host.

In Figure 3 on page 6, pages that contain required fields are denoted with an asterisk. For step-by-step instructions for using the basic mode to complete the information on these pages, see “Creating a new partition” on page 49.

c) Depending on the task mode you are using, click **Finish** or **OK** to create the partition.

A progress indicator is displayed until DPM finishes creating the partition.

When it finishes creating the partition definition, DPM opens the validation window, which displays a message indicating that your partition has been created, and lists more tasks that you can use to work with the new partition.

4. Use the **Start** task to start the partition.

You can open the **Start** task by clicking the link on the **Validation** window, or through two other methods shown in Figure 4 on page 7.

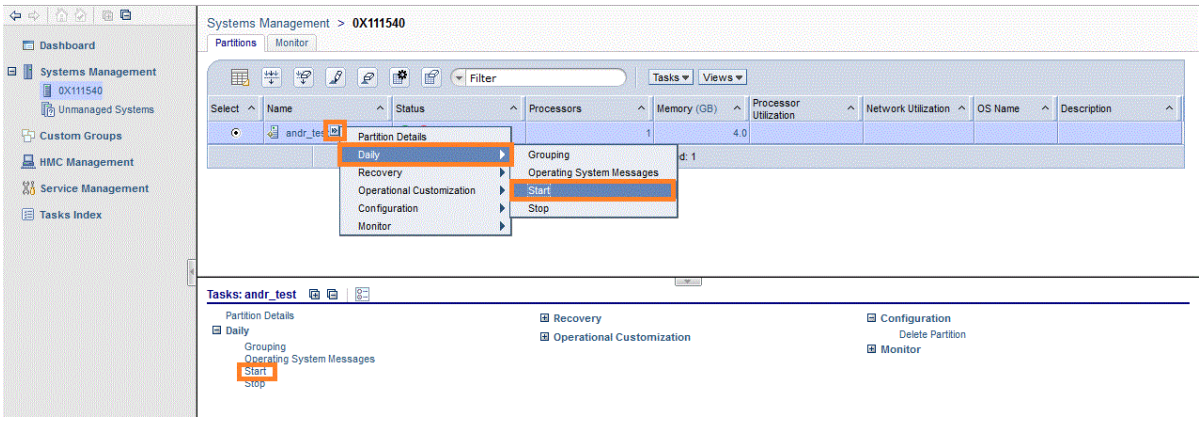

Figure 4. Methods of starting a new partition

- One way to access the Start task is to select the new partition and click the double-arrow icon in the Name field to display the cascading task menu. Then expand the **Daily** group, and click **Start**.
- Another way to access the Start task is to select the new partition, expand the Daily category in the Tasks area, and click **Start**.

A new window opens to display the progress of the start operation. Figure 5 on page 7 shows a portion of the **Start** window, with its progress indicators. In addition to displaying a progress indicator, the window also contains a Details column with messages that are updated as the start process continues. These messages indicate the progress of configuring partition resources and initializing the operating system or hypervisor to run in the partition.

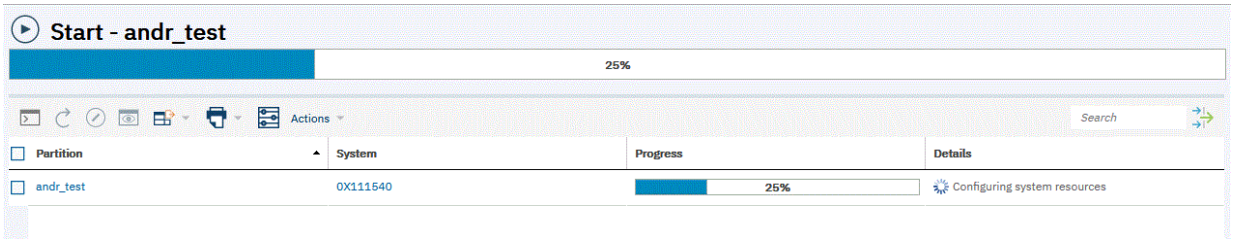

*Figure 5. Portion of the **Start** window for a new partition named andr_test*

When the start process completes, the Details column contains a success message, along with an **Open Console** link through which you can enter operating system commands.

5. Click the **Open Console** link to open the **Integrated ASCII Console** task, through which you can log in to the operating system that is running on the partition.

   After you log in, you can enter commands to view the processor, memory, and other resources that you configured for the partition. For example, Figure 6 on page 8 shows a sample Linux **lscpu** command and the resulting display of configured processor resources.

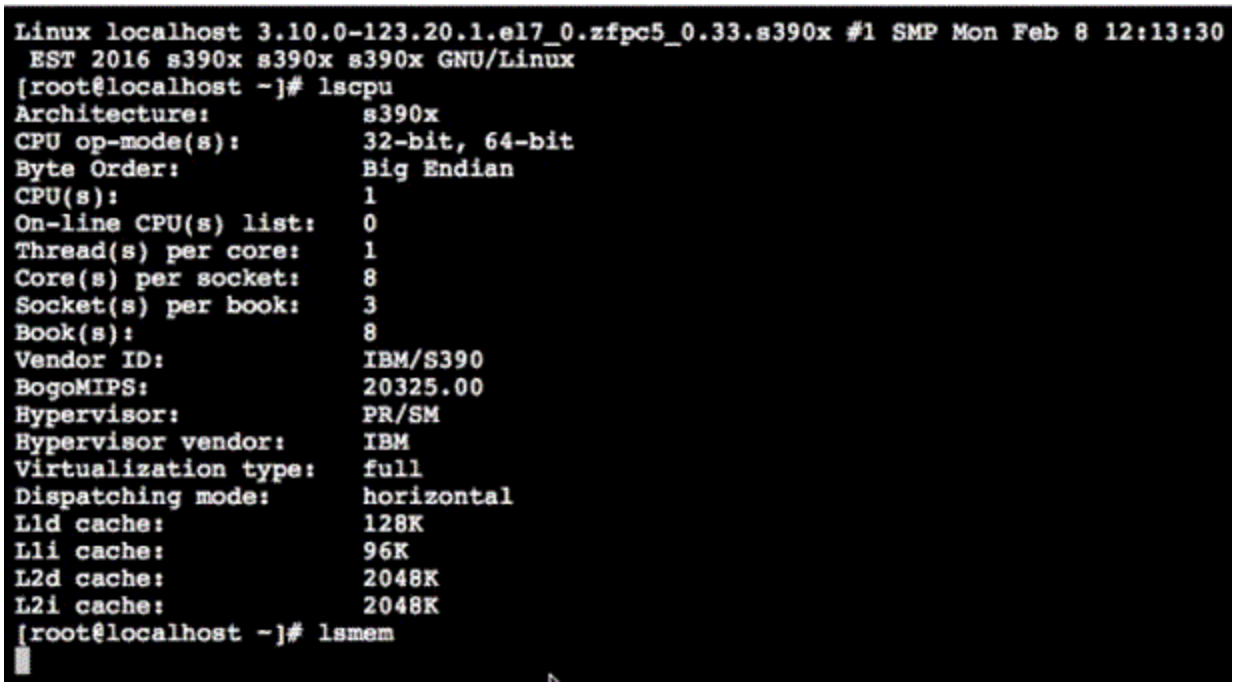

Figure 6. Sample Linux command and display of configured processor resources

Results

The partition and the Linux server are ready to support business applications.

Part 2. Basic concepts and terms for Linux administrators

Topics in this part explain concepts and terms that might be unfamiliar to system administrators who have little or no experience working on a mainframe or LinuxONE system.

Topics covered in this part are:

Chapter 3. Partitions: Virtual images of a mainframe or LinuxONE system

A partition is a virtual representation of the hardware resources of an IBM Z or LinuxONE system. A partition is the runtime environment for either a hypervisor and its guest operating-system images, each with their own applications; or a single operating system and its applications, which are sometimes called the *workload*.

The system planners at your company order and configure mainframe or LinuxONE systems according to their plan for the business applications that each system will support. This plan determines the system on which you configure your Linux server and its workload, and determines which system resources are available when you configure a partition.

The following operating systems and hypervisors can run in a partition on a DPM-enabled system:

- Various Linux distributions, which are listed on the IBM tested platforms page for Linux environments. These distributions include supported versions of Red Hat Enterprise Linux (RHEL), SUSE Linux Enterprise Server (SLES), and Ubuntu Server (KVM or LPAR DPM).
- z/VM 7.1 or later. z/VM is supported as a virtualization hypervisor on which you can run multiple Linux images.

DPM also supports Secure Service Container, which is a container technology through which you can more quickly and securely deploy firmware and software appliances. Unlike most other types of partitions, a Secure Service Container partition contains its own embedded operating system, security mechanisms, and other features that are specifically designed for simplifying the installation of appliances, and for securely hosting them.

Figure 7 on page 12 illustrates the physical and virtual resources of a mainframe or LinuxONE system, along with the firmware components that are used to manage these resources. Systems can be configured to run in either standard Processor Resource/Systems Manager (PR/SM) mode or IBM Dynamic Partition Manager (DPM) mode. DPM uses PR/SM functions but presents a simplified user interface for creating partitions and managing system resources through tasks in the Hardware Management Console (HMC) / Support Element (SE).

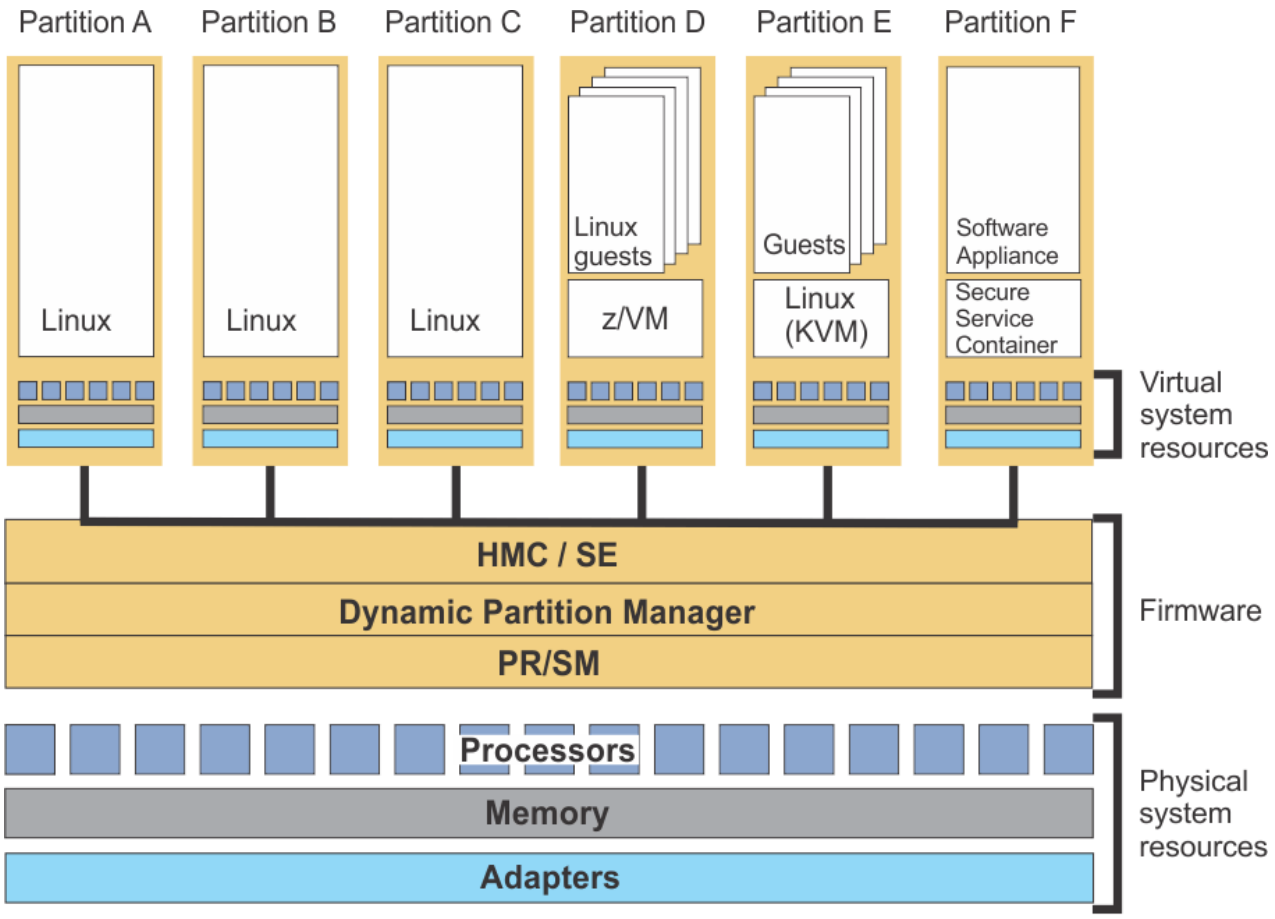

Figure 7. Partitions configured on a DPM-enabled system

In Figure 7 on page 12, several partitions are configured on a DPM-enabled system. Each partition hosts either a hypervisor or an operating system, and has virtual system resources that represent its share of physical resources: processors, memory, and adapters.

- Partitions A through C each host one Linux operating system image.
- Partition D hosts one z/VM image and its multiple Linux guests.
- Partition E hosts one Linux hypervisor (for example, Ubuntu KVM) and its multiple guests.
- Partition F is a Secure Service Container partition that hosts a supported software appliance.

Note that DPM does not manage any hypervisor guests, or any appliances that run in a Secure Service Container partition.

Partition properties and configuration settings

A *partition definition* contains the specific properties and configuration settings for one partition on a DPM-enabled system. You use the **New Partition** task to create a partition definition; through that task, you specify how many processors, how much memory, and which adapters to use.

When you use the **New Partition** task to create a partition definition, DPM indicates which system resources are available for your partition to use, and also shows the current usage or reservation of system resources by active (started) partitions or by partitions with reserved resources. You may define more resources than are currently available, and you can specify whether DPM is to reserve those resources for the partition. When you specify that the system resources for a partition are to be reserved, DPM does not allocate them to any other partitions. This reservation means that your partition is guaranteed to be startable; in contrast, partitions without reserved resources might fail to start, if sufficient resources are not available.

The following list describes key properties and configuration settings of partitions on a DPM-enabled system. The list labels correspond to navigation labels or individual fields in the **New Partition** task, and the **Partition Details** task, through which you can modify an existing partition definition. For a complete list of the partition properties and settings, see the online help for either task.

Name

A partition name must uniquely identify the partition from all other partitions defined on the same system. On a DPM-enabled system, you can define a name for your partition that is 1 - 64 characters in length. Supported characters are alphanumerics, blanks, periods, underscores, dashes, or at symbols (@). Names cannot start or end with blank characters. This partition name is shown in HMC task displays that contain information about system partitions.

A partition also has a short name, which is a name by which the operating system can identify the partition. By default, DPM automatically generates a partition short name that you can modify.

Partition type

Administrators can choose one of the following partition types for a new partition. Through the partition type, DPM can optimize the partition configuration for a specific hypervisor or operating system.

Linux

In this type of partition, you can install and run a Linux distribution as a single operating system, or as a hypervisor for multiple guests.

z/VM

In this type of partition, you can install and run z/VM as a hypervisor for multiple Linux guests.

Secure Service Container

This type of partition is a Secure Service Container, in which you can run only specific software appliances that the Secure Service Container supports.

Processors

Most DPM-enabled systems support one type of processor: Integrated Facility for Linux (IFL). In some cases, a system might also support an additional type: Central Processor (CP).

Each partition on a system can either have exclusive use of a specific number of physical processors installed on the system, or can share processor resources from the pool of physical processors that are not dedicated to other partitions on the same system. The number of available processors is limited to the number of entitled processors on the system. Entitled processors are processors that are licensed for use on the system; the number of entitled processors might be less than the total number of physical processors that are installed on the system.

When you create a new partition on a DPM-enabled system:

- You can select which processor type to use only if both types are installed on the system. Generally, IFLs are the most appropriate choice for Linux servers. If you want to enable simultaneous multithreading for this partition, you must select the IFL processor type.
- You can specify the number of processors to assign to the partition, and view how your selection affects the processing resources of other partitions on the system. The number of processors that you can assign ranges from a minimum value of 1 to a maximum value of the total number of entitled processors on the system.

Memory

Each partition on a DPM-enabled system has exclusive use of a user-defined portion of the total amount of entitled memory that is installed on the system. Entitled memory is the amount of memory that is licensed for use, which might be less than the total amount of memory that is installed on the system. The amount of memory that a specific partition requires depends on the storage limits of the operating system that will run in it, on the storage requirements of the applications that run on the operating system, and on the size of the I/O configuration.

When you define the amount of memory to be assigned, or allocated, to a specific partition, you specify an initial amount of memory, and a maximum amount that must be equal to or greater than the initial amount. The partition receives its initial amount when it is started. If the maximum amount

of memory is greater than the initial amount, you can add memory up to this maximum to the active partition, without stopping and restarting it.

Secure Service Container partitions require an initial amount of at least 4096 MB (4 GB).

Network

Network interface cards (NICs) provide a partition with access to internal or external networks that are part of or connected to a system. Each NIC represents a unique connection between the partition and a specific network adapter that is defined or installed on the system.

You need to define a NIC for each network connection that is required for the operating system or hypervisor that runs on this partition, or for the applications that the operating system or hypervisor supports. DPM supports several types of network adapters, including Open Systems Adapter-Express (OSA-Express) features, IBM HiperSockets, and Remote Direct Memory Access (RDMA) over Converged Ethernet (RoCE) Express features.

Note: Starting with DPM R5.2, you can create and manage HiperSockets only through the **Configure Partition Links** task. Although you can use the Network section of the **New Partition** and **Partition Details** tasks to manage NICs for OSA and RoCE adapters, you cannot use that section to manage HiperSockets NICs. For details, see Chapter 16, “The HiperSockets user experience with DPM R5.2,” on page 123.

Secure Service Container partitions require at least one NIC for communication with the Secure Service Container web interface.

Storage

Storage groups or tape links provide a partition with access to internal storage devices, or to external storage area networks (SANs) and devices that are connected to a system. A *storage group* is a logical group of storage volumes that share certain attributes, such as the type or size. A *tape link* defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN.

System administrators create storage groups or tape links for partitions to use. The system administrators work together with storage administrators to correctly configure a storage group or tape link and its associated devices for use.

For partitions to access storage, you attach one or more storage groups or tape links to the partition. Through storage groups and tape links, partitions can access the following types of storage:

- Fibre Connection (FICON) extended count key data (ECKD) direct-access storage devices (DASD), and Fibre Channel Protocol (FCP) Small Computer System Interface (SCSI) disk storage devices, including FCP tape libraries. These devices are physically located in the SAN. FICON and FCP storage groups and FCP tape links can be defined as either dedicated for use by only one partition, or shared by multiple partitions.
- Non-Volatile Memory Express (NVMe) solid state drives, which are installed in a system. Only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared. However, a partition that has attached NVMe storage groups can also have attached FICON and FCP storage groups, and FCP tape links.

Cryptos

The term *cryptos* is a commonly used abbreviation for adapters that provide cryptographic processing functions. DPM supports various Crypto Express features.

Crypto features are optional and, therefore, might not be installed on the system. If these features are installed, your decision to enable your partition to access them depends on your company's security policies, and the workload that your partition will support. Your system planner or security administrator can advise you about the use of available crypto features.

Partition links

Partition links interconnect two or more partitions that share the same network configuration and reside on the same system. Through the **Configure Partition Links** task, you can quickly configure network connections among partitions on the same system to improve performance.

The **New Partition** task (both basic and advanced modes) and **Partition Details** contain a section for partition links. However, this section is read-only because you can specify the partitions that use a partition link only through the **Configure Partition Links** task.

Boot options
When you define a partition with a type of **Linux** or **z/VM**, you can specify the boot option through which DPM locates and installs the executables for the hypervisor or operating system to be run in the partition. You can choose one of several different options, including booting from a storage device, network server, FTP server (with your choice of protocol), and Hardware Management Console removable media.

DPM automatically sets the boot option for the first-time start of Secure Service Container partitions.

Note: Starting with DPM R4.0, you can select options to validate the operating system image that you boot from a volume in a storage group. For more information, see Chapter 14, "Validating boot images of operating systems," on page 119.

Creating, starting, and managing a partition

To create a partition, you use the **New Partition** task, through which you define the hardware resources that the partition can use: processors, memory, adapters, and so on. The end result of the task is a partition definition, which you can modify through the **Partition Details** task, or use to start the partition through the **Start** task. When you start a partition, DPM uses the partition definition to determine which hardware resources to allocate to the partition, and starts the initialization process.

After the partition definition exists, you can use the **Partition Details** task to modify it; note that you cannot change the partition type after you create the partition definition. You can also use the **Stop** task to stop a partition, or the **Delete Partition** task to delete it. You can accomplish these tasks programmatically as well, through the Hardware Management Console Web Services application programming interfaces (APIs) for DPM.

To check on the status of partitions, select the **Systems Management** node in the HMC navigation pane, and select the **Partitions** tab. The Status column for each partition contains one of the following values.

Active
Indicates that the partition has successfully started and is operating normally.

Communications not active
Indicates a problem with the communication between the Hardware Management Console (HMC) and the Support Element (SE).

Degraded
Indicates that the partition successfully started and is operating, but the availability of physical resources to which it has access is less than required, as stated in the partition definition. This status might be acceptable, for example, for partitions that do not have reserved resources.

Paused
Indicates that, because a user has stopped all processors, the partition is not running its workload. In this case, because the partition was successfully started, its resources are shown as active and are still associated with this partition.

Reservation error
Indicates that the availability of physical resources does not match the reserved resources that are stated in the definition for this partition. The partition cannot start until sufficient resources are available.

Starting
Indicates the transitional phase between Stopped state and Active state, as the result of a Start task issued against this partition.

Status check
Indicates that the current status of the partition is unknown. This condition usually occurs under one of the following circumstances:

- When the SE is starting up; in this case, this partition status is temporary.
- When the SE and the DPM-enabled system to which it is attached cannot communicate.

Stopped
Indicates that the partition has normally ended its operation, and exists only as a partition definition.

Stopping
Indicates the transitional phase between Active state and Stopped state, as the result of a Stop task issued against this partition.

Terminated
Indicates that all of the processors for this partition are in a disabled wait state, or a system check stop occurred. The partition is not running its workload. In this case, because the partition was successfully started, its resources are shown as active and are still associated with this partition.

You can create as many partition definitions as you want, but only a specific number of partitions can be active at any given time. The system limit determines the maximum number of concurrently active partitions. Practical limitations of memory size, I/O availability, and available processing power usually reduce the number of concurrently active partitions to less than the system maximum. In fact, conditions on the system might prevent a partition from successfully starting, or change its status after it has successfully started. You can view the status of a partition through the **Partition Details** task or use the **Monitor System Events** task to set notifications for specific partition events, such as a change in status.

For more details about working with partitions, see Part 3, “Basic tasks for Linux administrators,” on page 39.

Chapter 4. Adapters: Connections to networks, storage, and more

Adapters on a system fall into several categories: Network, Storage, and Cryptos. Each adapter type plays a specific role in communication, or data transfer, for partitions and the applications that run in them. Most adapters are installed in the I/O cage or drawer of a physical processor frame. Depending on your company's planned use of specific systems, each system might have a different combination of installed adapters.

When adapters are installed in the processor frame, the adapters are configured using default settings. DPM automatically discovers these adapters and assigns names to them, using a standard naming convention. You can change the name and other default adapter settings through the **Manage Adapters** task, to conform with conventions that your company uses, or to provide more easily recognizable names for monitoring purposes.

To make use of the adapters configured on a DPM-enabled system, you select them when you use the **New Partition** task to create a new partition. Factors that determine your selections include:

- The specific adapters that are actually configured on the system.
- The requirements of the operating system and its applications, which are sometimes called the *workload* that your new partition will support.
- Any requirements or restrictions that your company has for the use of specific adapters. For example, your company might recommend selecting several adapters of the same type to maximize efficiency and provide redundancy.

Starting with DPM R5.0, you can also use *partition links*, which interconnect two or more partitions that share the same network configuration and reside on the same system. Through the **Configure Partition Links** task, you can quickly configure network connections among partitions on the same system to improve performance.

Linux servers require specific device drivers to use the adapters that are defined for a partition. For more information about the device drivers through which Linux servers can use adapters, see the *Device Drivers, Features, and Commands* documentation for the Linux kernel version that you are using. This documentation, which also describes commands and parameters for configuring Linux on IBM Z and LinuxONE servers, is available in IBM Documentation at https://www.ibm.com/docs/en/linux-on-systems?topic=overview-device-drivers-features-commands

Each partition on the system can be configured to access any combination of the I/O adapters that are either installed or configured on the system. Partitions can share most types of supported adapters, up to specific limits. The following topics provide a description of adapter types, by category.

Network adapters

Several types of network adapters enable communication through different networking transport protocols.

These network adapters are:

- Open Systems Adapter-Express (OSA-Express) adapters, which provide direct, industry-standard Ethernet LAN connectivity through various operational modes and protocols. OSA adapters can provide connectivity between partitions on the same system, as well as connectivity to external LANs.

  The supported OSA adapters vary, depending on the system configuration; for example, the z14 supports the OSA-Express6S, OSA-Express5S, and OSA-Express4S adapters.
- HiperSockets, which are virtual adapters that provide high-speed communications between partitions within a single system, without the need for any physical cabling or external networking connections. Each HiperSocket adapter represents a single internal network, and only those partitions with access to that adapter participate in that network.

- Remote Direct Memory Access (RDMA) over Converged Ethernet (RoCE) Express adapters. These adapters provide high speed, low latency data transfer over Ethernet networks.

  The supported RoCE adapters vary, depending on the system configuration; for example, the z14 supports the 10 Gigabit Ethernet (GbE) RoCE Express2 and 10 GbE RoCE Express adapters.

For a list of the network adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

DPM automatically discovers OSA and RoCE adapters because they are physical cards that are installed on the system. In contrast, HiperSockets are not physical adapters; you must configure them if you want to use them on your system. Depending on the DPM version that is installed on the system, use one of the following methods to create HiperSockets to interconnect partitions.

- With DPM R5.1 or earlier, use the **Create HiperSockets Adapter** task, which is available through the **Actions** list on the **Adapters** tab of the **Manage Adapters** task.
- With DPM R5.2, create and manage HiperSockets through the **Configure Partition Links** task, which provides a simplified and streamlined user experience for creating and managing HiperSockets connections.
  - For more information about HiperSockets partition links, see "HiperSockets partition links" on page 28.
  - For a description of the HiperSockets experience with DPM R5.2 compared to earlier releases, along with possible migration actions, see Chapter 16, "The HiperSockets user experience with DPM R5.2," on page 123.

Network interface cards (NICs) provide a partition with access to internal or external networks that are part of or connected to a system. Each NIC represents a unique connection between the partition and a specific network adapter that is defined or installed on the system.

Most systems have OSA adapters installed, and you will probably define a NIC to connect your partition to at least one of those OSA network connections. Your system planner or network administrator can advise you on which network connections to use for the workload that your partition supports. "Network adapters" on page 17 provides a conceptual illustration of partitions that are configured to use different types of network adapters for access to internal and external networks.

- Partitions A and B are both connected to the HiperSockets network within the DPM-enabled system, and to an OSA card for Ethernet access to an external network. (Depending on the DPM version that is installed on the system, you configure the NICs that the partitions use either through the **Configure Partition Links** task for a HiperSockets partition link, or through the Network section of the **New Partition** or **Partition Details** task.)
- Partition C has only one NIC defined, for access to a RoCE adapter, which provides Ethernet access between the DPM-enabled system and one other system in the network.
- If partitions A and B share the same OSA adapter or HiperSockets connection, you can create an SMC-D partition link (not shown in the figure) to attach to both partitions. Shared Memory Communications - Direct Memory Access (SMC-D) provides high-bandwidth, low-latency TCP/IP traffic over internal shared memory (ISM) devices for improved performance. For more information, see "SMC-D partition links" on page 29.

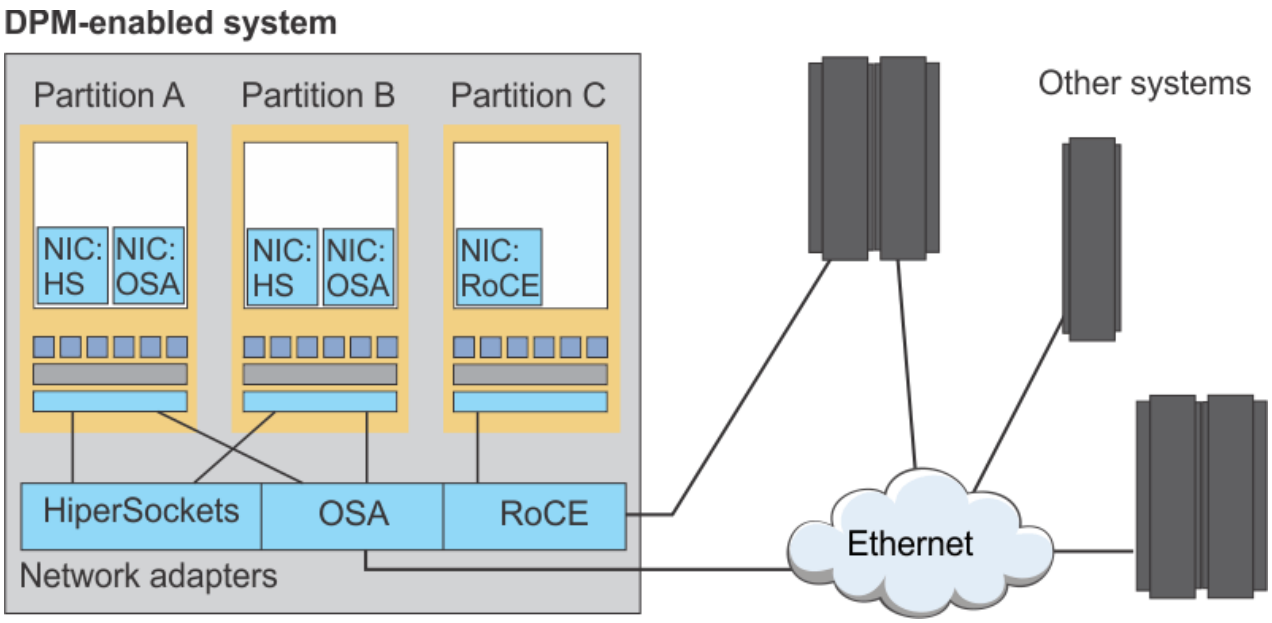

Figure 8. Partitions with NICs configured for access to network adapters on a DPM-enabled system

Storage adapters

Storage adapters provide partitions on a DPM-enabled system with access to external and internal storage devices. The type of available storage adapters varies, depending on the features installed on the system.

- FICON Express adapter cards connect the system to devices in the storage area network (SAN) through Fibre Channel connections. Each FICON adapter card is configured to operate in a specific mode, which determines the type of external storage device that can be connected to the adapter card.
  - Fibre Channel Protocol (FCP) mode provides access to Small Computer System Interface (SCSI) devices, which include tape libraries as well as disk storage.
  - FICON native (FC or FICON) mode provides access to extended count key data (ECKD) devices (also known as direct-access storage devices, or DASD).
- Non-Volatile Memory Express (NVMe) storage adapters use the PCI Express (PCIe) protocol to provide high-speed storage within a system. These storage adapters are available on IBM LinuxONE (LinuxONE) systems only, when those systems have IBM Adapter for NVMe1.1 features installed.

DPM automatically detects any storage adapters that are installed in the system. System or storage administrators use the **Configure Storage** task to connect external storage devices to the system, and to define storage groups or tape links that enable partitions to use storage resources. To access storage, you attach one or more storage groups or tape links to a partition, through either the **New Partition** task or **Partition Details** task. Also, you can attach tape links to selected partitions when you use the **Configure Storage** task either to create a tape link or to modify it.

For more information about storage adapter types, see the following topics.

- "FICON and FCP storage adapters" on page 19
- "NVMe storage adapters" on page 24

FICON and FCP storage adapters

Fibre Channel connections (FICON) provide high-speed data transfer between systems and storage devices. Fibre Channel networks consist of servers, storage controllers, and other storage devices as end nodes, which are interconnected by Fibre Channel switches, directors, and hubs. Switches and directors are used to build Fibre Channel networks or fabrics. Through cables, FICON adapter cards connect the DPM-enabled system to the devices in this storage area network (SAN).

FICON adapter cards operate in different modes, which determine the type of storage devices that you can access. Typically, storage administrators configure the mode in which each FICON adapter card operates.

- Fibre Channel Protocol (FCP) mode provides access to Small Computer System Interface (SCSI) devices, through single- or multiple-channel switches. Note that, because DPM runs all FCP adapters in N Port Identifier Virtualization (NPIV) mode, the SAN must support NPIV. Support for FCP mode is available with all DPM versions. In releases prior to R4.3, DPM detects but does not display FCP tape drives, so administrators cannot manage them through DPM tasks on the HMC; however, operating systems that are hosted by partitions on a DPM-enabled system can access those tape drives. Starting with DPM R4.3, however, administrators can use the **Configure Storage** task to view and manage tape devices, and to configure and provide access to tape storage.
- FICON native (FC or FICON) mode provides access to extended count key data (ECKD) devices, through point-to-point (direct) connections, or single- or multiple-channel switches. ECKD devices are more commonly known as direct-access storage devices (DASD). DPM supports access to ECKD devices, but does not support FICON tape drives. Starting with DPM R5.2, FICON channel-to-channel (CTC) is supported through partition links, but only for network connections between partitions on the same system (not for connections to storage devices). Also, DPM supports the use of parallel access volumes, but only through the optional HyperPAV feature on the IBM System Storage DS8000® series. Support for FICON mode is available with DPM R3.1 and later DPM versions.

Figure 9 on page 20 shows a sample physical FICON network that can be configured for a system that supports FCP tape and disk storage and FICON DASD.

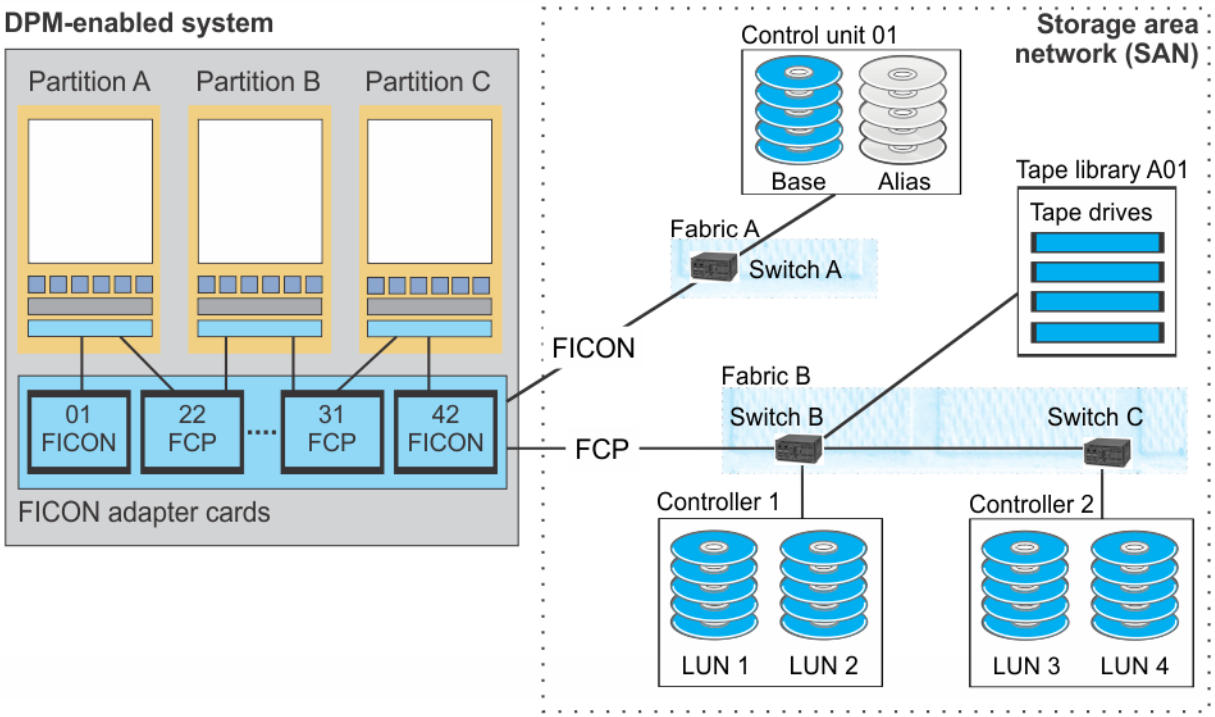

Figure 9. Sample physical FICON and FCP storage configuration

In Figure 9 on page 20:

- Partitions can access FICON storage devices, FCP storage devices, or both: Partitions A and C can access both, while Partition B accesses only FCP storage devices.
- Adapter cards 01 and 42 provide access through a single switch (A) to FICON DASD on Control Unit 01.
- Adapter cards 22 and 31 provide access through cascaded switches (B and C) to FCP storage disks on Controllers 1 and 2.
- Adapter cards 22 and 31 also provide access through switch B to tape drives on tape library A01.

DPM automatically discovers any FICON adapter cards that are configured on the system. These storage adapter cards are FICON Express features, which enable multiple concurrent I/O operations at various data transmission rates in gigabytes-per-second (Gbps), using Fibre Channel connections. The supported FICON Express adapter cards vary, depending on the system configuration; for example, the z14 supports the FICON Express16S+, FICON Express16S, and FICON Express8S adapter cards. For a list of the storage adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

System or storage administrators use the **Configure Storage** task to connect a system to devices in the SAN. They define the protocol mode of system adapters as either FCP or FICON and they build a visual copy of the FICON connections of the SAN to which the system is attached. Through this process, DPM generates the virtual configuration that is required to connect the system to the physical SAN hardware.

After completing the initial configuration through the **Configure Storage** task, and after attaching physical cables to connect the system to storage devices, administrators use the **Configure Storage** task to request and fulfill storage groups and tape links for partitions to use.

- For more information about storage groups, see “FICON and FCP storage groups” on page 21.
- For more information about tape links, see “FCP tape links” on page 22.

FICON and FCP storage groups

A *storage group* is a logical group of storage volumes that share certain attributes. For example, one attribute is shareability: you can define a storage group as either dedicated for use by only one partition, or shared by multiple partitions. When an administrator submits a request for one or more storage groups, DPM automatically generates the world wide port names (WWPNs) that are allocated to virtual storage resources when the storage group is attached to a partition. The request goes to one or more storage administrators, who fulfill the request through tools for managing storage subsystems.

To access disk storage, you attach one or more storage groups to a partition, through either the **New Partition** task or **Partition Details** task. During the attachment process, DPM generates the virtual storage resources (host bus adapters or FICON subchannels) that are required for partitions, and the operating systems that they host, to access the physical storage volumes in the SAN.

Figure 10 on page 21 shows several storage groups with key attributes, and information about the physical devices that an administrator has configured to fulfill them. These physical devices are the same as the devices shown in Figure 9 on page 20.

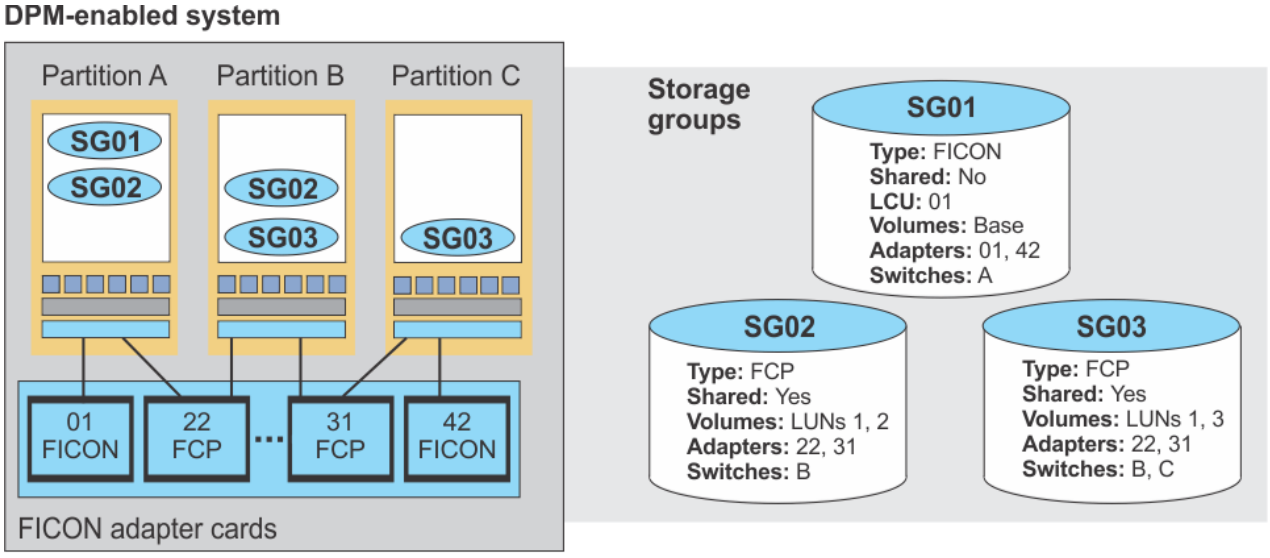

Figure 10. Sample FICON and FCP storage groups that are attached to partitions on the system

In Figure 10 on page 21, the ovals in the partitions indicate which storage groups are attached to each partition.

- Partition A can access storage group SG01, which consists of a set of FICON base volumes that are dedicated for use by only one partition. Partition A accesses these volumes through FICON-mode adapter card 01 and switch A.
- Partitions A and B share storage group SG02, which consists of FCP disks that both partitions can access through FCP-mode adapter card 22 and switch B.
- Similarly, partitions B and C share storage group SG03, which consists of FCP disks that both partitions can access through FCP-mode adapter card 31 and cascaded switches B and C.

FCP tape links

A *tape link* defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN. These attributes include storage resources such as system adapters, world wide port names (WWPNs), and the number of partitions that can share the connection. When an administrator submits a request for a tape link, DPM automatically generates the WWPNs that storage administrators use to fulfill the tape link request. The request goes to one or more storage administrators, who fulfill the request through tools for managing SAN switches.

To access tape storage, you attach one or more tape links to a partition, through the following methods:

- Through the **Configure Storage** task, either when you are creating a new tape link, or modifying an existing tape link. During either process, you can select partitions to which you want to attach the tape link.
- Through the **Storage** section of the **New Partition** task or **Partition Details** task.

When you finish the task or save your changes, DPM generates the HBAs that are required for partitions, and the operating systems that they host, to access the physical tape library in the SAN.

Figure 11 on page 22 shows two tape links with key attributes, and information about the physical devices that an administrator has configured to fulfill them.

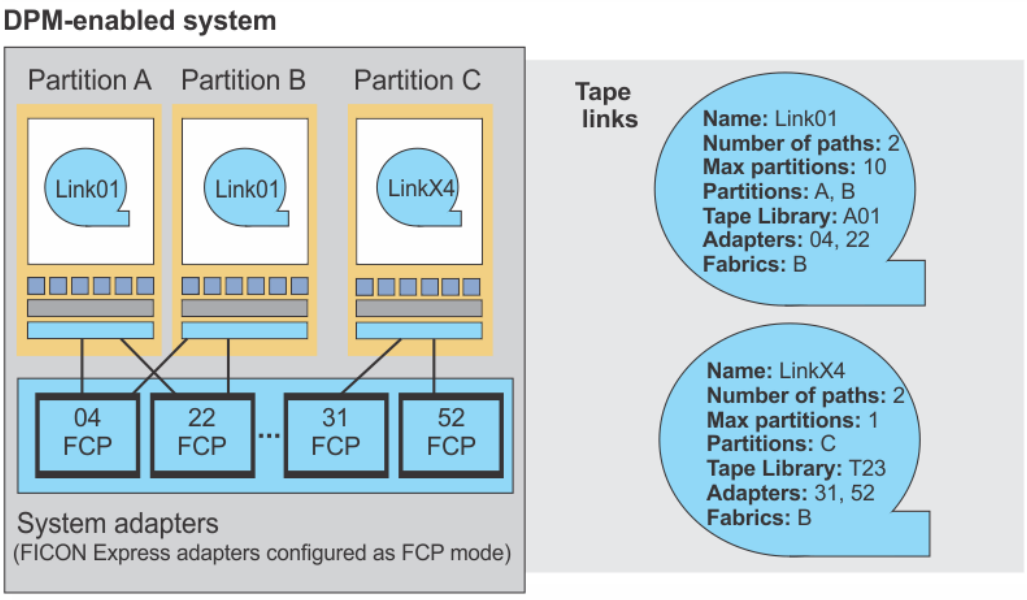

Figure 11. Sample FCP tape links that are attached to partitions on the system

In Figure 11 on page 22, the circles in the partitions indicate which tape links are attached to each partition.

- Partitions A and B share tape link Link01, which provides access to tape drives in tape library A01 through FCP-mode adapter cards 04 and 22 and fabric B.
- Partition C has exclusive access to tape link LinkX4, which provides access to tape drives in tape library T23 through FCP adapters 31 and 52 and fabric B.

For a tape link environment to be properly configured, all adapters that use the same fabric must have access through at least one control path to the same set of drives in the tape library. The following figures show different configurations for which a tape link is in Complete fulfillment state. In each figure, the two FCP adapters on the DPM-enabled system are both connected to the same two fabrics, which are labeled SAN Switch A and SAN Switch B. The differences between these tape environments include the tape library drives to which the adapters have access; the number of ports in use for each tape library drive; and the number of configured control paths (which are highlighted in yellow).

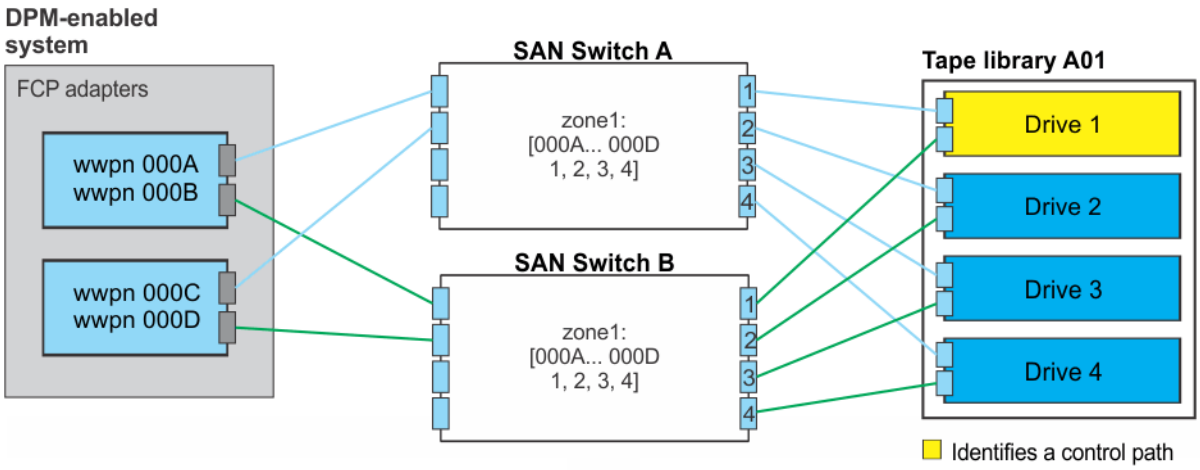

Figure 12. Example 1: adapters can access the same tape library drives through both drive ports and one control path

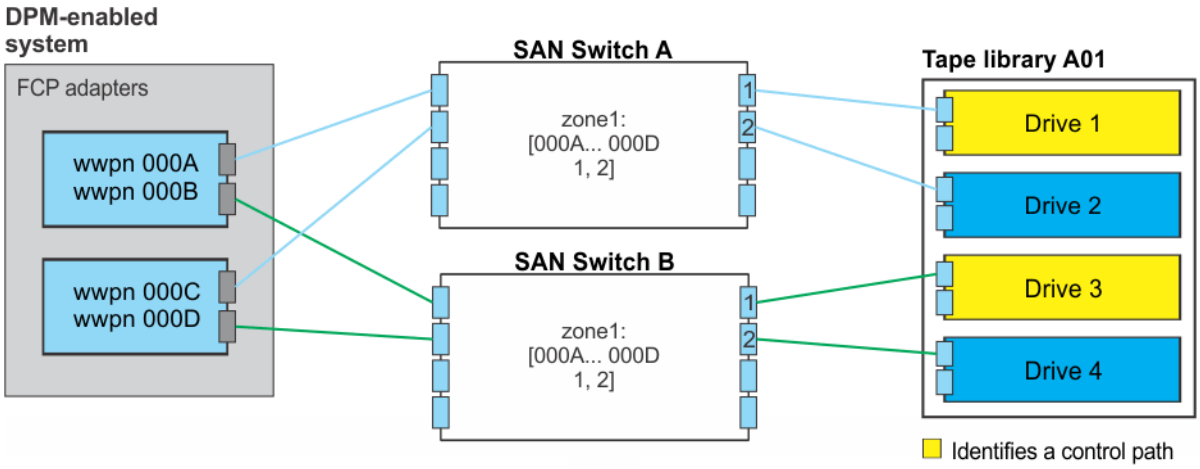

Figure 13. Example 2: adapters can access different tape library drives through single drive ports and a separate control path per fabric

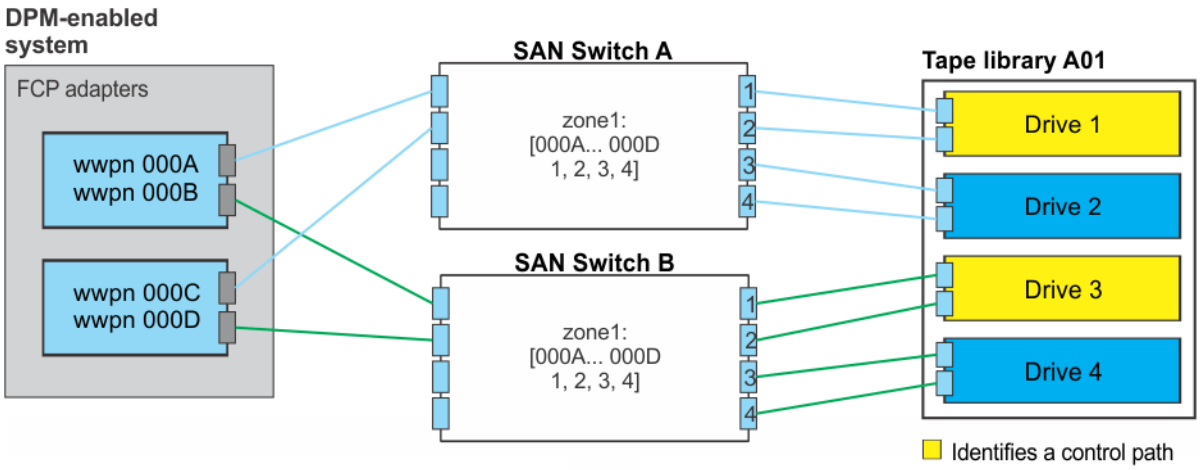

Figure 14. Example 3: adapters can access different tape library drives through both drive ports and a separate control path per fabric

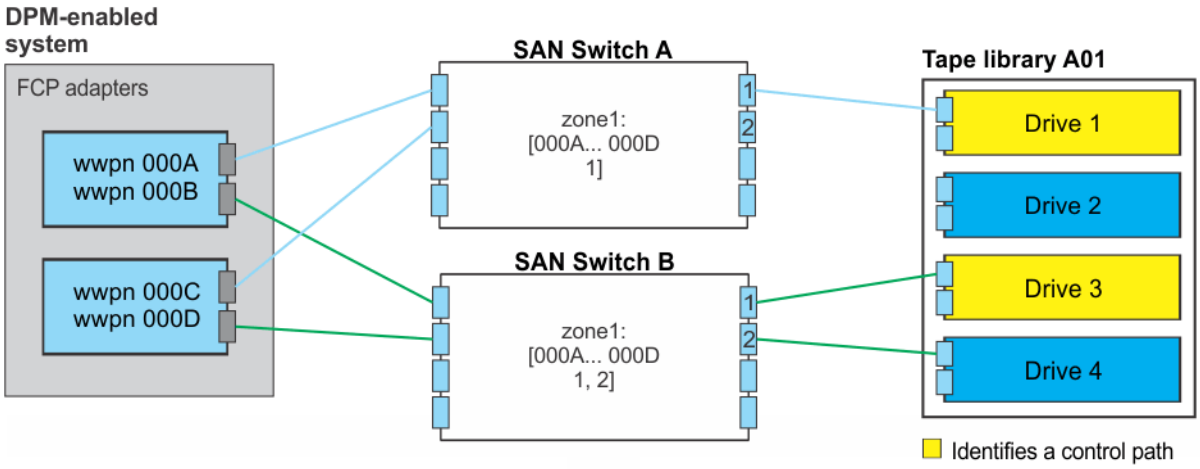

Figure 15. Example 4: adapters can access a different number of tape library drives through single drive ports and a separate control path per fabric

NVMe storage adapters

Starting with DPM R4.2, system administrators can enable partitions to use NVMe storage on a system that has IBM Adapter for NVMe1.1 features installed. These features are available on IBM LinuxONE (LinuxONE) systems only.

Non-Volatile Memory Express (NVMe) storage adapters use the PCI Express (PCIe) protocol to provide high-speed storage within a system. Each NVMe adapter consists of two pieces of hardware: an IBM-supplied carrier card installed in a system I/O drawer, and the solid state drive (SSD) that customers purchase. IBM service representatives install the NVMe SSDs in the carrier cards after the system is delivered to the customer site.

DPM automatically discovers any NVMe carrier cards that are installed in the system, and can detect whether an SSD is installed in each carrier card. Through **Connect Storage** and **Storage Cards** in the **Configure Storage** task, system administrators can view NVMe adapters in the visual display of system frames and I/O drawers, and view specific details about each adapter; for example, you can tell whether the carrier card has an SSD installed. They also can use the **Manage Adapters** task to view NVMe adapters, but these adapters are displayed in that task only when an SSD is installed in a carrier card. You cannot use either task to reconfigure NVMe storage adapters; reconfiguration requires properly removing

the carrier card and its SSD from the drawer and reinstalling them in a different physical location, as instructed by a service representative.

Through **Request Storage** in the **Configure Storage** task, system administrators can create a storage group containing one or more available NVMe SSDs that are installed in carrier cards. You can define these SSDs as either boot or data volumes.

To enable partitions to use NVMe storage, use either the **New Partition** task or **Partition Details** task to attach the storage group to the partition. You can attach one or more NVMe storage groups, and select an SSD volume in an attached NVMe storage group as the boot volume for an operating system or hypervisor. Note that only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared. However, a partition that has attached NVMe storage groups can also have attached FICON and FCP storage groups, and FCP tape links.

Crypto adapters

The term *cryptos* is a commonly used abbreviation for adapters that provide cryptographic processing functions. Industry Public Key Cryptography Standards (PKCS) and the Common Cryptographic Architecture (CCA) define various cryptographic functions, external interfaces, and a set of key cryptographic algorithms. These specifications provide a consistent, end-to-end cryptographic architecture across supported operating systems.

The use of the IBM cryptographic architecture is enabled through Crypto Express features, which provide a secure hardware and programming environment for cryptographic processes. The supported Crypto Express features vary, depending on the system configuration; for example, the z14 supports the Crypto Express6S and Crypto Express5S features. For a list of the cryptographic adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

DPM automatically discovers cryptographic features that are installed on the system. Each Crypto Express adapter can be configured in one of the following modes.

- Secure CCA coprocessor (CEX4C) for Federal Information Processing Standard (FIPS) 140-2 Level 4 certification.
- IBM Enterprise PKCS#11 (EP11) coprocessor (CEX4P) for an industry-standardized set of services that adhere to the PKCS #11 specification v2.20 and more recent amendments.
- Accelerator (CEX5A) for acceleration of public key and private key cryptographic operations that are used with Secure Sockets Layer/Transport Layer Security (SSL/TLS) processing.

Additionally, you can enable or disable the key import functions that are available through the CP Assist for Cryptographic Functions (CPACF) feature. CPACF supports clear and protected key encryption based on the Advanced Encryption Standard (AES) algorithm, and the Secure Hash Algorithm (SHA) with the Data Encryption Standard (DES) algorithm, and the Elliptic Curve Cryptography (ECC) algorithm. For operating systems and applications to take advantage of key encryption support, the partition in which they run must be configured to permit AES, or DES, or ECC protected key import functions.

Crypto features are optional and, therefore, might not be installed on the system. If these features are installed, your decision to enable your partition to access them depends on your company's security policies, and the workload that your partition will support. Your system planner or security administrator can advise you about the use of available crypto features.

Partition links

A *partition link* interconnects two or more partitions that share the same network configuration and reside on the same system. To create and manage a partition link, use the **Configure Partition Links** task.

To open the **Configure Partition Links** task to the partition links overview, you do not need any specific task authorization; however, to view any partition links in the overview, you must have object access to one or more partition links. To create, delete, or edit a partition link, you also must have a customized user ID with the predefined System Programmer Tasks role or equivalent permissions. For more details about authorization requirements, see the online help for the **Configure Partition Links** task.

The following list describes the types of partition links that you can create and manage through the **Configure Partition Links** task. Note that the DPM release that is installed on the system determines which types you can create and use.

FICON CTC
Starting with DPM R5.2, you can create FICON CTC partition links, which use Fibre Connection (FICON) channel-to-channel (CTC) connections to provide fast and efficient data transfer between partitions that reside on the same system.

For more information, see "FICON CTC partition links" on page 26.

HiperSockets
Starting with DPM R5.2, you can create HiperSockets partition links, which use HiperSockets technology to provide high-speed communication between partitions that reside on the same system.

For more information, see "HiperSockets partition links" on page 28.

SMC-D
Starting with DPM R5.0, you can create SMC-D partition links, which enable communication between partitions on the same system through the Shared Memory Communications - Direct Memory Access (SMC-D) Version 2 technology, which provides high-bandwidth, low-latency TCP/IP traffic over internal shared memory (ISM) devices for improved performance.

For more information, see "SMC-D partition links" on page 29.

FICON CTC partition links

Starting with DPM R5.2, you can create FICON CTC partition links. A FICON CTC partition link can connect only partitions that reside on the same system. These partitions use the partition link only for data transfer among the group of partitions; a FICON CTC partition link does not provide access to storage devices. The system on which the partitions reside must have FICON connections that are available to use as paths for the partition link.

When you create a FICON CTC partition link, you define the link characteristics (such as name and type); add at least two existing partitions to use the link; define the configured network paths for all added partitions to use; and define the devices that enable the added partitions to communicate through the new link. To view existing or configure new FICON connections (paths), you can use a link in the **Configure Partition Links** task to go to **FICON CONNECTIONS**, which is part of the **Configure Storage** task.

- For an overview of the updates to **FICON CONNECTIONS**, see Chapter 17, "Configuring FICON connections for use with FICON CTC partition links," on page 127.
- For instructions and authorization requirements for creating a FICON CTC partition link, see the *New partition link: FICON CTC* topic in the online help for the **Configure Partition Links** task.

One advantage to using FICON CTC partition links is the ability to configure a z/VM Single System Image (SSI) cluster to reduce the complexity of adding and managing z/VM hypervisors. With an SSI cluster in place, you can configure Live Guest Relocation (LGR) to avoid planned outages by moving Linux virtual servers without disruption to their workloads.

For example, consider the four partitions in Figure 16 on page 27.

- All of these partitions are running the z/VM operating system and reside on the same DPM-enabled system. The z/VM operating system must be z/VM Version 7.1 or later.
- On that system, an administrator has defined FICON connections that use the following FICON adapters: FICON 0108 A01B-04, FICON 0140 A20B-02, FICON 0109 A01B-04, and FICON 0141 A20B-02. These connections are defined as switched connections that are intended for both CTC and Storage usage, which means that these connections go through a configured fabric and switch in the storage area network (SAN), and can be used for both network traffic between partitions on the same system, and data transfer between the system and storage devices.

With this configuration, the four partitions can be interconnected through a FICON CTC partition link and can become members of a z/VM SSI cluster.

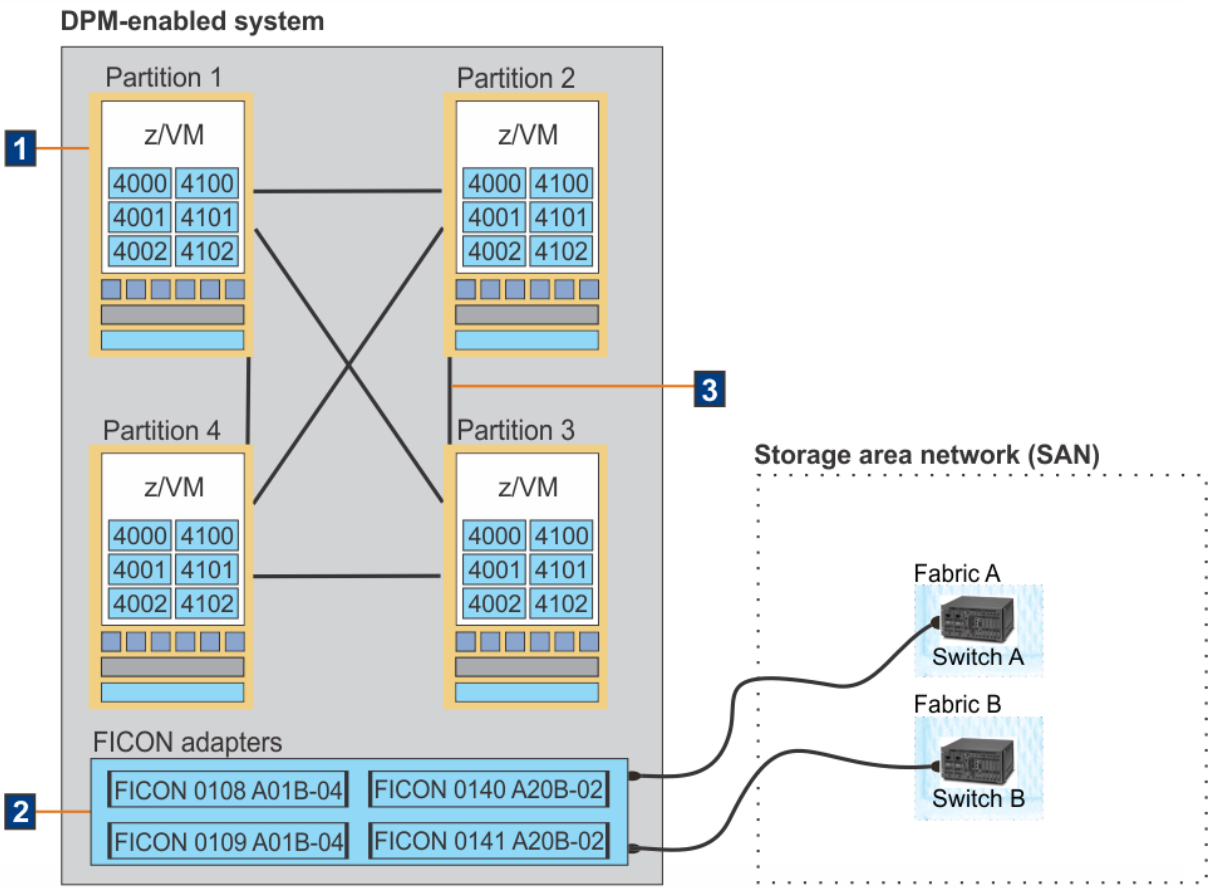

Figure 16. Sample z/VM SSI cluster, with members interconnected through a FICON CTC partition link

Given the configuration shown in Figure 16 on page 27, an administrator uses the **Configure Partition Link** task to create a FICON CTC partition link, providing a name for the link and selecting the DPM-enabled system. The administrator then completes the following steps through the **Configure Partition Link** task.

1. Adds the four partitions to the list of partitions that can use the FICON CTC partition link.
2. Defines the paths to interconnect the four partitions. Only one path is required, but defining at least two paths is the suggested practice, for improved bandwidth, performance, and redundancy. The administrator defines each path, one at a time, by completing the following steps.
   a. Selects **Add path** to add an existing path.
   b. Through the Add path dialog, selects **Switched** as the type of path to add. (Other connection types are available for different use cases.)
   c. Selects the first set of adapters, FICON 0108 A01B-04 and FICON 0140 A20B-02, from the drop-down lists, and selects **Add** to add the path. These two system adapters are both connected to Switch A in Fabric A. When the administrator creates the partition link, a path is established from adapter FICON 0108 A01B-04 to Switch A, and back into adapter FICON 0140 A20B-02.
   d. Repeats these steps to add another path that uses a second set of adapters: FICON 0109 A01B-04 and FICON 0141 A20B-02. These two system adapters are both connected to Switch B in Fabric B. When the administrator creates the partition link, a path is established from adapter FICON 0109 A01B-04 to Switch B, and back into adapter FICON 0141 A20B-02.
   e. Selects **Next** to proceed to the next step.
3. Reviews the device information associated with each added partition. Devices numbers are automatically supplied, but the administrator can change them. Figure 17 on page 28 shows the sample device numbers assigned to each partition for the first path, which uses adapters FICON 0108

A01B-04 and FICON 0140 A20B-02. The device number assignment for the second path (adapters FICON 0109 A01B-04 and FICON 0141 A20B-02) is similar, except the device numbers are 4100, 4101, and 4102.

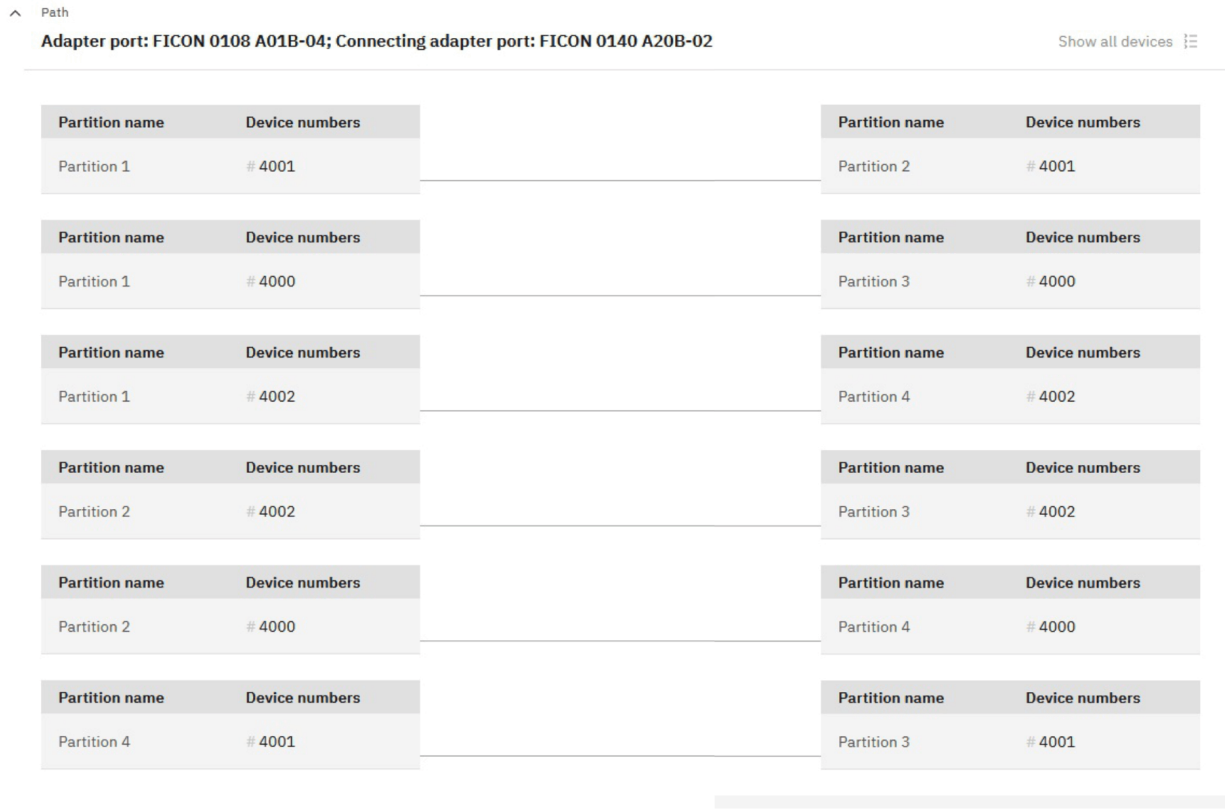

Figure 17. Sample device number assignments for partitions using a FICON CTC partition link

After the administrator reviews the summary for the new FICON CTC partition link and selects **Create** to create it, DPM asynchronously attaches the partition link to all four partitions.

With the FICON CTC partition link defined and attached to all four partitions, it is ready for use. The paths that it provides can be used for Inter-System Facility for Communications (ISFC) based SSI communications. If any of the selected partitions are active at the time this partition link is created, you might need to use commands on the operating system of each active partition to verify that the devices are available, configure them for use, and to confirm data transfer between the connected partitions.

- For detailed instructions about defining a FICON CTC partition link, see the *New partition link: FICON CTC* topic in the online help for the **Configure Partition Links** task. This topic includes sample z/VM commands for configuring and verifying the data transfer between active partitions.
- For information about z/VM SSI clusters, go to the z/VM library in IBM Documentation (https://www.ibm.com/docs/en/zvm), select the version of z/VM that you are using, and search for the topic, *Setting Up z/VM Single System Image Clusters*.

HiperSockets partition links

Starting with DPM R5.2, you can create HiperSockets partition links, which connect partitions that reside on the same system. HiperSockets are virtual adapters that provide high-speed communications between partitions within a single system, without the need for any physical cabling or external networking connections. The communication is through the system memory, so a HiperSockets adapter and switch provide access to an I/O channel that is analogous to an internal local area network (LAN).

The HiperSockets implementation is based on the OSA-Express Queued Direct I/O (QDIO) protocol, and is sometimes called internal QDIO, or IQDIO. Each HiperSockets partition link consists of one HiperSockets adapter and switch for all of the partitions that use the partition link. A DPM-enabled system supports up to 32 HiperSockets adapters.

Each HiperSockets adapter supports several different maximum frame size (MFS) settings to accommodate different bandwidth requirements. The MFS setting determines the size of the largest packet that TCP/IP can transmit; on activation, TCP/IP adjusts its maximum transmission unit (MTU) according to the value of the MFS setting.

When you create a HiperSockets partition link, you define the link characteristics (such as name, type, and MFS setting); add at least two existing partitions to use the link; and define the devices that enable the added partitions to communicate through the new link. For instructions and authorization requirements, see the *New partition link: HiperSockets* topic in the online help for the **Configure Partition Links** task.

Support for HiperSockets is available in prior releases of DPM; however, with DPM R5.2, you need to use different HMC tasks to create, edit, and delete HiperSockets connections. With previous releases of DPM, administrators used a combination of the **Manage Adapters** task, the **New Partition** task, and the **Partition Details** task to create and manage HiperSockets connections. Starting with R5.2, you create and manage HiperSockets through the **Configure Partition Links** task, which provides a simplified and streamlined user experience. For more information about this change, and potential migration actions that you might need to take, see Chapter 16, “The HiperSockets user experience with DPM R5.2,” on page 123.

SMC-D partition links

Starting with DPM R5.0, you can create SMC-D partition links, which enable communication between partitions on the same system through the Shared Memory Communications - Direct Memory Access (SMC-D) Version 2 technology. This technology provides high-bandwidth, low-latency TCP/IP traffic over internal shared memory (ISM) devices for improved performance. To configure an SMC-D partition link, use the **Configure Partition Links** task.

An SMC-D partition link uses one virtual peripheral component interconnect (PCI) adapter, which, on IBM Z and LinuxONE systems, is called an internal shared memory (ISM) adapter. Each ISM adapter is uniquely identified by its virtual channel identifier (VCHID), and is externalized as a virtual function ID (FID). A function ID is a hexadecimal number that uniquely identifies the ISM device that is assigned to a specific partition. Each system has a limit of 32 ISM adapters, and each ISM adapter can have up to 256 FIDs, depending on the number of FIDs that are already in use on the system. To create an SMC-D partition link, at least one VCHID and at least two FIDs must be available on the system.

The partitions that use the same SMC-D partition link must share the same Open Systems Adapter-Express (OSA-Express) adapter or HiperSockets connection. This shared network connection is required for the initial "handshake" through the full TCP/IP stack, to establish the connection. Afterward, communication between the partitions takes place over the ISM device, effectively eliminating the overhead of traffic flow through the full TCP/IP stack.

To visualize the setup and configuration for an SMC-D partition link, consider the configuration shown in Figure 18 on page 30.

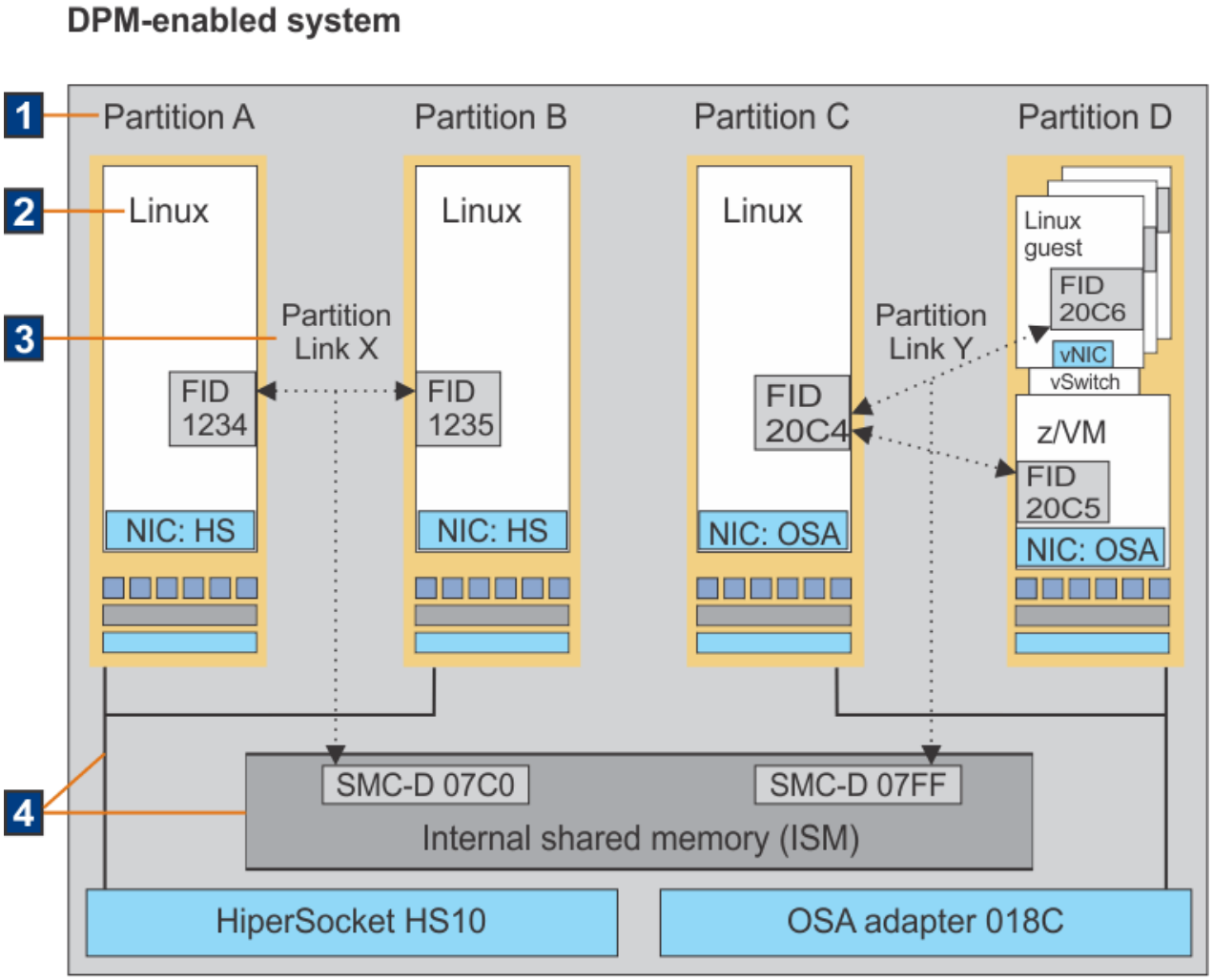

Figure 18. Sample SMC-D partition links configuration

1. This DPM-enabled system has four partitions that are configured to use either HiperSockets or OSA adapters to communicate with other partitions. Partitions A and B have network interface cards (NICs) configured to use HiperSocket HS10 as one of their network connections, while partitions C and D have NICs configured so they share OSA adapter 018C as one of their network connections. (Depending on the DPM version that is installed on the system, you configure the NICs that the partitions use either through the **Configure Partition Links** task for a HiperSockets partition link, or through the Network section of the **New Partition** or **Partition Details** task.)
2. Partitions A, B, and C each host one Linux distribution; partition D hosts a z/VM hypervisor with Linux guests. To take advantage of SMC-D Version 2 technology, a Linux administrator installs the `smc-tools` package on each Linux distribution, and enables the kernel configuration `CONFIG_SMC` and `CONFIG_SMC_DIAG` variables to use the socket monitoring interface. Also, the applications running on each Linux distribution are configured to use `AF_SMC` sockets.
3. To enable the partitions in this example to support the use of SMC-D, you need to create two SMC-D partition links, X and Y, because not all partitions have the same network configuration. (If all four partitions had a NIC configured for the same virtual HiperSockets or physical OSA adapter, you could define only one partition link and add all four partitions.)

   To create partition links X and Y, use the **Configure Partition Links** task to complete the following steps. You can define only one partition link at a time.

   a. Specify the system and other partition link attributes: the SMC-D type, partition link name, and an optional description.

b. Add at least two partitions to interconnect through the partition link. The list of partitions that you can add is limited to those partitions to which your HMC user ID has object access.

c. Review the automatically assigned function IDs that are associated with the added partitions. By default, each partition has one assigned function ID. For example, for partition A, the function ID 1234 is the external representation of the ISM adapter for partition link X (SMC-D 07C0).

   You have the option of changing the function ID numbers or adding function IDs, depending on the requirements of the operating system, hypervisor, or workload that the partition hosts. For example, Partition D hosts a z/VM hypervisor with Linux guests, each of which have a separate function ID to associate with the ISM adapter for partition link Y (SMC-D 07FF).

d. Submit the request to create the partition link. As a result:

   - The partition link is associated with an ISM adapter on the specified system. Each ISM adapter has a name that consists of the partition link type and the hexadecimal 4-character VCHID. For partition link X, the adapter name is SMC-D 07C0; for partition link Y, the adapter name is SMC-D 07FF.
   - The partition link is asynchronously attached to the partitions that you added during the create process. In this example, partition link X is attached to partitions A and B, and partition link Y is attached to C and D. (For partitions in Active state, DPM dynamically configures the partition link as soon as it is created.)

4. After you start the partitions, use Linux commands to bring the function IDs online and verify that they are available. For example, on the operating system console for partition A, enter `echo 1 >/sys/bus/pci/slots/00001234/power` to bring the function ID online, then use the `lspci` command to verify that the device is available.

   After entering similar commands on the operating system console for partition B, the Linux operating systems running on partitions A and B can complete their initial communication through TCP/IP using HiperSocket HS10. Afterward, the TCP/IP traffic between partitions A and B flows over the partition link, through the ISM adapter SMC-D 07C0. Similarly, after entering the appropriate Linux commands and completing the initial TCP/IP communication between the operating systems on partitions C and D, the TCP/IP traffic between those partitions flows over the partition link Y, through the ISM adapter SMC-D 07FF.

For more information about the **Configure Partition Links** task and the authorization required to use it, see the HMC online help for that task. For prerequisites and information sources for SMC-D Version 2, see “About partition links” on page 97.

Chapter 5. Operating systems and hypervisors

Partitions on a DPM-enabled system can host a single operating system or hypervisor. DPM supports the Linux operating system and several specialized hypervisors.

Partition types and supported operating systems and hypervisors

Administrators can choose one of the following partition types for a new partition. Through the partition type, DPM can optimize the partition configuration for a specific hypervisor or operating system.

Linux
In this type of partition, you can install and run various Linux distributions, which are listed on the IBM tested platforms page for Linux environments. These distributions include supported versions of Red Hat Enterprise Linux (RHEL), SUSE Linux Enterprise Server (SLES), and Ubuntu Server (KVM or LPAR DPM). Depending on its intended use, the Linux distribution can function as a single operating system image, or as a hypervisor that hosts multiple guests (for example, Ubuntu KVM).

z/VM
In this type of partition, you can install and run z/VM 7.1 or later. z/VM is supported as a virtualization hypervisor on which you can run multiple Linux images.

Secure Service Container
This type of partition is a Secure Service Container, in which you can run only specific software appliances that the Secure Service Container supports.

Figure 19 on page 33 shows a sample configuration of Linux servers and possible workloads.

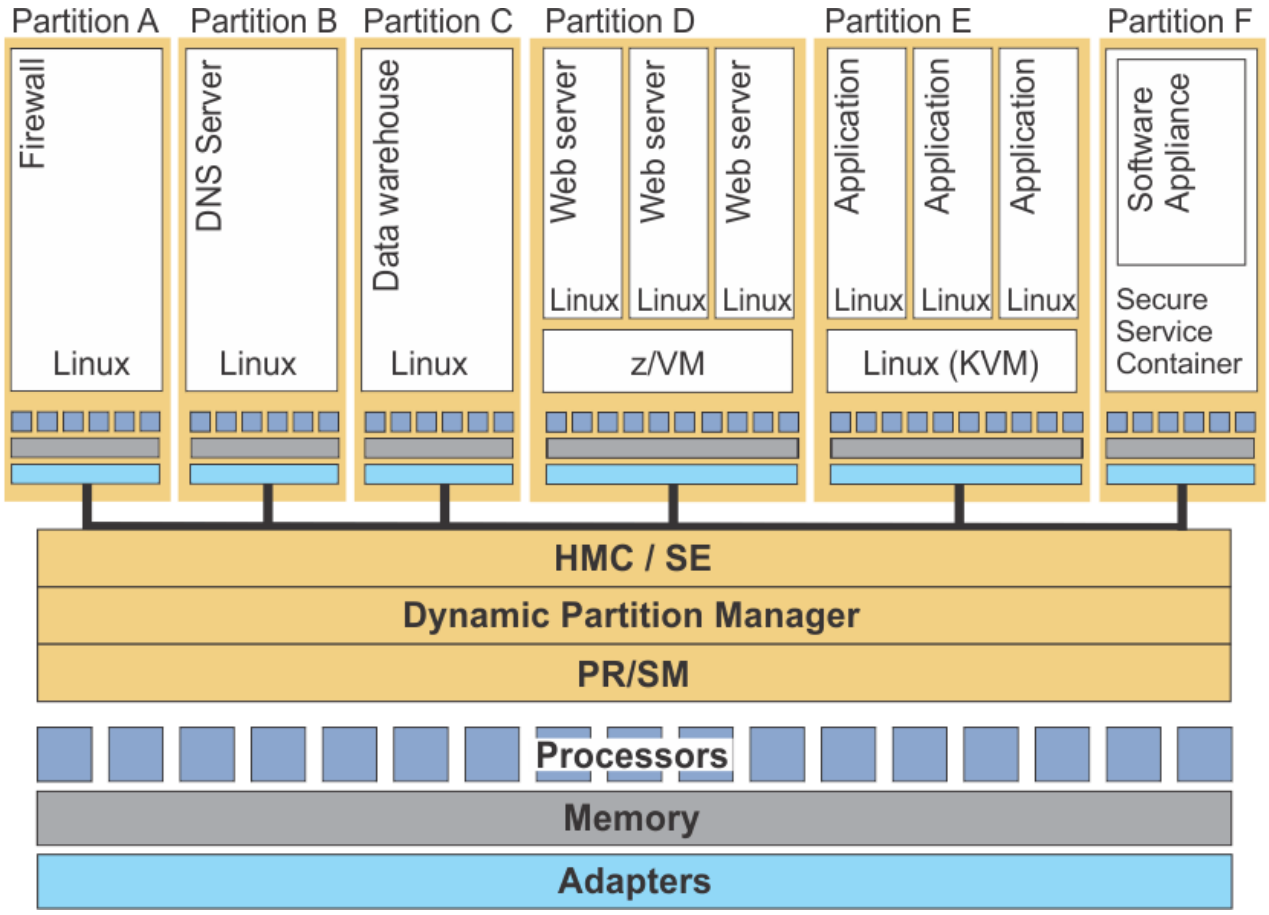

Figure 19. Example: Linux servers configured in partitions on a DPM-enabled system

- Partitions A, B, and C each support a single Linux server that provides specific functions or applications within the environment: firewall protection, domain name server (DNS), and data warehouse.
- Partition D is configured to run a z/VM hypervisor that hosts multiple Linux web servers.
- Partition E is configured to run a Linux hypervisor (for example, Ubuntu KVM) and multiple Linux images running various applications.
- Partition F is configured as a Secure Service Container that hosts a software appliance.

For details about the specific versions of operating systems and hypervisors that DPM supports, see "Requirements for the hypervisor or operating system" on page 98.

Installing an operating system or hypervisor in a partition

When you define a partition, you can specify the boot option through which DPM locates and installs the executables for the hypervisor or operating system to be run on the partition. You can select a boot option through the Boot section of the **New Partition** task or, for an existing partition, the **Partition Details** task.

If you are using the advanced mode of the **New Partition** task, or using the **Partition Details** task, you also have the option of setting a time limit for the boot operation. By default, the time-out setting has a value of 60 seconds.

Select a boot option that is appropriate for the type of partition that you are defining.

- "Boot options for Linux partitions" on page 34
- "Boot options for z/VM partitions" on page 35
- "Boot option for Secure Service Container partitions" on page 37

Boot options for Linux partitions

For partitions with a type of **Linux**, you can choose one of several different options, including booting from a storage device, network server, and Hardware Management Console (HMC) removable media. The following list provides a summary of boot options for Linux partitions; for more detail about boot options, see step "9" on page 56 in "Creating a new partition" on page 49, or use the online help for the **New Partition** task or the **Partition Details** task.

None
Select this option if you want to start a partition without a hypervisor or operating system. Although the partition can be started, it is not in a usable state.

Storage device (SAN)
Select this option when the hypervisor or operating system executables reside on an internal or external storage device. This option is available only when at least one storage group is attached to the partition. When you specify this option, you need to select a boot volume in an attached storage group; you can select a boot volume in any attached FCP, FICON, or NVMe storage group. If you plan to boot the operating system or hypervisor from a volume in an NVMe storage group, check the product documentation for the operating system or hypervisor to make sure that it supports booting from NVMe storage.

Note: Starting with DPM R4.0, you can select options to validate the operating system image that you boot from a volume in a storage group. For more information, see Chapter 14, "Validating boot images of operating systems," on page 119.

Network server (PXE)
Select this option when you want to use a preboot execution environment (PXE) on a network server. This option is available only if a network interface card (NIC) for either an OSA port or HiperSockets switch is defined for the partition. (Depending on the DPM version that is installed on the system, a HiperSockets switch is configured for a partition either through the **Configure Partition Links** task for a HiperSockets partition link, or through the Network section of the **New Partition** or **Partition Details** task.)

FTP server
Select this option if you want to use FTP to boot an image that is located on a different system. To specify this option, you need to provide the host name, user name, and password associated with the FTP server, as well as an .INS file, which maps image components (for example, kernel, ramdisk, parameter file) to the appropriate storage addresses in main memory.

FTPS server
Select this option if you want to use the FTP Secure (FTPS) protocol to boot an image that is located on a different system. FTPS uses the Secure Socket Layer (SSL) protocol to secure data. With this option, you need to supply a host name, user ID, password, and .INS file, as described for the **FTP server** boot option.

SFTP server
Select this option if you want to use the Secure File Transfer Protocol (SFTP) to boot an image that is located on a different system. SFTP uses the Secure Shell (SSH) protocol to secure data. With this option, you need to supply a host name, user ID, password, and .INS file, as described for the **FTP server** boot option.

Hardware Management Console removable media
Select this option if you want to use an INS file from a media drive that is connected to the HMC. The media drive must be available when you are creating the partition definition and when the partition is started. Possible drive selections are **CD/DVD drive** or **USB flash memory drive**, depending on what media drives are installed in the HMC.

ISO image
Select this option when you want to upload an ISO file that is located on your workstation file system. This option is available only when you are connecting to the HMC through a remote browser. An ISO file is a collection of files and metadata for installing software.

Boot options for z/VM partitions

For partitions with a type of **z/VM**, you can choose one of several boot options that are described in step "4" on page 36 of the following procedure, which provides an overview of the DPM-specific portion of a traditional, first-level z/VM installation process. For complete instructions, use the *Installation Guide* for the version of z/VM that you are installing. The z/VM library is available in IBM Documentation at https://www.ibm.com/docs/en/zvm

1. Prepare to access the installation files. Note that, depending on the system, a DVD drive might not be available on the HMC. In this case, you can use an alternate HMC media drive instead of a DVD drive, or use an electronic deliverable.
   - If you are using the **Hardware Management Console removable media** boot option, load the z/VM product DVD in the HMC DVD drive. Note that, when you select this option, installation can take up to several hours to complete.
   - If you are using any of the FTP boot options, upload the contents of each DVD or electronic deliverable to a new directory on the FTP server. After the contents of the z/VM product deliverable have been uploaded, upload the contents of the installation recommended service upgrade (RSU) deliverable to the same directory, overwriting any duplicate files. (For details about directory path names and required space, see the z/VM *Installation Guide*.)
   - If you are using the **ISO image** boot option, complete the following steps.
     a. Upload the contents of each DVD or electronic deliverable to a new directory on your hard drive.
     b. After the contents of the z/VM product deliverable have been uploaded, upload the contents of the installation recommended service upgrade (RSU) deliverable to the same directory, overwriting any duplicate files. (For details about directory path names and required space, see the z/VM *Installation Guide*.)
     c. Using the tool of your choice, create an ISO image file of the directory.
2. On the main HMC page, expand the **Systems Management** node to view managed systems, and select the DPM-enabled system on which the partition resides. On the **Partitions** tab for the selected system, find the table entry for the z/VM partition, and select it.

3. Open an integrated 3270 console for the partition in which you are installing z/VM. You can open the **Integrated 3270 Console** task through the cascading task menu next to the partition name, or through the Recovery category in the task area.
4. Open the **Partition Details** task and navigate to the **Boot** section.
   a. Specify one of the following boot options, and select the INS file for the version of z/VM that you are installing; for example, `710VM.ins`

      Hardware Management Console removable media
      Select this option if you want to use an INS file from a media drive that is connected to the HMC. The media drive must be available when you are creating the partition definition and when the partition is started. Possible drive selections are **CD/DVD drive** or **USB flash memory drive**, depending on what media drives are installed in the HMC.

      When you select this option:

      i) If more than one type of media drive is available on the HMC, select the radio button for the media drive on which the INS file resides. Otherwise, skip to the next step.

      ii) Either enter the fully qualified name (relative to the mount point) of an INS file, or complete the following steps.

         a) Select **Browse** to start a search on the target media drive to retrieve a list of INS files. Any INS files found are displayed in a separate window.

         b) Select only one INS file and click **OK** to close the Browse Removable Media window.

      FTP server
      Select this option if you want to use FTP to boot an image that is located on a different system. Provide the following information:

      Host name
      Enter either the fully qualified domain name of the FTP server, or its IP address.

      User name
      Enter the user name on the target FTP server.

      Password
      Enter the password associated with the user name on the target FTP server.

      INS file
      Either click **Browse** to retrieve a list of INS files from the target FTP server and select one file, or enter the fully qualified name (relative to FTP root) of an INS file.

      Depending on the size of the FTP site, browsing might require more time than manually entering the full path and name of the INS file. Also note that the browsing function returns INS files found in the user's home directory or its subdirectories. Because you cannot select a starting directory, or navigate to a directory above the user's home directory, manually entering the full path and name of the INS file might be more expedient.

      If you click **Browse**, a separate window displays the user's home directory and its subdirectories. Select one INS file, and click **OK** to close the Browse FTP Server window.

      FTPS server
      Select this option if you want to use the FTP Secure (FTPS) protocol to boot an image that is located on a different system. FTPS uses the Secure Socket Layer (SSL) protocol to secure data. With this option, you need to supply a host name, user ID, password, and .INS file, as described for the **FTP server** boot option.

      SFTP server
      Select this option if you want to use the Secure File Transfer Protocol (SFTP) to boot an image that is located on a different system. SFTP uses the Secure Shell (SSH) protocol to secure data. With this option, you need to supply a host name, user ID, password, and .INS file, as described for the **FTP server** boot option.

ISO image
Select this option when you want to upload an ISO file that is located on your workstation file system. This option is available only when you are connecting to the HMC through a remote browser.

When you select this option:

i) Select **Browse** to find the ISO image file on your workstation file system. You cannot select an ISO image from an HMC media drive. As soon as you select an ISO image file, DPM starts to upload the file, and displays a progress indicator for the upload operation.

ii) After the upload operation completes, click **Browse** to search the ISO image file for the INS file that you want to use. Any INS files found are displayed in a separate window. Select only one INS file and click **OK** to close the Browse ISO Image window.

b. Select **OK** to save the boot option in the partition definition, and close the Partition Details window.

5. Using one of the following methods, open the **Start** task to start the partition.

   a. From the entry for the selected partition on the **Partitions** tab, select the double-arrow icon in the Name field to display the cascading task menu, and select **Start**.

   b. Expand the **Daily** category in the task area, and select **Start**.

   A new window opens to display the progress of the start operation. In addition to displaying a progress indicator, this window also contains a Details column with messages that are updated as the start process continues. These messages indicate the progress of configuring partition resources and initializing the z/VM RAMDISK. If the start process is successful, the z/VM system loads with the MAINT user ID logged on.

6. Through the Integrated 3270 Console window, run the **DVDPRIME** command with the *dasdtype* and *source* that you are using to install.

   dasdtype
   Specify either **3390** or **FBA**.

   source
   Specify the *source* value that corresponds to the boot option that you specified.

   - For the **Hardware Management Console removable media** boot option, specify **dvd** as the source.
   - For the FTP boot options, specify **`server`** as the source.
   - For the **ISO image** boot option, specify **dvd** as the source.

7. Complete the installation by following the instructions in the z/VM *Installation Guide* for a non-Single System Image (SSI) traditional installation.

Boot option for Secure Service Container partitions

DPM automatically sets the boot option for Secure Service Container partitions to **Secure Service Container**. This boot option cannot be changed unless you first change the partition type.

For more information about creating and using Secure Service Container partitions, see the appropriate edition of *Secure Service Container User's Guide*, which is available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.

Working with an installed operating system or hypervisor

When you start a partition, DPM configures partition resources and initializes the operating system or hypervisor, according to the information you supply through the **New Partition** or **Partition Details** task. After the start process completes and the partition becomes active, you can open one of the following tasks to log in to the operating system or hypervisor.

- To log in to a Linux operating system, use the **Operating System Messages** task or the **Integrated ASCII Console** task. The **Integrated ASCII Console** task must be enabled through the operating system before you can use it.
- To log in to a z/VM hypervisor that is hosting multiple Linux guests, use the **Integrated 3270 Console** task.

Configuring secure execution for a Linux hypervisor

If the IBM Secure Execution for Linux feature is enabled on the system, you can configure a Linux hypervisor for secure execution, which isolates and protects any guests that run on a hypervisor by restricting host access to guest workloads and data.

- To determine whether the IBM Secure Execution for Linux feature is enabled on the system, go to the **General** section of the **System Details** task and check the values displayed for the Secure Execution field.
- To configure Linux for secure execution, see the product documentation for the Linux distribution that you are using as a hypervisor. This feature supports Linux (KVM) hypervisors.
- To determine whether the Linux hypervisor that runs on a partition is configured for secure execution, go to the **General** section of the **Partition Details** task and check the value displayed for the Secure Execution field.

Where to find more information about operating systems and hypervisors

For additional information about a specific operating system or hypervisor, see the appropriate resource:

- For Linux distributions, see the Linux on IBM Systems topics in IBM Documentation, at: https://www.ibm.com/docs/en/linux-on-systems?topic=linuxone-library-overview
- For the z/VM hypervisor, see the documentation for the version of z/VM that you are installing. The z/VM library is available in IBM Documentation at https://www.ibm.com/docs/en/zvm

  Note: DPM supports z/VM with the limitations listed in “Requirements for the hypervisor or operating system” on page 98, so not all z/VM functions described in the z/VM library are available for use.
- For more information about creating and using Secure Service Container partitions, see the appropriate edition of *Secure Service Container User's Guide*, which is available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.

Part 3. Basic tasks for Linux administrators

Topics in this part provide a planning checklist and step-by-step instructions for creating and starting a partition, and its operating system or hypervisor, on a DPM-enabled system. Also included is a summary of HMC tasks for monitoring and managing partitions, adapters, and other resources on a DPM system. These topics are appropriate for any administrator who creates or manages DPM partitions.

Topics covered in this part are:

Chapter 6. Planning checklist for creating a partition

Before you can use the **New Partition** task to create a new partition, you need to know some specifics about your company's IT environment and about the type of applications that your new partition will support. Use the checklist in this topic to help you prepare to fill in information on the pages or in the sections of the **New Partition** task, which you can use in either basic or advanced mode. Although this checklist does not cover every field or selection that you might make, it covers key decisions and functions that enable you to determine which **New Partition** task mode to use, and helps you identify other IT personnel who might need to supply you with information.

Before you can use the **New Partition** task to create a new partition, you need to know the following information. You might need to consult with your company's system planner, network administrator, storage administrator, or security administrator for some of this information.

- The resource requirements of the operating system and its applications, which are sometimes called the *workload*, that your new partition will support. Specific resources include processor capacity, memory, network or storage connections, and security requirements.
- The requirements or restrictions, if any, that your company has for the use of the adapters that are installed and configured on the system.
- The naming and numbering conventions, if any, that your company uses for its hardware resources, such as partitions and storage devices.

Note: When you create a network or storage connection for the partition, you also select an adapter from a list that DPM displays in the **New Partition** task. Although these adapters are configured on the system, they might not be attached by cables to external systems or devices. Make sure that you consult with the network administrator or storage administrator to determine which adapters are cabled (not all adapters require cables to external devices).

Table 1 on page 41 lists the key decisions and information that you might need to supply while using the **New Partition** task.

- If any terms in the checklist are unfamiliar, see the topics in Part 2, “Basic concepts and terms for Linux administrators,” on page 9, or use the online help for the **New Partition** task.
- After you have completed the checklist, see the information in “Creating a new partition” on page 49.

Table 1. Planning checklist for defining your new partition

✓	Planning item or decision	Your notes:
	Partition characteristics: Choose the system on which your new partition will reside, and choose a unique name for your partition. You can also decide whether you want to provide a short name for the operating system to use, provide a unique partition ID that is assigned to your partition each time it is started, select a type, and reserve partition resources.	**System name:** **Partition name:** **Partition ID:** **Partition type:** Linux | z/VM | Secure Service Container **Reserve resources:** Yes | No
	Status: Define the acceptable availability status values for the partition, based on the importance of its workload. Setting status values is useful if you want to know when various conditions have affected the operation of your partition. The default value is Active, which means that any other condition is flagged with an exception icon.	For a list and explanation of status values for partitions, see the online help for the Status section of the **New Partition** task. This section is available only in advanced task mode.

Table 1. Planning checklist for defining your new partition (continued)		
✓	**Planning item or decision**	**Your notes:**
	Controls: Use the Controls section to enable or disable partition access to various controls. By default, all settings are unchecked. The major control categories are: • Partition access • Counter facility authorization • Sampling facility authorization	For a complete list and explanation of available controls, see the online help for the Controls section of the **New Partition** task. This section is available only in advanced task mode.
	Processors: Based on your knowledge of the workload this partition will support, determine the amount of processor resource it requires. If you have run this workload in another environment, you might already know its capacity requirements; if not, you can use the default value or specify a value, and make adjustments through the **Partition Details** task after starting the partition and observing the workload performance. If you want to enable simultaneous multithreading for this partition, you must select the IFL processor type.	**Amount:** _____ **Type:** IFL | CP **Shared:** Yes | No
	Memory: Based on your knowledge of the workload this partition will support, determine the amount of memory it requires. Specify a maximum amount if you want the partition to have access to additional memory resources without having to stop and restart it. You can specify initial values and use the **Partition Details** task to make adjustments, if necessary. If you are creating a Secure Service Container partition, you must specify an initial amount of at least 4096 MB (4 GB).	**Amount:** _____ MB | GB | TB **Maximum amount:** _____ MB | GB | TB

Table 1. Planning checklist for defining your new partition (continued)

✓	Planning item or decision	Your notes:
	Network connections: Create a network interface card (NIC) for each network to which the partition needs access. For each NIC, provide a name and optional device number, and select one network adapter from the list of available adapters. For availability, select at least two network adapters of the same type, and create a NIC for each one. For partitions with a type of **Linux** or **z/VM** only, you also can optionally specify a virtual LAN (VLAN) identifier only if you plan to select an OSA-Express or HiperSockets adapter. For any type of partition, you can optionally specify a media access control (MAC) address, also only if you plan to select an OSA-Express or HiperSockets adapter. If you are creating a Secure Service Container partition, you must specify at least one NIC for communication with the Secure Service Container web interface. Although you can specify a VLAN ID, note that DPM does not provide VLAN enforcement for Secure Service Container partitions. **Note:** Starting with DPM R5.2, you cannot create and manage NICs for a HiperSockets adapter in the Network section of this task. Instead, after creating your new partition, use the **Configure Partition Links** task to attach a HiperSockets partition link to your partition, and review the default NIC and devices that are created for it.	**NIC name:** **NIC device ID:** **VLAN ID:** **MAC address:** **Adapter type:** HiperSocket | OSA | RoCE **NIC name:** **NIC device ID:** **VLAN ID:** **MAC address:** **Adapter type:** HiperSocket | OSA | RoCE **NIC name:** **NIC device ID:** **VLAN ID:** **MAC address:** **Adapter type:** HiperSocket | OSA | RoCE

Table 1. Planning checklist for defining your new partition (continued)		
✓	**Planning item or decision**	**Your notes:**
	Storage: Attach one or more storage groups or tape links to enable a partition to access storage resources that are connected to the system. Use the attributes and other information to determine which storage groups or tape links to select. A *storage group* is a logical group of storage volumes that share certain attributes. FCP storage groups can be shared by multiple partitions, and multiple storage groups can be attached to one partition. In contrast, only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared. However, a partition that has attached an NVMe storage group can also attach FICON and FCP storage groups or FCP tape links. A *tape link* defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN. These connection attributes include storage resources such as system adapters, world wide port names (WWPNs), and the number of partitions that can share the connection. Note that you can also attach a tape link to a selected partition through the **Configure Storage** task, when you use it to either create a new tape link or modify an existing one.	**Storage group name:** **Type:** FCP | FICON | NVMe **Storage group name:** **Type:** FCP | FICON | NVMe **Storage group name:** **Type:** FCP | FICON | NVMe **Tape link name:** **Tape link name:** **Tape link name:**
	Partition links: After you finish using the **New Partition** task to create a new partition, you can open the **Configure Partition Links** task to attach one or more partition links to the partition. You can attach a partition link to existing partitions only. A *partition link* interconnects two or more partitions that share the same network configuration and reside on the same system. Depending on the version of DPM that is installed on the system, your partition can use one or more of the following partition link types: FICON CTC, HiperSockets, or SMC-D. For more information about partition links, see "Partition links" on page 25.	**Partition link name:** **Type:** FICON | HiperSockets | SMC-D **Other partitions to add to the partition link:** **Partition link name:** **Type:** FICON | HiperSockets | SMC-D **Other partitions to add to the partition link:** **Partition link name:** **Type:** FICON | HiperSockets | SMC-D **Other partitions to add to the partition link:**

Table 1. Planning checklist for defining your new partition (continued)		
✓	**Planning item or decision**	**Your notes:**
	Operating system / Hypervisor: For a list of supported operating systems and hypervisors, see Chapter 5, "Operating systems and hypervisors," on page 33. When you know which operating system or hypervisor that you want to run in your partition, determine the location where the executables reside, and the name of the ISO image file or .INS file. The location determines which boot option you select. Only one boot option, **ISO image**, requires the ISO file name.	**Operating system | Hypervisor:** **Location:** SAN | Net boot | FTP | HMC | local drive **ISO file name:** **.INS file name:**
	Boot option: Select a boot option through which DPM can locate and upload the required files to initialize the hypervisor or operating system when the partition itself is started. With all options except **None**, you can specify a time limit (in seconds) for the load operation. With the **Storage device (SAN)** option, you also can specify additional information, such as OS load parameters and options to validate the operating system image. DPM automatically sets the boot option for the first-time start of a Secure Service Container partition. For a list and descriptions of the boot options, see the online help for the **New Partition** task.	**Boot loader time-out value:** _____ seconds **Storage device (SAN):** Storage group boot volume: **FTP server:** Host name: User name / password: Protocol: FTP | FTPS | SFTP **HMC removable media:** Type of media drive: CD/DVD | USB (Note that, depending on the system, a DVD drive might not be available on the HMC.)

Chapter 7. Creating and starting a new partition

To create a partition on a DPM-enabled system, use the **New Partition** task.

For more information, see the following topics:

- “Selecting which New Partition task mode to use” on page 47
- “Creating a new partition” on page 49
- “Starting a partition and its operating system or hypervisor” on page 60

Selecting which New Partition task mode to use

The **New Partition** task offers two modes through which you can create a partition: basic and advanced. Basic is the default mode, but you have the option of setting advanced as the default mode.

Basic
: The basic task, which is presented the first time that you open the **New Partition** task, provides a quick, guided method of creating a partition; DPM either provides default values or automatically generates many of the values for partition properties that are required to successfully start a partition. Some of these properties are not displayed or editable in the basic task mode. To navigate through the task, use the **Next** and **Back** buttons. When you have finished entering values in the required fields, click **Finish** to create the partition definition.

Advanced
: The advanced task, which you can launch from the basic task, enables experienced users to view all partition properties and to change any default values. To access each section in the advanced task, click the appropriate link in the navigation pane, or scroll down the main page and expand or collapse each section as necessary. When you have finished entering values in the required fields, click **OK** to create the partition definition.

To use the **New Partition** task in either mode, you need to use a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role.

Comparing the task modes

Table 2 on page 47 lists key partition properties, and indicates whether you can edit those properties using the **New Partition** task in either basic or advanced mode.

- A dash (—) indicates a property that you cannot edit. With the exception of partition links, DPM either provides default values or automatically generates values for these properties.
- A check mark (✔) indicates a property that you can edit.

*Table 2. Comparison of editable partition properties in the basic and advanced **New Partition** task modes*

Partition property	Basic mode	Advanced mode
Partition name	✔	✔
Partition short name and ID	—	✔
Partition type	✔	✔
Reserved resources	—	✔
Acceptable partition status values	—	✔

*Table 2. Comparison of editable partition properties in the basic and advanced **New Partition** task modes (continued)*

Partition property	Basic mode	Advanced mode
Controls: • **Partition access** • **Counter facility authorization** • **Sampling facility authorization**	—	✓ Access to this section requires the use of the SERVICE user ID, or a user ID with either the System Programmer Tasks role or the Service Representative Tasks role.
Shared processors	✓	✓
Dedicated processors	—	✓
Processing weights and capping	—	✓
Memory (initial allocation)	✓	✓
Maximum memory (dynamic allocation)	✓	✓
Network interface cards (NICs)	✓	✓
VLAN ID and MAC address for NICs	—	✓
Storage (storage groups, tape links, or HBAs)	✓	✓ In this mode only, you can edit device numbers for FCP storage groups and tape links, and change adapters for FCP storage groups.
Cryptos (security)	✓ (if installed on system)	✓ (if installed on system) In this mode only, permitting AES, DES, or ECC protected key import is available.
Partition links	— This property is not editable. You can add a partition to a partition link only through the **Configure Partition Links** task.	— This property is not editable. You can add a partition to a partition link only through the **Configure Partition Links** task.
Boot options	✓ Location options in "Boot from" list, plus **Secure Boot** options	✓ Location options in "Boot from" list, plus advanced boot settings, **Secure Boot** options and boot loader settings

Switching between task modes

You have the option of switching between the basic and advanced task modes, and the option of setting the advanced mode as the default mode whenever you subsequently launch the **New Partition** task. To switch from the basic mode to the advanced mode, click **Advanced**, which is located in the lower left corner of the **New Partition** window. Clicking **Advanced** opens a confirmation dialog through which you can set the advanced mode as the default mode whenever you launch the **New Partition** task.

If you start in basic mode and switch to advanced mode

- If you edited any fields in the basic mode and then switch to the advanced mode, your changes are automatically carried over into the advanced mode. For example, if you entered a name for your new partition on the **Name** page of the basic task, that name is displayed on the **General** page of the advanced task.
- To switch back to the basic task mode, click **Basic**, which is located in the lower left corner of the **New Partition** window.
  - Clicking **Basic** opens a confirmation dialog through which you can set the basic mode as the default mode whenever you launch the **New Partition** task.
  - If you edited **any** fields in the advanced mode, those changes are not preserved when you switch back to the basic mode. However, any edits that you originally made in the basic mode are preserved. In other words, switching from advanced mode to basic mode wipes out all changes that you made in advanced mode, and restores the changes that you made in basic mode.

If you start in advanced mode and switch to basic mode

If you edited any fields in the advanced mode and then switch to the basic mode, your changes are discarded, even if the partition property is available for editing in the basic mode.

Creating a new partition

This procedure provides step-by-step instructions for using the **New Partition** task to create a new partition.

Before you begin

The **New Partition** task offers two modes through which you can create a partition: basic and advanced. This procedure provides instructions only for the basic mode of the **New Partition** task. Because the advanced mode is similar, however, you can use these instructions for the advanced mode as well. Note that some pages, or sections, of the advanced mode might have slightly different names and additional content, compared to the basic mode. If you want to review the differences between the two modes, see “Selecting which New Partition task mode to use” on page 47.

- Make sure you have the appropriate authorization to use the **New Partition** task. You need to use a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role.
- Use the online help for the **New Partition** task together with these instructions; the online help explains the page elements and functions in more detail. To access the online help, click **Help** on the **New Partition** task window. Note that the basic and advanced modes of the task have separate online help; to access the help for the advanced mode, switch to that mode and then click **Help**.
- If you are creating a partition only to familiarize yourself with the process, you can accept default or automatically generated property values or settings. After you successfully complete the **New Partition** task, you can use the **Partition Details** task to modify the partition definition to conform to your company's conventions and planned use for this system.

  Notes:

  - After you create a partition through the **New Partition** task, you cannot change the partition type through the **Partition Details** task.

  - Regardless of the mode you use for the **New Partition** task, the Partition links section only provides links for more information, because you can attach a partition link to a partition only through the **Configure Partition Links** task.
- If you want to supply your own property values or configuration settings rather than accepting default values, use the checklist in Chapter 6, “Planning checklist for creating a partition,” on page 41 to gather the information that you need to select or fill in values in the **New Partition** task.

About this task

The basic mode of the **New Partition** task provides a quick, guided method of creating a partition; DPM either provides default values or automatically generates many of the values for partition properties that are required to successfully start a partition. Some of these properties are not displayed or editable in the basic task mode.

Some of the following individual steps are marked as required, which indicates that the corresponding task page contains fields for which you need to supply a value or make a selection. The end result of the task is a partition definition, which you can modify through the **Partition Details** task, or use to start the partition through the **Start** task.

Although the steps in this procedure include information that is specific to creating a Secure Service Container partition, you can find more detailed instructions either in the online help for the **New Partition** task or in the *Secure Service Container User's Guide*, which is available on https://www.ibm.com/docs/en/systems-hardware.

Procedure

1. Open the **New Partition** task.

   You can access this task from the main HMC page by selecting the Systems Management node and expanding the Configuration task group; by selecting a specific DPM-enabled system; or by selecting the task in the Tasks index. For example:

   a) Select a DPM-enabled system listed under the Systems Management node.

   b) From the Configuration task group, click the link for the **New Partition** task.

   The **New Partition** window opens, with a page overlay that highlights key task controls on the window.

   c) Click the **Okay, got it** button to remove the page overlay.

   The Welcome page is displayed.

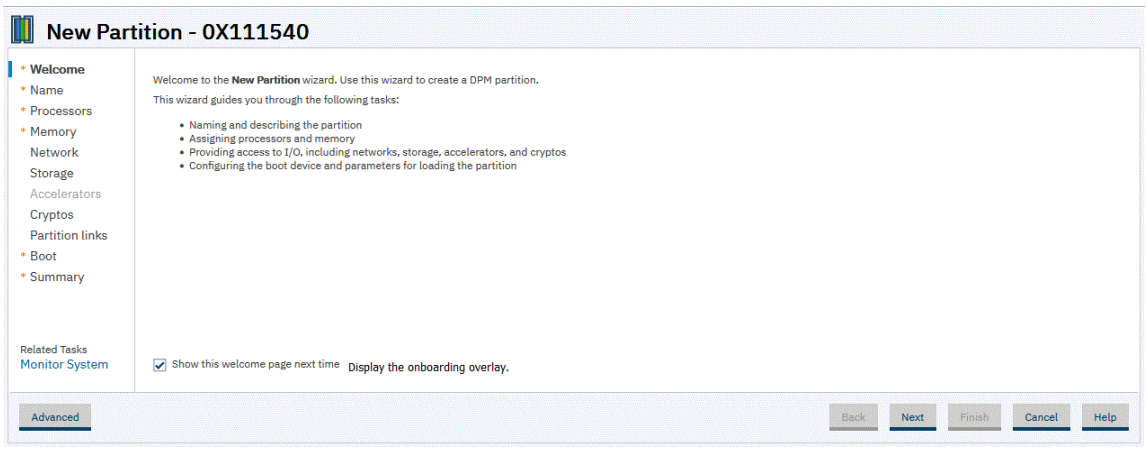

Figure 20. Welcome page of the New Partition task in basic mode

   d) On the Welcome page, you can use two controls to modify the page display.

- Click the **Show this welcome page next time** check box if you want to see the Welcome page the next time that you open this task. By default, the check box is not selected.
- Click the icon at the end of the check box label if you want to restore the page overlay.

e) Click **Next** to navigate to the next page in the task.

2. Required: Use the Name page to enter the name of the new partition, the partition type, and an optional description.

   A partition name must uniquely identify the partition from all other partitions defined on the same system.

   a) Specify the name of the new partition, which can be 1 - 64 characters in length. Supported characters are alphanumerics, blanks, periods, underscores, dashes, or at symbols (@). Names cannot start or end with blank characters.

   b) Optionally, specify a description for the partition. The description can be up to 1024 characters in length.

   c) Specify one of the following values that identifies the type of partition that you are creating.

      Linux
      In this type of partition, you can install and run a Linux distribution as a single operating system, or as a hypervisor for multiple guests.

      z/VM
      In this type of partition, you can install and run z/VM as a hypervisor for multiple Linux guests.

      Secure Service Container
      This type of partition is a Secure Service Container, in which you can run only specific software appliances that the Secure Service Container supports.

      If you select the partition type **Secure Service Container**, the page display includes fields for entering a master user ID and password to secure access to the Secure Service Container web interface. If you need help supplying values for these fields, see the online help.

   d) When you have finished, click **Next** to navigate to the next page in the task.

3. Required: Use the Processors page to define the number of shared virtual processors for the partition, and to view various charts that are based on your selections.

   The virtual processors are allocated from physical processors of the selected type.

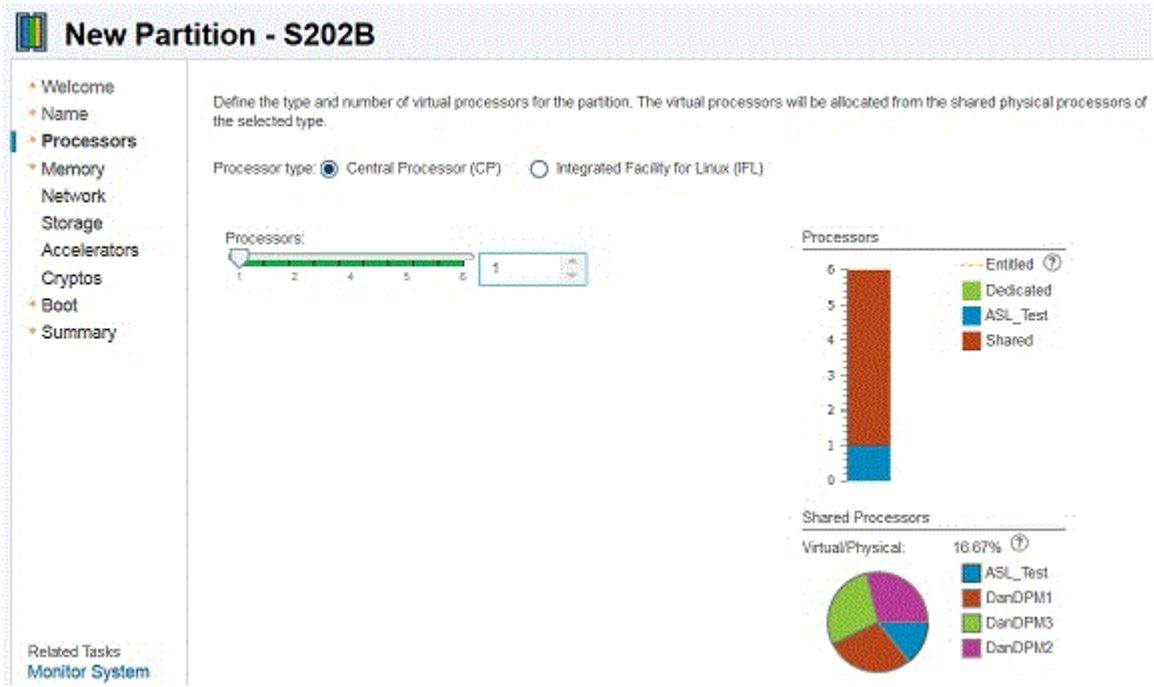

Figure 21. Processors page of the New Partition task in basic mode

a) If the Processors type field is displayed, select a value. If you want to enable simultaneous multithreading for this partition, you must select the IFL processor type.

b) Review the Processors bar chart to determine how many processors are available on this system, and how many are already in use or reserved for other partitions.

c) Select the number of processors that you want to assign to your new partition.

   If you are creating a partition only to familiarize yourself with the process, you can accept the default value. Otherwise, base your selection on your knowledge of the processing requirements of the operating system and applications that you plan to run in this new partition.

d) Review the Processors bar chart and pie chart to understand how your selection affects the availability of processing resources on the system.

   Although you can select a number of processors greater than the number that is currently available, your new partition will not start unless currently active, unreserved partitions are stopped or more processors are added to the system.

e) When you have finished, click **Next** to navigate to the next page in the task.

4. Required: Use the Memory page to define the initial and maximum amounts of memory to be assigned to the new partition.

   When you define the amount of memory to be assigned, or allocated, to a specific partition, you specify an initial amount of memory, and a maximum amount that must be equal to or greater than the initial amount. If you are creating a partition only to familiarize yourself with the process, you can accept the default values for both the Memory and Maximum Memory fields. Otherwise, base your selection on your knowledge of the memory requirements of the operating system and applications that you plan to run in this new partition.

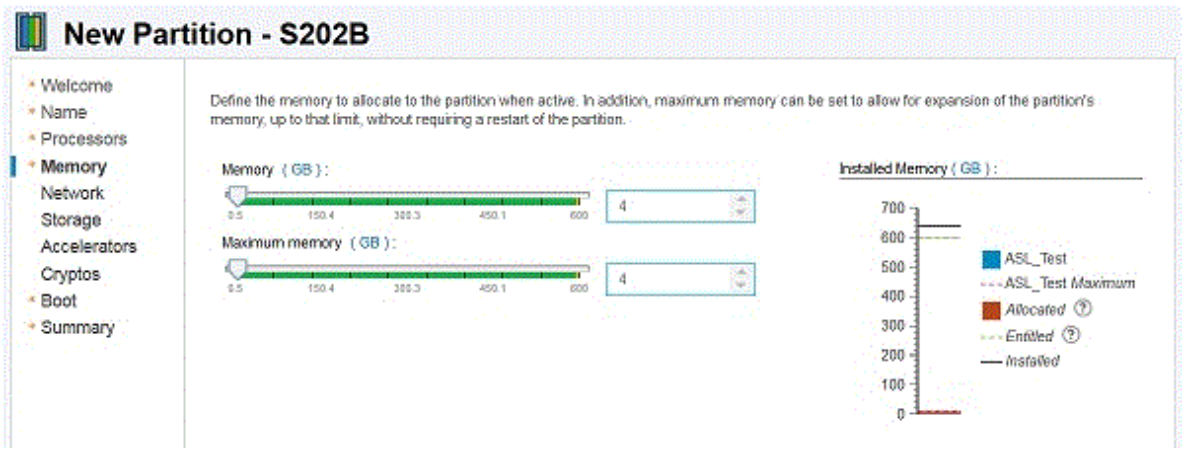

Figure 22. Memory page of the New Partition task in basic mode

a) Review the Installed Memory bar chart to determine how much memory is available on this system, and how much is already in use or reserved for other partitions.

b) Select the amounts of initial and maximum memory that you want to assign to your new partition.

   If you are creating a Secure Service Container partition, you must specify an initial amount of at least 4096 MB (4 GB).

c) To understand how your selection affects the availability of memory resources on the system, review the updated Installed Memory bar chart.

d) When you have finished, click **Next** to navigate to the next page in the task.

5. Use the Network page to define network interface cards (NICs) to enable the new partition to access specific networks.

   If you are creating a partition only to familiarize yourself with the process, you do not need to create any NICs unless you want to do something more than simply start the partition when you have finished creating it. If you are only trying out the process, skip to step “6” on page 55 of these instructions. Otherwise, you need to create a NIC for each network connection that is required for the operating system or hypervisor that runs on this partition, or for the applications that the operating system or hypervisor supports.

   - For availability, select at least two network adapters of the same type, and create a NIC for each one.
   - If you are creating a Secure Service Container partition, you must specify at least one NIC for communication with the Secure Service Container web interface.

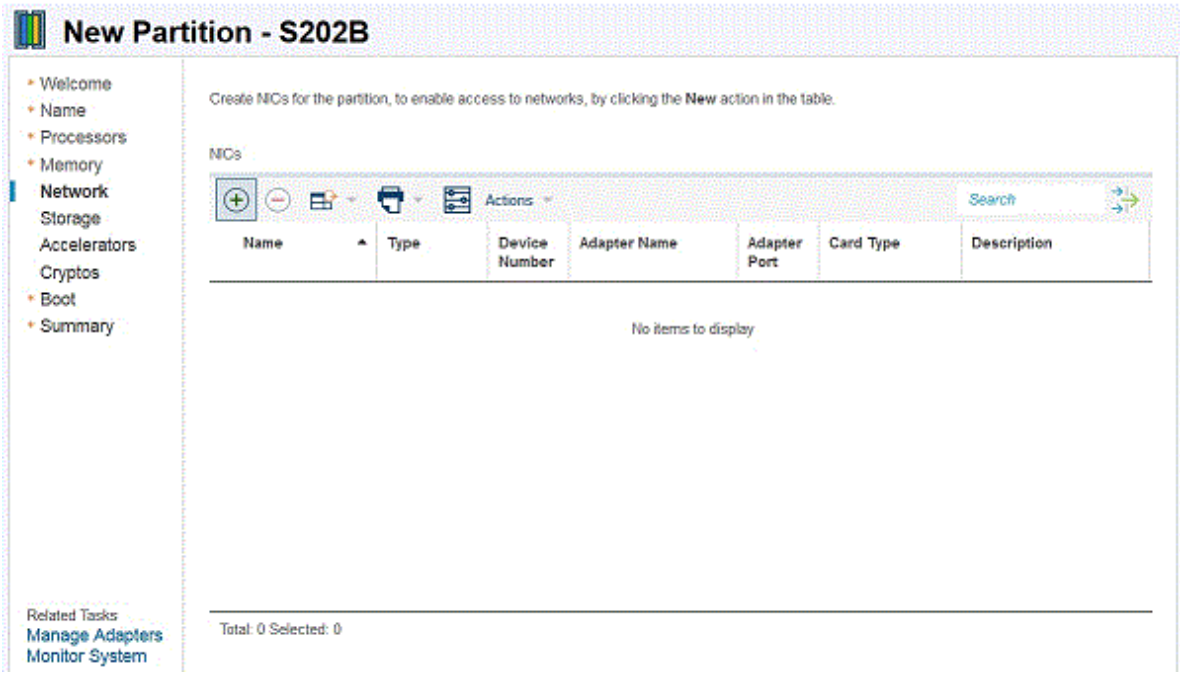

Figure 23. Network page of the New Partition task in basic mode

When you first use the **New Partition** task, the Network display contains an empty NICs table. To create a NIC, complete the following steps.

a) From the Actions list in the NICs table, select **New** to open the **New Network Interface Card** window.

b) Enter a unique, meaningful name and, optionally, a description of the new NIC.

c) If you are creating a Secure Service Container partition, supply values for the additional information about the network connection that is required to access the Secure Service Container web interface.

   This information includes an optional, virtual local area network (VLAN) identifier, the required IP address and type, and a mask / prefix.

   If you need more detailed descriptions as you provide these configuration values, see the online help.

d) Review the entries in the Adapter Ports and Switches table to determine which network adapters are configured on the system.

   i) Check the percentages listed in the Uplink Utilization and Adapter NIC Allocation columns. If the percentage in either column is high (for example, 90%) for a specific port or switch, consider selecting a different port or switch on the same network.

   ii) Look for a warning icon next to the name in the Adapter Name column; if the warning icon is displayed for a specific port or switch, select a different one on the same network.

   iii) Select one port or switch by clicking the radio button in the Select column. Note that, if you select an OSA-Express adapter port other than port 0, you need to manually specify the relative port number through a Linux `qeth` device driver command, before entering the Linux command to bring the device online. Instructions for specifying a port number are provided at the end of the procedure in "Starting a partition and its operating system or hypervisor" on page 60.

e) Click **OK** to create the new NIC and close the **New Network Interface Card** window.

f) Check the entry for the new NIC that is displayed in the NICs table on the Network page. Change the device number if your company uses a specific numbering convention for its networks.

g) If you are creating a Secure Service Container partition, provide the network settings that are displayed after the NICs table.

These settings include a host name, default gateway, and DNS servers.

If you need more detailed descriptions as you provide these configuration values, see the online help.

h) Repeat the preceding steps, as necessary, to create a new NIC for each network connection that your new partition requires.

i) When you have finished, click **Next** to navigate to the next page in the task.

6. Use the Storage page to attach storage groups or tape links that enable the partition to access storage networks and hardware that is connected to the DPM-enabled system.

   The Storage section contains a Storage Groups table and a Tape Links table, each with controls that you can use to attach storage groups or tape links to the partition.

   If you are creating a partition only to familiarize yourself with the process, you do not need to attach any storage groups or tape links unless you want to boot a specific hypervisor or operating system image that resides on a storage device. If you are only trying out the process, skip to step "7" on page 56 of these instructions. Otherwise, continue with this step.

   System administrators create storage groups and tape links to enable partitions (and the operating systems and applications that they host) to use physical storage hardware that is connected to the system. A *storage group* is a logical group of storage volumes that share certain attributes. A *tape link* defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN.

   To attach one or more storage groups or tape links to the partition, complete the following steps.

   a. When you first use the **New Partition** task, the Storage display contains an empty Storage Groups table and Tape Links table. Select the plus icon in the table toolbar to open the **Attach Storage Groups** or **Attach Tape Links** window.

   b. On the **Attach Storage Groups** window, select one or more storage groups listed in the Storage Groups table to attach to this partition.

      - The suggested practice is to select storage groups that are in the Complete fulfillment state, but you can select any storage group except for those with a fulfillment state of Incomplete, or those that are already attached to the maximum number of partitions. If you do select groups in states other than Complete, some storage might not be available for use when you start the partition.
      - Use the additional information in the Storage Groups table, as necessary, to decide which storage groups to attach.

      When you have finished selecting storage groups to attach, select **OK** to close the **Attach Storage Groups** window.

   c. On the **Attach Tape Links** window, select one or more tape links listed in the table to attach to this partition.

      - The suggested practice is to select tape links that are in the Complete fulfillment state, but you can select any tape link except for those with a fulfillment state of Incomplete, or those that are already attached to the maximum number of partitions. If you do select links in states other than Complete, some storage might not be available for use when you start the partition.
      - Use the additional information in the table, as necessary, to decide which tape links to attach.

      When you have finished selecting tape links to attach, select **OK** to close the **Attach Tape Links** window.

   d. Check the entries for the storage groups or tape links that you selected, which are now displayed in the Storage Groups table or Tape Links table in the Storage section. If necessary, you can use the minus icon in the table toolbar to remove a storage group or tape link from the table.

   e. When you have finished, review another section or click **OK** to save the partition definition.

The next page to open might be either Cryptos or Partition links, depending on the system configuration.

7. If the system has configured cryptographic features, use the Cryptos page to enable the new partition to use the cryptographic features that it requires.

   Crypto features are optional and, therefore, might not be installed on the system. If none are installed, the Cryptos page is disabled, and you can skip to step “9” on page 56 of these instructions.

   If cryptographic features are installed on the system but you are creating a partition only to familiarize yourself with the process, you can skip to step “9” on page 56. Otherwise, use instructions in the online help to enable your partition to use cryptographic adapters.

8. Use the information in the **Partition links** section to view or learn about partition links, which interconnect two or more partitions that share the same network configuration and reside on the same system.

   Through links in this section, you can open the **Configure Partition Links** task to the overview page, or open a new window to display the online help for that task.

9. Required: Use the Boot page to select the location of the executables for the hypervisor or operating system to be run in this partition, or to upload the required files to initialize the hypervisor or operating system when the partition itself is started.

   Some of these boot options require that you find and select an ISO image file, which is a collection of files and metadata for installing software, and an .INS file, which maps image components (for example, kernel, ramdisk, parameter file) to the appropriate storage addresses in main memory.

   The "Boot from" menu lists the boot options that are available for the hypervisor or operating system. If an option in the list is disabled, hover your cursor over that option to display additional information for that option. If necessary, take appropriate action to make that selection available; for example, if you want to use the Storage device (SAN) option, return to the Storage page to attach a storage group with a boot volume.

   Use the **Secure Boot** option to have DPM verify that the software signature matches the signature from the distributor. If the signatures do not match, the boot process fails. This option is enabled only under the conditions listed in Chapter 14, “Validating boot images of operating systems,” on page 119.

   If you have selected the partition type **Secure Service Container**, note that option set in the "Boot from" menu is **Secure Service Container**. This boot option cannot be changed unless you first change the partition type.

   To define a boot option for other types of partitions, complete the following steps.

   a) Click the down arrow to display the available options in the "Boot from" menu.

   b) Choose one of the available options and provide any additional information that is required.

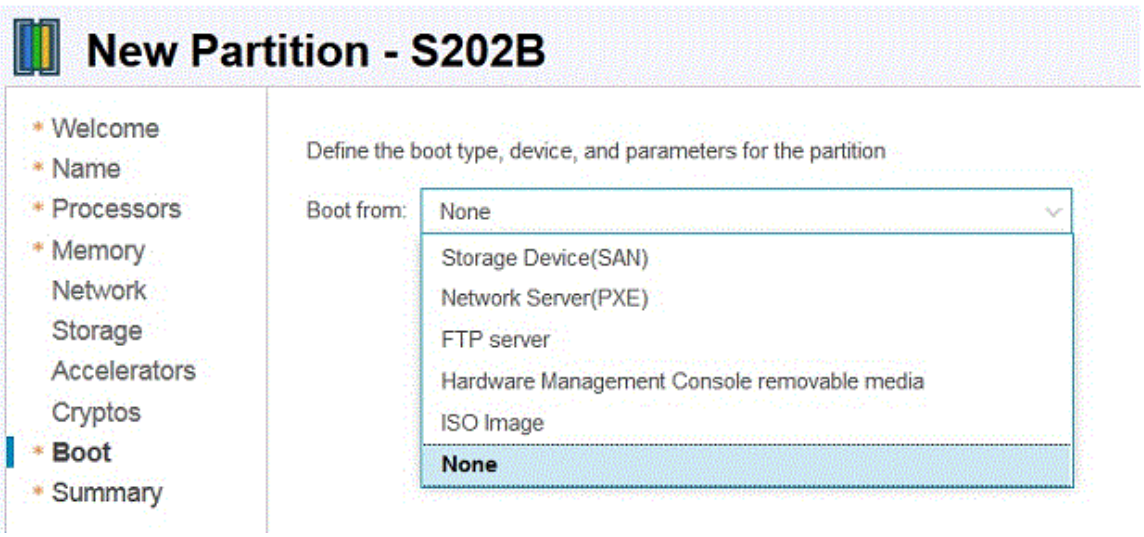

Figure 24. Boot page of the New Partition task in basic mode

When you select a specific boot option, the display shows editable fields and other information related to the selected option.

None
Select this option if you want to start a partition without a hypervisor or operating system. Although the partition can be started, it is not in a usable state.

Storage device (SAN)
Select this option when the hypervisor or operating system executables reside on an internal or external storage device. This option is available only when at least one storage group is attached to the partition. When you specify this option, you need to select a boot volume in an attached storage group.

The Storage Groups table displays the available FCP or FICON or NVMe storage groups that contain a boot volume. To view the available boot volumes, expand any table entry by selecting the storage group. The expanded table display contains a Boot Volume table that lists all available boot volumes that the storage group contains. The Boot Volume table content and Advanced Boot Volume Settings fields vary, depending on the storage group type.

- For each boot volume in an FCP storage group, the Boot Volume table provides the universally unique identifier (UUID) and capacity of the volume, along with a user-supplied description, if any.
- For each boot volume in a FICON storage group, the Boot Volume table provides the name of the storage subsystem in which the volume resides, along with the volume ID, capacity, type, and device number. If a user-supplied description is available, it is also displayed in the table.
- For each boot volume in an NVMe storage group, the Boot Volume table provides the boot volume serial number and capacity, along with a user-supplied description, if any. When you select an NVMe volume, note that NVMe namespace management is not supported, so you can boot programs only from namespace ID=1.

Select the boot volume on which the operating system or hypervisor image resides. If you plan to boot the operating system or hypervisor from a volume in an NVMe storage group, check the product documentation for the operating system or hypervisor to make sure that it supports booting from NVMe storage.

Note: Starting with DPM R4.0, you can select options to validate the operating system image that you boot from a volume in a storage group. These options are described in the online help for this task. For an overview of this capability, see Chapter 14, “Validating boot images of operating systems,” on page 119.

Network server (PXE)
Select this option when you want to use a preboot execution environment (PXE) on a network server. This option is available only if a network interface card (NIC) for either an OSA port or HiperSockets switch is defined for the partition.

When you select this option, the NIC table displays the available network interface cards. Select the NIC for the adapter that connects the partition to the network on which the network boot server resides.

FTP server
Select this option if you want to use FTP to boot an image that is located on a different system. Provide the following information:

Host name
Enter either the fully qualified domain name of the FTP server, or its IP address.

User name
Enter the user name on the target FTP server.

Password
Enter the password associated with the user name on the target FTP server.

INS file
Either click **Browse** to retrieve a list of INS files from the target FTP server and select one file, or enter the fully qualified name (relative to FTP root) of an INS file.

Depending on the size of the FTP site, browsing might require more time than manually entering the full path and name of the INS file. Also note that the browsing function returns INS files found in the user's home directory or its subdirectories. Because you cannot select a starting directory, or navigate to a directory above the user's home directory, manually entering the full path and name of the INS file might be more expedient.

If you click **Browse**, a separate window displays the user's home directory and its subdirectories. Select one INS file, and click **OK** to close the Browse FTP Server window.

FTPS server
Select this option if you want to use the FTP Secure (FTPS) protocol to boot an image that is located on a different system. FTPS uses the Secure Socket Layer (SSL) protocol to secure data. With this option, you need to supply a host name, user ID, password, and .INS file, as described for the **FTP server** boot option.

SFTP server
Select this option if you want to use the Secure File Transfer Protocol (SFTP) to boot an image that is located on a different system. SFTP uses the Secure Shell (SSH) protocol to secure data. With this option, you need to supply a host name, user ID, password, and .INS file, as described for the **FTP server** boot option.

Hardware Management Console removable media
Select this option if you want to use an INS file from a media drive that is connected to the HMC. The media drive must be available when you are creating the partition definition and when the partition is started. Possible drive selections are **CD/DVD drive** or **USB flash memory drive**, depending on what media drives are installed in the HMC.

When you select this option:

i) If more than one type of media drive is available on the HMC, select the radio button for the media drive on which the INS file resides. Otherwise, skip to the next step.

ii) Either enter the fully qualified name (relative to the mount point) of an INS file, or complete the following steps.

a) Select **Browse** to start a search on the target media drive to retrieve a list of INS files. Any INS files found are displayed in a separate window.

b) Select only one INS file and click **OK** to close the Browse Removable Media window.

ISO image
Select this option when you want to upload an ISO file that is located on your workstation file system. This option is available only when you are connecting to the HMC through a remote browser.

When you select this option:

i) Select **Browse** to find the ISO image file on your workstation file system. You cannot select an ISO image from an HMC media drive. As soon as you select an ISO image file, DPM starts to upload the file, and displays a progress indicator for the upload operation.

ii) After the upload operation completes, click **Browse** to search the ISO image file for the INS file that you want to use. Any INS files found are displayed in a separate window. Select only one INS file and click **OK** to close the Browse ISO Image window.

Sample image
Select this option if you want to test your partition using a sample Linux operating system that IBM provides with DPM. Use this sample system for checking only operating system commands and IP connectivity.

c) When you have finished, click **Next** to navigate to the next page in the task.

10. Use the Summary page to review the properties for the new partition.

    You might need to vertically scroll the page to view all of the partition properties. If necessary, click **Back** to return to a particular page to change a property value or setting.

11. Required: On the Summary page, click **Finish** to save the partition definition.

    A progress indicator is displayed until DPM finishes creating the partition.

Results

DPM opens the validation window when it finishes creating the partition definition. The validation window displays a message indicating that your partition has been created, and lists additional tasks that you can use to work with the new partition.

What to do next

To work with the partition, select any of the links on the validation window to open a related task in a separate window.

Start the partition
Opens the **Start** task, with this partition selected as the partition to start.

Setup auto-start
Opens the Start Options section in the **System Details** task, through which you can specify that the partition is to be started automatically, when the system is started. You can specify the order in which the partition is started, relative to other partitions on the system, or add the partition to an auto-start group.

Setup scheduled operations
Opens the **Customize Scheduled Operations** task, through which you can automate start and stop operations for a partition by scheduling them to be run on specific dates and times.

Create monitors
Opens the **Monitor System Events** task, through which you can define specific events for which you want to be notified, if these events occur. For example, you can request to be notified when network traffic on a system, or processor utilization on a partition, reaches a specific threshold that you set.

When you are finished reviewing the information on the validation window or using the provided links to related tasks, click **Close** to close the validation window.

Starting a partition and its operating system or hypervisor

This procedure provides step-by-step instructions for starting a partition with a type of **Linux** or **z/VM**, and its operating system or hypervisor.

Before you begin

- For partitions with a type of **Secure Service Container**, see the appropriate edition of *Secure Service Container User's Guide* for information about starting and managing Secure Service Container partitions and their appliances. This book is available on https://www.ibm.com/docs/en/systems-hardware.
- Make sure that you log in to the Hardware Management Console (HMC) with a user ID that has authorization to use the **Start** task to start a partition. You can use either a customized user role that is authorized to this task, or one of the default user IDs listed for the **Start** task in Appendix A, "DPM task and resource roles," on page 183.

Procedure

1. On the main HMC page, expand the **Systems Management** node to view managed systems, and select the DPM-enabled system on which the partition resides.
2. On the **Partitions** tab for the selected system, find the table entry for the partition that you want to start, and select it.
3. Select the double-arrow icon in the Name field to display the task menu, and select **Partition Details** to verify the boot option for this partition.
   a) If you have not already done so, use the Boot page to select the location of the executables for the hypervisor or operating system to be run in this partition, or to upload the required files to initialize the hypervisor or operating system when the partition itself is started.
   b) Select **OK** to apply any changes and close the Partition Details window.
4. Use the **Start** task to start the selected partition.
   a) From the entry for the selected partition on the **Partitions** tab, select the double-arrow icon in the Name field to display the cascading task menu.
   b) Expand the **Daily** group, and select **Start**.

   If one or more of the partitions to be started have attached storage groups that are being configured or modified, a warning message is displayed. The warning message includes the name of the affected partitions. The Start task does not continue until you make a selection.

   - Select **YES** to allow the affected partitions to be started.
   - Select **NO** to cancel the start operation for only the affected partitions.

   A new window opens to display the progress of the start operation. In addition to displaying a progress indicator, this window also contains a Details column with messages that are updated as the start process continues. These messages indicate the progress of configuring partition resources and initializing the operating system or hypervisor to run in the partition.

Results

The Details column contains messages that indicate the outcome.

- **Success** indicates partitions that have started.
- **Failed** indicates partitions that failed to start.
- **Cancelled** indicates partitions for which the start operation was canceled.

If the result is anything other than successful, use the information in the Details column to diagnose and correct the problem.

What to do next

Open the appropriate console task through which you can log in to the operating system or hypervisor that is running on the partition.

- To log in to a Linux operating system, use the **Operating System Messages** task or the **Integrated ASCII Console** task. The **Integrated ASCII Console** task must be enabled through the operating system before you can use it.
- To log in to a z/VM hypervisor that is hosting multiple Linux guests, use the **Integrated 3270 Console** task.

Configuring partition resources on the operating system

If this time is the first time that you have started this partition, you need to configure the partition resources (processors, memory, and adapters) through configuration files on the operating system. The suggested practice is to open the **Partition Details** task and use it as a reference as you create or modify the appropriate configuration files on the operating system.

Depending on the version of Linux that you have installed, the operating system might automatically configure some resources.

- Remote Direct Memory Access (RDMA) over Converged Ethernet (RoCE) devices are automatically configured when you are running any of the minimum supported Linux versions. For recommended Linux on IBM Z and LinuxONE distribution levels, see the IBM tested platforms at: https://www.ibm.com/support/pages/linux-ibm-z-tested-platforms
- Auto-configuration of other devices requires a version of the Linux operating system that supports auto-configuration. These other devices include Fibre Channel connections (FICON) in Fibre Channel Protocol (FCP) mode, IBM HiperSockets, and Open Systems Adapter-Express (OSA-Express) devices. See the Red Hat, SUSE, or Ubuntu product information page to determine which RHEL, SLES, or Ubuntu Server version provides this support.

Ensuring that FICON or FCP storage groups are visible to the Linux operating system

After you start the new partition, you might need to enter Linux commands to make FICON or FCP storage groups available to the operating system that the partition hosts. NVMe storage groups are automatically detected by the operating system, so you do not need to enter Linux commands to make that type of storage group available to the operating system. Similarly, the tape devices that are available through attached tape links are automatically detected by the operating system, so you do not need to enter Linux commands for tape devices either.

Typically, the operating system stores the FCP HBA or FICON volume configuration so it can automatically bring the devices online on the next reboot, so you need to take action only for the initial boot of the operating system.

When attaching a storage group in Complete state

- For an FCP storage group:
  - If the storage group contained the boot volume, the operating system brings online all of the HBAs for this storage group, and all volumes in the storage group are available. No action is required unless you have attached other storage groups.
  - If the storage group does not contain the boot volume, and the operating system is not configured to bring HBAs online automatically, you need to issue the **chccwdev** command to bring online all of the HBAs.
- For a FICON storage group, the operating system brings online only the boot volume. You need to issue the **chccwdev** command to bring online all of the remaining volumes in the storage group that contains the boot volume, as well as the volumes in any other storage groups that you attached.

When attaching an unfulfilled storage group that becomes Complete as the partition is running

- For an FCP storage group:
  - If adapters were assigned to HBAs while the partition is running, you need to use the **chchp** command to activate the channel paths for those new adapters.

- To access the volumes in the storage group, you need to issue the **chccwdev** command to bring online all of the HBAs.

- For a FICON storage group:
  - If the adapters connecting the storage group to the storage subsystem were assigned while the partition is running, use the **chchp** command to activate the channel paths for those new adapters.
  - All volumes are offline. You need to issue the **chccwdev** command to bring online all of the volumes in the storage group.

To find the IDs that you need to use for the Linux commands, use the following tasks.

- HBA device numbers are available in the Host Bus Adapters (HBA) table when you expand the storage group table entry in the Storage section of the **Partition Details** task.
- Channel path IDs for FCP adapters are shown in the Host Bus Adapters (HBA) table when you expand the storage group table entry in the Storage section of the **Partition Details** task.
- Channel path IDs for FICON adapters are shown on the **ADAPTERS** tab of the Storage Group details; open the **Configure Storage** task and select the storage group in the **Storage Overview** to open the Storage Group details page.
- FICON volume device numbers are shown on the **VOLUMES** tab of the Storage Group details page; open the **Configure Storage** task and select the storage group in the **Storage Overview** to open the Storage Group details page.

Attaching partition links to a stopped or active partition

Use the **Configure Partition Links** task to attach a partition link to one or more stopped or started partitions. To open the **Configure Partition Links** task to the partition links overview, you do not need any specific task authorization; however, to view any partition links in the overview, you must have object access to one or more partition links. To create, delete, or edit a partition link, you also must have a customized user ID with the predefined System Programmer Tasks role or equivalent permissions.

To attach a partition link to a stopped or active partition:

- You need to have the correct authorization to either create or edit the partition link, and you need object access to the partition.
- When you either create a new or edit an existing partition link through the **Configure Partition Links** task, you add the partition during the create or edit process.
- When you create a new partition link or save your changes to an existing partition link, DPM asynchronously attaches the partition link to the partitions that you added as part of the create or edit request. For partitions in Active state, DPM dynamically configures the partition link as soon as it is created.

For more information about required authorization plus instructions for creating or editing a partition link, see the online help for the **Configure Partition Links** task.

Verifying that the partition resources are online

To verify that the partition resources are online, use the appropriate Linux commands, samples of which are displayed in the following list.

- To display information about processor resources, use the **lscpu** command. The following screen shows a sample display that results from entering this command.

```
[root@lbskvm4 ~]# lscpu
Architecture:          s390x
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Big Endian
CPU(s):                8
On-line CPU(s) list:   0-7
Thread(s) per core:    2
Core(s) per socket:    8
Socket(s) per book:    3
Book(s):               8
Vendor ID:             IBM/S390
BogoMIPS:              7936.00
Hypervisor:            PR/SM
Hypervisor vendor:     IBM
Virtualization type:   full
Dispatching mode:      horizontal
L1d cache:             128K
L1i cache:             96K
L2d cache:             2048K
L2i cache:             2048K
[root@lbskvm4 ~]#
```

*Figure 25. Sample displays resulting from the **lscpu** command*

- To display information about memory resources, use the **lsmem** command. The following screen shows a sample display that results from entering this command.

```
[root@lbskvm4 ~]# lsmem
Address Range                       Size (MB)  State    Removable  Device
==========================================================================
0x0000000000000000-0x00000001ffffffff       8192  online   no         0
0x0000000200000000-0x000000f5ffffffff     999424  online   yes        1-122
0x000000f600000000-0x000000ffffffffff      40960  online   no         123-127
0x0000010000000000-0x0000030dffffffff    2154496  offline  -          128-390

Memory device size  : 8192 MB
Memory block size   : 8192 MB
Total online memory : 1048576 MB
Total offline memory: 2154496 MB
[root@lbskvm4 ~]#
```

*Figure 26. Sample displays resulting from the **lsmem** command*

- To display information about adapters, use the appropriate command for the device type. For example, to view Open Systems Adapter-Express (OSA-Express) features, use the **lsqeth**, **lscss**, and **lschp** device driver commands. The following screens show sample displays that result from entering these commands.

```
0.0.0005 host1
[root@lbskvm4 ~]# lsqeth
Device name                   : enccw0.0.0001
------------------------------------------------------------------------------
        card_type             : OSD_1000
        cdev0                 : 0.0.0001
        cdev1                 : 0.0.0002
        cdev2                 : 0.0.0003
        chpid                 : 13
        online                : 1
        portname              : DUMMY
        portno                : 0
        state                 : UP (LAN ONLINE)
        priority_queueing     : always queue 0
        buffer_count          : 128
        layer2                : 1
        isolation             : none

[root@lbskvm4 ~]# lscss
Device   Subchan.  DevType CU Type Use  PIM PAM POM  CHPIDs
------------------------------------------------------------------------------
0.0.0001 0.0.0000  1732/01 1731/01 yes  80  80  ff   13000000 00000000
0.0.0002 0.0.0001  1732/01 1731/01 yes  80  80  ff   13000000 00000000
0.0.0003 0.0.0002  1732/01 1731/01 yes  80  80  ff   13000000 00000000
0.0.0006 0.0.0003  1732/03 1731/03      80  80  ff   39000000 00000000
0.0.0005 0.0.0004  1732/03 1731/03 yes  80  80  ff   2a000000 00000000
0.0.0004 0.0.0005  1732/03 1731/03 yes  80  80  ff   2e000000 00000000
0.0.0007 0.0.0006  1732/03 1731/03      80  80  ff   01000000 00000000
[root@lbskvm4 ~]#
```

*Figure 27. Sample displays resulting from the **lsqeth** and **lscss** commands*

```
[root@lbskvm4 ~]# lschp
CHPID  Vary  Cfg.  Type  Cmg  Shared  PCHID
============================================
0.01   1     1     25    2    1       01f0
0.13   1     1     11    2    1       017c
0.2a   1     1     25    2    1       0121
0.2e   1     1     25    2    1       0109
0.39   1     1     25    2    1       0144
[root@lbskvm4 ~]#
```

*Figure 28. Sample displays resulting from the **lschp** command*

To display information about adapters that use the PCI Express (PCIe) protocol, such as Non-Volatile Memory Express (NVMe) adapters, use the **lspci** command, as shown in Figure 29 on page 65.

```
localhost:/home/dpm # lspci
0101:00:00.0 Non-Volatile memory controller: Samsung Electronics Co Ltd NVMe SSD
 Controller 172Xa/172Xb (rev 01)
0201:00:00.0 Non-Volatile memory controller: Samsung Electronics Co Ltd NVMe SSD
 Controller 172Xa/172Xb (rev 01)
0202:00:00.0 Non-Volatile memory controller: Intel Corporation NVMe Datacenter S
SD [3DNAND, Beta Rock Controller]
```

*Figure 29. Sample displays resulting from the **lspci** command*

To display information about FCP tape storage, use the **lscss** command to display the HBA device numbers that the partition is using for tape links, and the **lstape** command to list the available tape drives. Figure 30 on page 65 shows sample results from the **lstape** command.

```
((root@localhost))>lstape --scsi-only --verbose
Generic Device         Target           Vendor   Model            Type     State
        HBA            WWPN                      Serial
sg0     st0            0:0:0:0          IBM      ULT3580-HH6      tapedrv  running
        0.0.0003       0x2002000e11159c32        90WT800375
sg1     sch0           0:0:0:1          IBM      3573-TL          changer  running
        0.0.0003       0x2002000e11159c32        00L2U78Z8185_LL0
sg2     st1            0:0:1:0          IBM      ULT3580-HH6      tapedrv  running
        0.0.0003       0x2005000e11159c32        1068012586
sg3     st2            1:0:0:0          IBM      ULT3580-HH6      tapedrv  running
        0.0.0004       0x2002000e11159c32        90WT800375
sg4     sch1           1:0:0:1          IBM      3573-TL          changer  running
        0.0.0004       0x2002000e11159c32        00L2U78Z8185_LL0
sg5     st3            1:0:1:0          IBM      ULT3580-HH6      tapedrv  running
        0.0.0004       0x2005000e11159c32        1068012586
```

*Figure 30. Sample displays resulting from the **lstape** command*

Specifying the relative port number of an OSA device

If the partition is connected to a network through an OSA-Express adapter port other than port 0, you need to manually specify the relative port number through a Linux `qeth` device driver command, before entering the Linux command to bring the device online. The following sample commands show how to create a device group, to specify the relative port number and layer mode, and to bring the group of devices online. The highlighted command (the second line) specifies the port number; that command contains 1 for the port number, along with the attribute `portno`.

```
echo 0.0.1100,0.0.1101,0.0.1102 > /sys/bus/ccwgroup/drivers/qeth/group
echo 1 > /sys/bus/ccwgroup/drivers/qeth/0.0.1100/portno
echo 1 > /sys/bus/ccwgroup/drivers/qeth/0.0.1100/layer2
echo 1 > /sys/bus/ccwgroup/drivers/qeth/0.0.1100/online
```

Configuring secure execution for a Linux hypervisor

If the IBM Secure Execution for Linux feature is enabled on this system, you can configure a Linux operating system that functions as a hypervisor for secure execution, which isolates and protects any guests that run on a hypervisor by restricting host access to guest workloads and data.

- To determine whether the IBM Secure Execution for Linux feature is enabled on the system, go to the **General** section of the **System Details** task and check the values displayed for the Secure Execution field.
- To configure Linux for secure execution, see the product documentation for the Linux distribution that you are using as a hypervisor.
- To determine whether the Linux hypervisor that runs on a partition is configured for secure execution, go to the **General** section of the **Partition Details** task and check the value displayed for the Secure Execution field.

Finding additional information about operating system or hypervisor commands

- For more information about using Linux commands to work with partition resources and adapters, see the *Device Drivers, Features, and Commands* documentation for the Linux kernel version that you are using. This documentation, which also describes commands and parameters for configuring

Linux on IBM Z and LinuxONE servers, is available in IBM Documentation at https://www.ibm.com/docs/en/linux-on-systems?topic=overview-device-drivers-features-commands

- For information about using z/VM commands to work with partition resources and adapters, see the *z/VM: CP Commands and Utilities Reference* for the z/VM version that you are using. The z/VM library is available in IBM Documentation at https://www.ibm.com/docs/en/zvm

Chapter 8. Dynamically modifying the resources of an active partition

You can use the **Partition Details** task to add processors, memory, and devices to an active partition, without stopping and restarting it. When you click **Apply** to save any changes you have made through the **Partition Details** task, DPM updates the partition definition but does not bring any of the new resources or devices online. To do so, you must use the appropriate operating system or hypervisor commands. Note that you cannot change the partition type through the **Partition Details** task.

Depending on the version of Linux that you have installed, the operating system might automatically configure some partition resources:

- Remote Direct Memory Access (RDMA) over Converged Ethernet (RoCE) devices are automatically configured when you are running any of the minimum supported Linux versions. For recommended Linux on IBM Z and LinuxONE distribution levels, see the IBM tested platforms at: https://www.ibm.com/support/pages/linux-ibm-z-tested-platforms
- Auto-configuration of other devices requires a version of the Linux operating system that supports auto-configuration. These other devices include Fibre Channel connections (FICON) in Fibre Channel Protocol (FCP) mode, IBM HiperSockets, and Open Systems Adapter-Express (OSA-Express) devices. See the Red Hat, SUSE, or Ubuntu product information page to determine which RHEL, SLES, or Ubuntu Server version provides this support.

To manually configure partition resources on the HMC and on the operating system that a partition hosts, use the following examples as models for your changes. Note that the content of the screen captures in these topics might differ from what you see on the HMC, depending on the DPM version and the host system that you are using.

- "Example: Adding more processor resources" on page 67
- "Example: Adding more memory resources" on page 69
- "Example: Adding a new network device" on page 71

Use the following instructions to dynamically add or manage storage resources for a partition.

- "Instructions: Attaching storage groups or tape links" on page 74
- "Instructions: Detaching and reattaching an FCP storage group" on page 76
- "Instructions: Changing the adapters that are assigned to an FCP storage group" on page 77
- "Instructions: Changing the adapters that are assigned to an FCP tape link" on page 78

Example: Adding more processor resources

Consider the display in the following screen, which shows that a sample partition has two threads per core, with eight processors online.

```
[root@lbskvm4 /]# lscpu
Architecture:          s390x
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Big Endian
CPU(s):                8
On-line CPU(s) list:   0-7
Thread(s) per core:    2
Core(s) per socket:    8
Socket(s) per book:    3
Book(s):               8
Vendor ID:             IBM/S390
BogoMIPS:              7936.00
Hypervisor:            PR/SM
Hypervisor vendor:     IBM
Virtualization type:   full
Dispatching mode:      horizontal
L1d cache:             128K
L1i cache:             96K
L2d cache:             2048K
L2i cache:             2048K
```

*Figure 31. Sample display for the **lscpu** command showing current processor resources*

To bring more processors online, complete the following steps.

1. Use the **Partition Details** task to increase the number of processors for this partition from four to six cores, and click **Apply** to save your changes and close the Partition Details window.

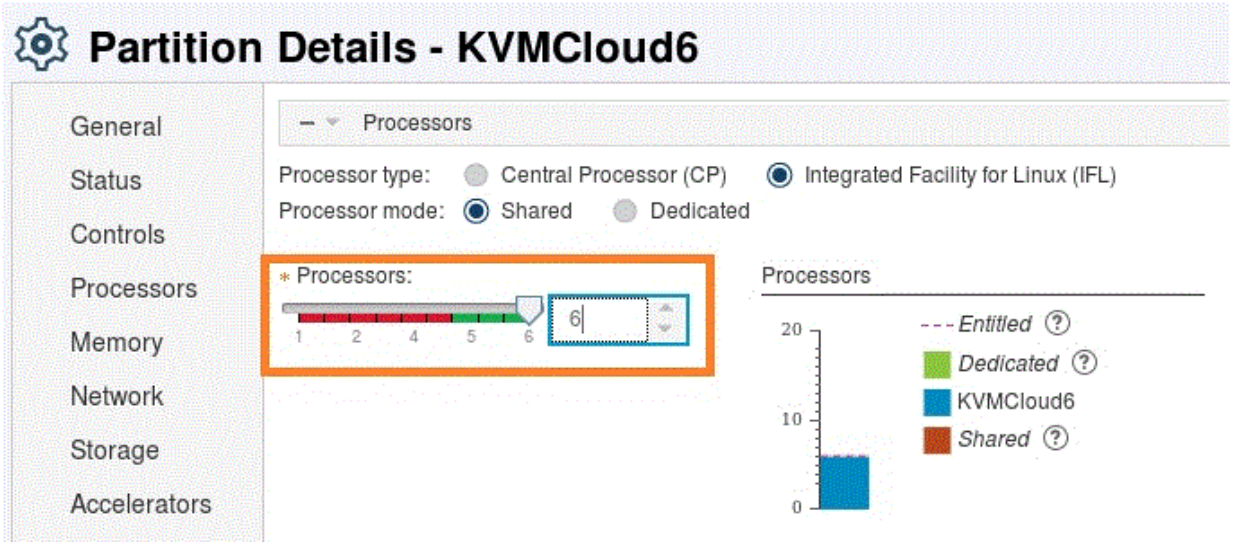

Figure 32. Sample screen of the Processors section in the Partition Details window

2. Through the Linux **lscpu** command, verify that the number of processor cores has increased.

```
[root@lbskvm4 /]# lscpu
Architecture:          s390x
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Big Endian
CPU(s):                12
On-line CPU(s) list:   0-7
Off-line CPU(s) list:  8-11
Thread(s) per core:    2
Core(s) per socket:    8
Socket(s) per book:    3
Book(s):               8
Vendor ID:             IBM/S390
BogoMIPS:              7936.00
Hypervisor:            PR/SM
Hypervisor vendor:     IBM
Virtualization type:   full
Dispatching mode:      horizontal
L1d cache:             128K
L1i cache:             96K
L2d cache:             2048K
L2i cache:             2048K
```

*Figure 33. Sample display for the **lscpu** command showing additional processor resources*

3. Use the Linux **chcpu** command to configure and then enable the additional processor cores.

```
[root@lbskvm4 /]# chcpu -c 8-11
CPU 8 configured
CPU 9 is already configured
CPU 10 configured
CPU 11 is already configured
[root@lbskvm4 /]# chcpu -e 8-11
CPU 8 enabled
CPU 9 enabled
CPU 10 enabled
CPU 11 enabled
[root@lbskvm4 /]#
```

*Figure 34. Sample display for the **lscpu** command showing configured processor resources*

Example: Adding more memory resources

Consider the display in the following screen, which shows that a sample partition has 1 terabyte (TB) of memory online, and 2 TB offline. It also shows that the memory size is in 8 gigabyte (GB) increments.

```
[root@lbskvm4 ~]# lsmem
Address Range                                 Size (MB)  State    Removable  Device
==========================================================================================
0x0000000000000000-0x00000001ffffffff         8192       online   no         0
0x0000000200000000-0x000000f5ffffffff         999424     online   yes        1-122
0x000000f600000000-0x000000ffffffffff         40960      online   no         123-127
0x0000010000000000-0x0000030dffffffff         2154496    offline  -          128-390

Memory device size  : 8192 MB
Memory block size   : 8192 MB
Total online memory : 1048576 MB
Total offline memory: 2154496 MB
[root@lbskvm4 ~]#
```

*Figure 35. Sample display for the **lsmem** command*

To bring more memory online, complete the following steps.

1. Use the **Partition Details** task to increase the amount of memory for this partition from 1 TB to 2 TB, and click **Apply** to save your changes and close the Partition Details window.

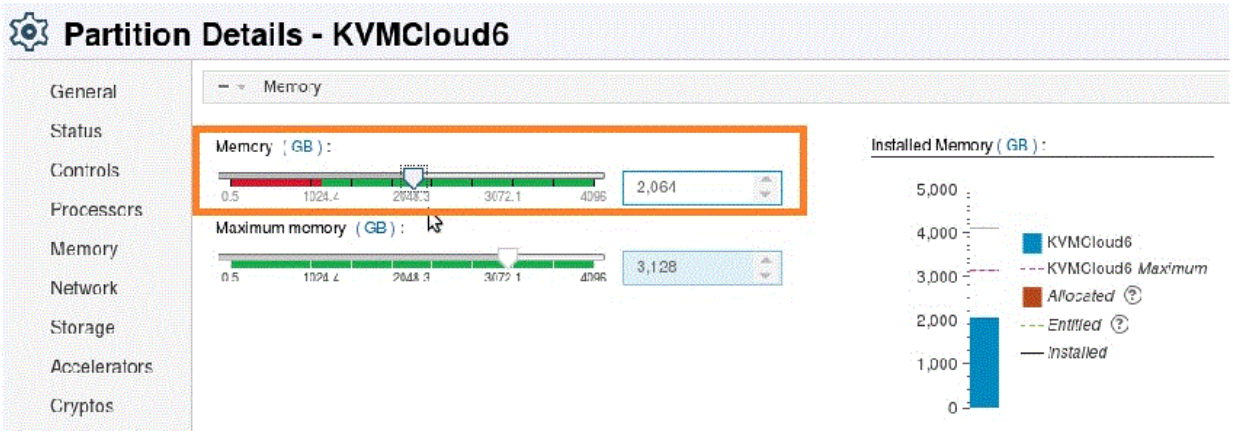

Figure 36. Sample screen of the Memory section in the Partition Details window

2. Then, through the Linux **chmem** command, increase the amount of online memory in 8 GB increments.

```
[root@lbskvm4 /]# time chmem -e 8g

real    0m0.691s
user    0m0.157s
sys     0m0.553s
[root@lbskvm4 /]# lsmem
Address Range                                 Size (MB)  State    Removable  Device
==========================================================================================
0x0000000000000000-0x00000001ffffffff         8192       online   no         0
0x0000000200000000-0x000000f5ffffffff         999424     online   yes        1-122
0x000000f600000000-0x000000ffffffffff         40960      online   no         123-127
0x0000010000000000-0x00000103ffffffff         16384      online   yes        128-129
0x0000010400000000-0x0000030dffffffff         2138112    offline  -          130-390

Memory device size  : 8192 MB
Memory block size   : 8192 MB
Total online memory : 1064960 MB
Total offline memory: 2138112 MB
[root@lbskvm4 /]#
```

*Figure 37. Sample display for the **chmem** command*

Example: Adding a new network device

In this example, the Linux operating system currently has seven network devices configured, as shown in the following display.

```
[root@lbskvm4 ~]# lscss
Device   Subchan.  DevType CU Type Use  PIM PAM POM  CHPIDs
------------------------------------------------------------------------------
0.0.0001 0.0.0000  1732/01 1731/01 yes  80  80  ff   13000000 00000000
0.0.0002 0.0.0001  1732/01 1731/01 yes  80  80  ff   13000000 00000000
0.0.0003 0.0.0002  1732/01 1731/01 yes  80  80  ff   13000000 00000000
0.0.0006 0.0.0003  1732/03 1731/03      80  80  ff   39000000 00000000
0.0.0005 0.0.0004  1732/03 1731/03 yes  80  80  ff   2a000000 00000000
0.0.0004 0.0.0005  1732/03 1731/03 yes  80  80  ff   2e000000 00000000
0.0.0007 0.0.0006  1732/03 1731/03      80  80  ff   01000000 00000000
[root@lbskvm4 ~]#
```

*Figure 38. Sample display for the **lscss** command showing current devices*

1. Use the **Partition Details** task to add a new network interface card (NIC).

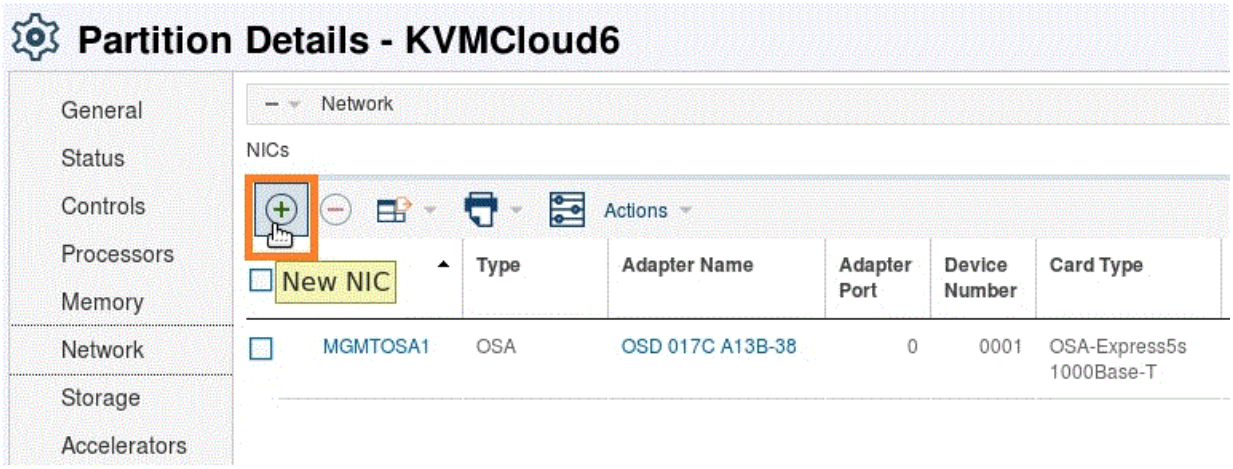

Figure 39. Sample screen of the Network section with the New NIC icon highlighted

2. Select the adapter for the new network connection.

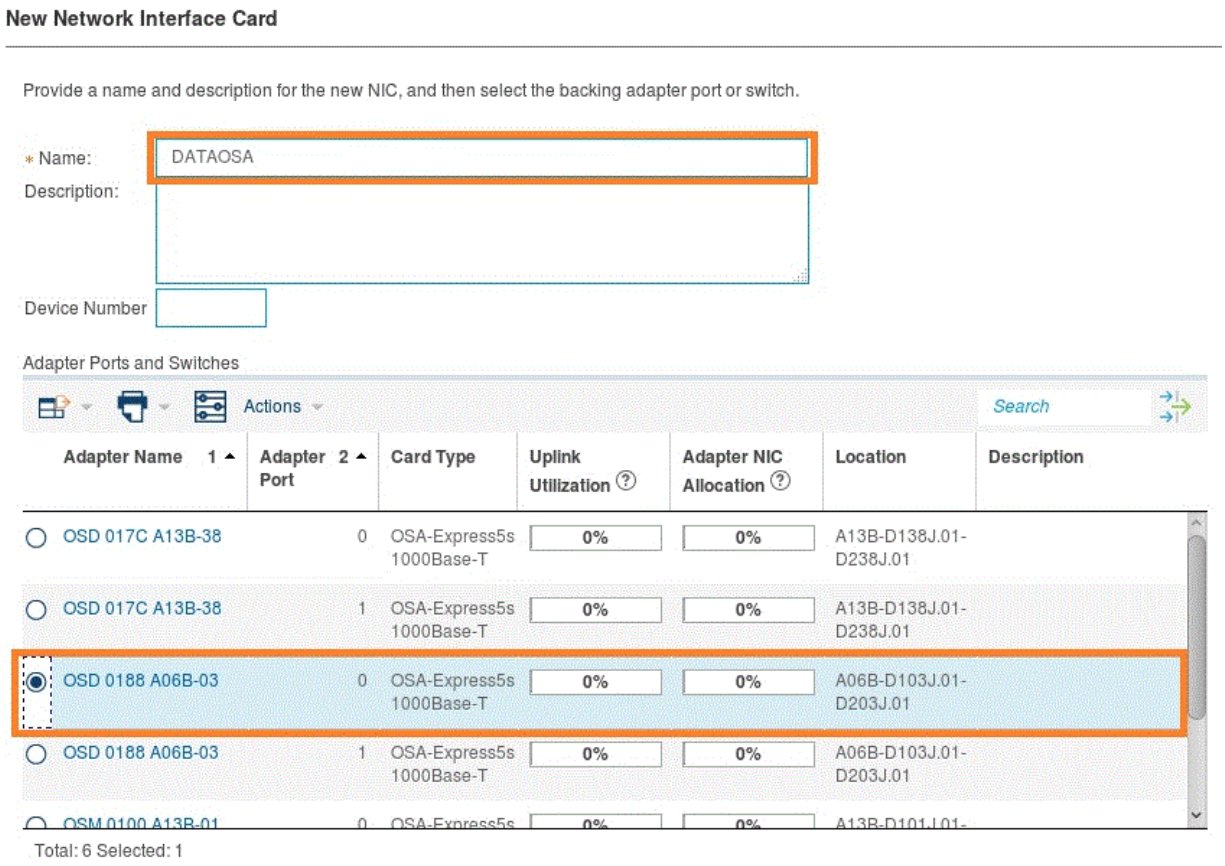

Figure 40. Sample screen of the New Network Interface Card window

3. Click **OK** to save the new NIC definition, and check the updated NICs table in the **Network** section of the **Partition Details** task.

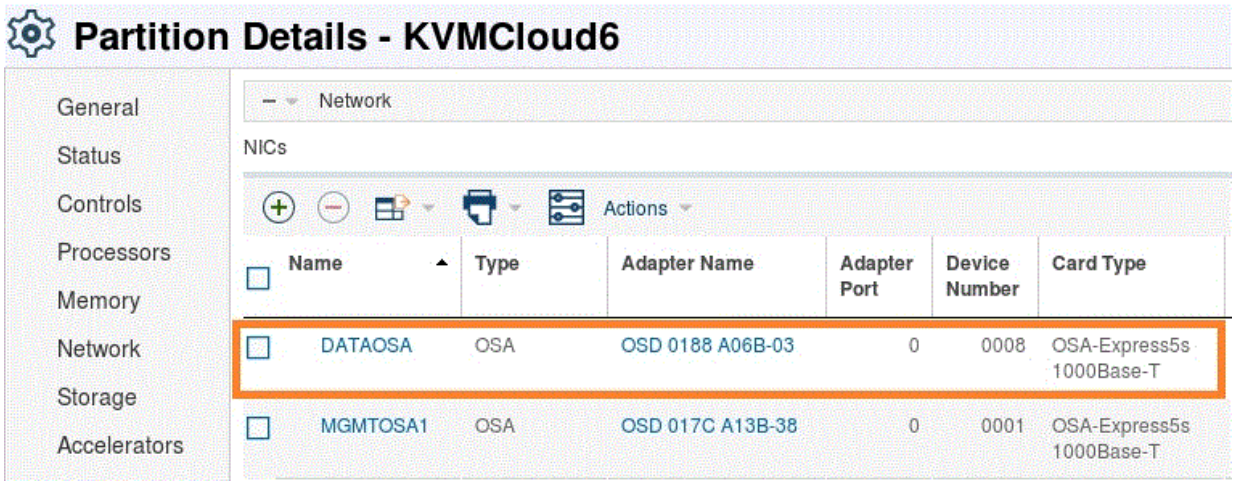

Figure 41. Sample screen of the Network section with the newly added NIC

4. Click **Apply** to save your changes and close the Partition Details window.
5. Then, through the Linux **`znetconf`** command, define the new devices 0.0.0008 through 0.0.000a.

```
[root@lbskvm4 /]# znetconf -u
Scanning for network devices...
Device IDs                Type    Card Type      CHPID Drv.
------------------------------------------------------------
0.0.0008,0.0.0009,0.0.000a 1731/01 OSA (QDIO)        14 qeth
[root@lbskvm4 /]# znetconf -a 0.0.0008 -o layer2=1
Scanning for network devices...
Successfully configured device 0.0.0008 (enccw0.0.0008)
[root@lbskvm4 /]# znetconf -c
Device IDs                Type    Card Type      CHPID Drv. Name             State
------------------------------------------------------------------------------
0.0.0001,0.0.0002,0.0.0003 1731/01 OSD_1000          13 qeth enccw0.0.0001    online
0.0.0008,0.0.0009,0.0.000a 1731/01 OSD_1000          14 qeth enccw0.0.0008    online
[root@lbskvm4 /]#
```

*Figure 42. Sample display for the **znetconf** command showing current devices*

Notes: If the display for the **znetconf -u** command does not list the newly added device:

- The adapter might be offline. Use the **lschp** command to determine the current state of the new adapter, and use the **chchp** command to bring the adapter online. Then issue the **znetconf** command again.
- The device might be included in a list of devices to be ignored by Linux. If `cio_ignore` is active, the list is automatically adjusted to accommodate all devices that are configured on the HMC interface **only** when you reboot the operating system. To dynamically add the device, use `cio_ignore -r` to remove the device from the list, then set the device online.

Issuing an **lsqeth** command displays the successfully defined network device, which can be defined to the Linux TCP/IP stack or passed to a virtual switch. Figure 43 on page 74 illustrates a sample display for the **lsqeth** command.

```
[root@lbskvm4 /]# lsqeth
Device name                   : enccw0.0.0001
-------------------------------------------------
        card type             : OSD 1000
        cdev0                 : 0.0.0001
        cdev1                 : 0.0.0002
        cdev2                 : 0.0.0003
        chpid                 : 13
        online                : 1
        portname              : DUMMY
        portno                : 0
        state                 : UP (LAN ONLINE)
        priority queueing     : always queue 0
        buffer_count          : 128
        layer2                : 1
        isolation             : none

Device name                   : enccw0.0.0008
-------------------------------------------------
        card_type             : OSD_1000
        cdev0                 : 0.0.0008
        cdev1                 : 0.0.0009
        cdev2                 : 0.0.000a
        chpid                 : 14
        online                : 1
        portno                : 0
        state                 : UP (LAN ONLINE)
        priority_queueing     : always queue 0
        buffer_count          : 64
        layer2                : 1
        isolation             : none

[root@lbskvm4 /]#
```

*Figure 43. Sample display for the **lsqeth** command showing details for devices*

Instructions: Attaching storage groups or tape links

Through the Storage section of the **Partition Details** task, you can attach one or more FICON, FCP, or NVMe storage groups or FCP tape links to an existing partition. FCP storage groups can be shared by multiple partitions, and multiple storage groups can be attached to one partition. FCP tape links also can be either shared by many partitions or dedicated to one. In contrast, only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared.

Note: In addition to using the **Partition Details** task to attach an FCP tape link, you can also attach a tape link to a selected partition through the **Configure Storage** task, when you use it to either create a new tape link or modify an existing one.

In the **Partition Details** task, the Storage section contains a Storage Groups table and a Tape Links table. To attach new storage groups or tape links to the partition, complete the following steps.

1. Select the plus icon in the table toolbar to open the **Attach Storage Groups** or **Attach Tape Links** window.

2. On the **Attach Storage Groups** window, select one or more storage groups listed in the Storage Groups table to attach to this partition.
   - The suggested practice is to select storage groups that are in the Complete fulfillment state, but you can select any storage group except for those with a fulfillment state of Incomplete, or those that are already attached to the maximum number of partitions. If you do select groups in states other than Complete, some storage might not be available for use immediately.
   - Use the additional information in the Storage Groups table, as necessary, to decide which storage groups to attach. For descriptions of the columns in the Storage Groups table, see the online help.

   When you have finished selecting storage groups to attach, select **OK** to close the **Attach Storage Groups** window.
3. On the **Attach Tape Links** window, select one or more tape links listed in the table to attach to this partition.
   - The suggested practice is to select tape links that are in the Complete fulfillment state, but you can select any tape link except for those with a fulfillment state of Incomplete, or those that are already attached to the maximum number of partitions. If you do select links in states other than Complete, some storage might not be available for use when you start the partition.
   - Use the additional information in the table, as necessary, to decide which tape links to attach.

   When you have finished selecting tape links to attach, select **OK** to close the **Attach Tape Links** window.
4. Check the entries for the storage groups or tape links that you selected, which are now displayed in the Storage Groups table or Tape Links table in the Storage section. If necessary, you can use the minus icon in the table toolbar to remove a storage group or tape link from the table.
5. When you have finished, click **OK** to save the partition definition.

   If the partition is running, or when you restart a stopped partition, you might need to enter Linux commands to make any newly attached storage groups available to the operating system that the partition hosts. NVMe storage groups are automatically detected by the operating system, so you do not need to enter Linux commands to make that type of storage group available to the operating system. Similarly, the tape devices that are available through attached tape links are automatically detected by the operating system, so you do not need to enter Linux commands for tape devices either. The actions required for FCP or FICON storage groups depend on the type and fulfillment state, and whether the storage group contained the boot volume for the operating system.

   Note: If you issue the **`lscss`** command and the device number of the newly attached storage group is not listed, the device might be included in a list of devices to be ignored by Linux. If `cio_ignore` is active, the list is automatically adjusted to accommodate all devices that are configured on the HMC interface **only** when you reboot the operating system. To dynamically add the device, use `cio_ignore -r` to remove the device from the list, then set the device online.

   When attaching a storage group in Complete state when the partition is stopped

   - For an FCP storage group:
     - If the storage group contained the boot volume, the operating system brings online all of the HBAs for this storage group, and all volumes in the storage group are available. No action is required unless you have attached other storage groups.
     - If the storage group does not contain the boot volume, and the operating system is not configured to bring HBAs online automatically, you need to issue the **chccwdev** command to bring online all of the HBAs.
   - For a FICON storage group, the operating system brings online only the boot volume. You need to issue the **chccwdev** command to bring online all of the remaining volumes in the storage group that contains the boot volume, as well as the volumes in any other storage groups that you attached.

When attaching a Complete storage group to a running partition, or attaching an unfulfilled storage group that becomes Complete as the partition is running

- For an FCP storage group:
  - If adapters were assigned to HBAs while the partition is running, you need to use the **chchp** command to activate the channel paths for those new adapters.
  - To access the volumes in the storage group, you need to issue the **chccwdev** command to bring online all of the HBAs.
- For a FICON storage group:
  - If the adapters connecting the storage group to the storage subsystem were assigned while the partition is running, use the **chchp** command to activate the channel paths for those new adapters.
  - All volumes are offline. You need to issue the **chccwdev** command to bring online all of the volumes in the storage group.

To find the IDs that you need to use for the Linux commands, use the following tasks.

- HBA device numbers are available in the Host Bus Adapters (HBA) table when you expand the storage group table entry in the Storage section of the **Partition Details** task.
- Channel path IDs for FCP adapters are shown in the Host Bus Adapters (HBA) table when you expand the storage group table entry in the Storage section of the **Partition Details** task.
- Channel path IDs for FICON adapters are shown on the **ADAPTERS** tab of the Storage Group details; open the **Configure Storage** task and select the storage group in the **Storage Overview** to open the Storage Group details page.
- FICON volume device numbers are shown on the **VOLUMES** tab of the Storage Group details page; open the **Configure Storage** task and select the storage group in the **Storage Overview** to open the Storage Group details page.

Instructions: Detaching and reattaching an FCP storage group

When you detach an FCP storage group from a partition, DPM does not preserve the HBAs, device numbers, or backing adapters that were in use for that storage group. Consequently, if you reattach the storage group to the same partition, the device numbers and the backing adapters of the HBAs are not guaranteed to be the same as they were before the detachment. The same condition is true if you attach the FCP storage group to a new partition: the device numbers and the backing adapters of the HBAs are not guaranteed to be the same as they were when the storage group was attached to a different partition.

If the operating system image for the partition resides on a boot volume in the storage group that you reattach, the operating system might not start when the partition is restarted. (Operating systems that are started from a storage volume usually have a preconfigured device number and a path to the volume.) To avoid this situation, administrators must review the device numbers and the backing adapters of the HBAs, after reattaching the storage group and before restarting the partition. If necessary, the administrators must change the device number to match the preconfigured device number for the operating system, and make sure that the preconfigured device number is assigned to the backing adapter that was assigned to the HBA before the detachment.

Notes:

- If the storage group that is being reattached contains the boot volume for the operating system, you must stop the partition before detaching and reattaching the storage group. Running workloads can be disrupted if you detach and reattach a storage group that contains boot volumes while the partition is active. (If a storage group contains only data volumes, you do not have to stop the partition.)
- When you detach and reattach a FICON storage group, the device numbers of storage volumes do not change because they are associated with the storage group volumes.

Use the following instructions to detach an FCP storage group that contains a boot volume, and reattach it to the same partition.

1. If the partition is active, use the **Stop** task to stop the partition.
2. Open the **Partition Details** task for the partition.
   a. Go to the **Boot** section. If the **Storage device (SAN)** boot option is selected, and a boot volume in an FCP storage group is selected, note the name of the storage group.
   b. Go to the **Storage** section, and select the FCP storage group that contains the boot volume for the operating system.
      i) Expand the storage group table entry to show the Host Bus Adapters (HBA) table, and record the device number and the assigned adapter.
      ii) In the Storage Group table toolbar, select the minus icon to detach the storage group.
3. When you reattach the storage group, make sure that the partition is stopped and, if necessary, reopen the **Partition Details** task to the **Storage** section.
   a. In the Storage Group table toolbar, select the plus icon to open the **Attach Storage Groups** window.
   b. On the **Attach Storage Groups** window, select the storage group.
   c. Select **OK** to close the **Attach Storage Groups** window.
   d. Select and expand the entry for the storage group, which is listed in the Storage Groups table in the **Storage** section.
      i) Look for the adapter that you recorded before detaching the storage group. If it is listed, continue to the next step (check the device number for the HBA). Otherwise, complete the following steps:
         a) Select **Change Adapters** to open the FCP adapter assignment window.
         b) In the Assigned Adapters table, select an existing adapter, and select **UNASSIGN**.
         c) In the Adapter Candidates table, find the adapter that you recorded, and select **ASSIGN**.
         d) Select **SAVE** to save your changes and return to the **Storage** section of the **Partition Details** task.
      ii) Check the device number for the HBA that is associated with the recorded adapter. If necessary, change the device number to match the preconfigured device number that the operating system uses (the device number that you recorded before detaching the storage group).
      iii) Select **Apply** to save your changes.
   e. Go to the **Boot** section of the **Partition Details** task.
      i) Select **Storage device (SAN)** as the Boot from option.
      ii) Use the radio button in the Select column to select the reattached FCP storage group that contains the boot volume for the operating system.
   f. Select **OK** to save your changes and close the **Partition Details** window.
4. Use the **Start** task to restart the partition.

Instructions: Changing the adapters that are assigned to an FCP storage group

In the **Configure Storage** task, when you open the Storage Group details page for an FCP storage group, you can review the adapters assigned to a storage group and remove or replace them with other adapters that are available for use by a partition. However, if an FCP adapter is configured while the storage group is attached to an active partition, DPM cannot detect and list the new adapter as available for use by any partition.

To make sure that you can choose a new adapter from a complete list of available adapters, perform the following steps on the HMC.

1. Open the **Configure Storage** task to the Storage Overview page, and select the table row for the FCP storage group. The Storage Details page opens.

2. Select the **PARTITIONS** tab to display a list of the partitions to which this storage group is attached. If any partitions are listed as Active, use the **Stop** task to stop them. After all of the active partitions are stopped, continue to the next step.
3. Select the **Connection Report** icon to open the **Connection Report** page for the FCP storage group. On the **Connection Report** page, select the **Update report** icon (↻) to start a new background check of the available connections for the storage group. When the check is complete, the Report Date field is updated.
4. After the background check completes, verify that the new adapter is listed in the Mainframe section of the connection report, and that no errors are associated with the adapter. Close the Connection Report page.
5. On the **PARTITIONS** tab, expand the table row for one of the partition for which you want to use the new adapter, and select **Change Adapter**. On the **FCP adapter assignment** window, complete the following steps.
   a. Review the entries in the Assigned Adapters table and, if necessary, select an existing adapter, and select **UNASSIGN** to remove it from the table.
   b. In the Adapter Candidates table, find the table entry for the new adapter.
   c. In the adapter table entry, select **ASSIGN** to assign the new adapter.
   d. Select **SAVE** to return to the Storage Group details page.

   Repeat these steps for each partition for which you want to use the new adapter.
6. Check the fulfillment state of the storage group. When the state is Complete, use the **Start** task to restart the partitions.

Instructions: Changing the adapters that are assigned to an FCP tape link

In the **Configure Storage** task, when you open the Tape Link details page for an FCP tape link, you can select the **ADAPTERS** tab to review the adapters that are assigned to the tape link. To change the adapters for a tape link, select **Modify** to open the Tape Link details page in Modification mode. Modification mode is indicated by a large blue bar that contains the Modification label, plus the **CANCEL** and **SAVE** buttons. In this mode, you can add or delete adapters only by changing the number of connecting paths. Remember that changes to this connectivity setting have an impact on bandwidth, performance, and redundancy. You also can replace currently assigned adapters with other available adapters, and resolve adapter mismatches when the fulfillment state of the tape link is Pending with mismatches.

When you save your changes, the fulfillment state of the tape link changes to Pending, and DPM automatically generates a request that you can send to one or more storage administrators; this email includes zoning instructions for the storage administrators to follow to fulfill your request.

The following topics describe the methods for changing the adapters for a tape link, and factors that you need to consider when using each method.

Modify the number of connecting paths

Changes that you make through the **Number of connecting paths** slider, text entry field, or spin button are reflected in the adapters table. The changes vary, depending on whether you are decreasing the number of paths, increasing the number of paths, or both, during a single modification session.

Only decrease the number of connecting paths

When you decrease the number of paths, DPM automatically grays out the appropriate number of adapter rows from the table, selecting the adapters to remove in the following order.

1. Adapters to be selected by the storage administrator (placeholder rows) that DPM assigned or that you selected to replace assigned adapters.
2. Unzoned adapters that are already assigned to the tape link.
3. Zoned ("Matching") adapters that are already assigned to the tape link.

4. Unzoned adapters that you selected to replace assigned adapters.
5. Zoned ("Matching") adapters that you selected to replace assigned adapters.

Each adapter that DPM selects for removal is marked with a recover icon () to the right of the table row. If you prefer to remove different adapters, select the recover icon for any marked adapter, and the table display changes to show each adapter row with a trash can icon, so you can select which assigned adapters to delete. An inline message tells you how many adapters you need to select for deletion. When you click the trash can icon, DPM marks the adapter to be removed with one of the following marks, to the left of the table row:

- A red dot to indicate the adapter that was most recently selected for removal.
- A warning icon (), when this change is disruptive to active partitions that are using the tape link.

Only increase the number of connecting paths

When you increase the number of connecting paths, DPM adjusts the Adapters table by adding the corresponding number of table rows; for example, if you increase the number of paths by 2, the table contains two new table rows.

- DPM preselects adapters that are connected to the tape library already, and that provide optimal redundancy. Optimal redundancy for adapters is based on the following factors, which are listed in priority order from highest to lowest: on the location in the I/O drawers, on the drawer domain, on the current allocation, and on the connection to SAN fabrics.
- If the total number of preselected adapters is less than the number of connecting paths that you selected, placeholder rows represent the remaining number of adapters for the storage administrator to assign. If you do not supply a specific adapter for a placeholder row, the storage administrator selects the adapter for you, as part of fulfilling your modification request.

If more adapters are available for selection, you can select the exchange icon () to replace a preselected adapter.

Increase and decrease the number of paths in a single modification session

If you increase and decrease the number of connecting paths within a single modification session, DPM automatically adds or removes Adapter table rows in a specific order.

- When you increase the number of connecting paths, DPM automatically adds the appropriate number of adapters, preselecting them in the following order.
  1. Adapters that you already deleted in this modification session, if any.
  2. Zoned ("Matching") adapters that were not assigned previously to this tape link.
  3. Adapters that were previously assigned to this tape link, but were replaced through the exchange dialog.
  4. Adapters to be selected by the storage administrator (placeholder rows).
- When you decrease the number of connecting paths, DPM automatically removes the appropriate number of adapter rows from the table, selecting the adapters to remove in the following order.
  1. Adapters to be selected by the storage administrator (placeholder rows) if you increased the paths in this modification session.
  2. Zoned ("Matching") adapters that DPM preselected if you increased the paths in this modification session.
  3. Remaining placeholder rows, if any, including placeholder rows that DPM assigned or that you selected to replace assigned adapters.
  4. Unzoned adapters that are already assigned to the tape link.
  5. Zoned ("Matching") adapters that are already assigned to the tape link.
  6. Unzoned adapters that you selected to replace assigned adapters.
  7. Zoned ("Matching") adapters that you selected to replace assigned adapters.

Replace assigned adapters

To replace an assigned adapter (or add an adapter to a placeholder row), complete the following steps. For the best results, try to assign adapters that reside in different system I/O drawers and in different domains; that are not on the same card; and that are connected to different fabrics. Inline messages provide warnings if the selected adapters do not meet these criteria.

1. Select the exchange icon (). A dialog opens and displays information about the assigned adapter or placeholder row that you want to exchange, and available adapters to replace it.
2. If you want a storage administrator to select an adapter for you, select **Adapter to be assigned by the storage administrator** under the Available adapters heading. Otherwise, use the information in the Available adapters table to select a replacement adapter. Note that any adapter with an existing error condition is marked with an incomplete icon (). The suggested practice is to avoid selecting such adapters.

   MATCH
   If an adapter is already connected to the tape library that you are using for this tape link, this column contains the label "Matching" in the adapter row. Otherwise, this column is empty.

   NAME
   Specifies the name of the FCP adapter. DPM assigns a default adapter name in the form *adapter_type pchid partial_location*, which can help you determine whether you are selecting adapters that, for optimal redundancy, reside in different drawers and different domains. For example, in the sample default name FCP 0171 Z22B-11:

   - FCP is the type.
   - 0171 is the physical channel path identifier (PCHID).
   - Z22B is the plug location of the I/O drawer, with the first letter denoting the frame in which the drawer resides.
   - 11 is the slot in the drawer in which the adapter is plugged.

   For rack mount configurations, the *partial_location* section of the default name begins with AIO*x*, where A is the frame identifier, and *x* is the number of the I/O drawer.

   FABRIC ID
   Displays the worldwide name (WWN) of the uplink Fibre Channel switch. For optimal redundancy, use this value to select adapters that are connected to different fabrics.

   ADAPTER ID
   Specifies the physical channel ID of the adapter; this ID is a four-character hexadecimal number.

   TYPE
   Indicates the type of adapter card, which varies depending on the adapter cards that the system supports. Valid values include specific FICON Express adapter names.

   LOCATION
   Specifies the physical location of the adapter in the I/O drawer of the system.

   ALLOCATION
   Indicates the percentage of host bus adapters (HBAs) that are currently allocated to this adapter, shown in a bar graph and in numeric format. The displayed percentage includes HBAs only for started and reserved partitions. If the percentage is high (for example, 90%), consider assigning a different adapter.
3. Select **Replace** to save your selection and close the dialog window. On the **ADAPTERS** tab, the table row for the adapter that you just selected is marked with one of the following icons.

   - A pending icon () indicates that zoning is required before the fulfillment state of the tape link can change to Complete.
   - An incomplete icon () indicates an existing error condition for the adapter. The suggested practice is to replace such an adapters with different ones.

- A warning icon (⚠), when this change is disruptive to active partitions that are using the tape link.

4. Repeat these steps, as necessary, to replace any more assigned adapters.

Resolve pending mismatches

When the fulfillment state of the tape link is Pending with mismatches, the **ADAPTERS** tab display contains three separate sections through which you can change the number of connecting paths, view and delete unrequested and zoned adapters, or view and replace assigned adapters. You can use any one of those three actions, or a combination of them, to resolve the pending mismatches.

For example, suppose that you requested a tape link with two connecting paths, and you selected two specific, available adapters for your tape link. If a third adapter is already zoned for the tape library that is selected for your tape link, the fulfillment state of the tape link is Pending with mismatches because three zoned adapters exceeds the requested number of two connecting paths. On the **ADAPTERS** tab, the third adapter is listed in the table of Unrequested and zoned adapters, which is displayed above the assigned adapters table. Through Modification mode, you can resolve this mismatch through one of the following actions.

- Increase the number of connecting paths to 3. In this case, the unrequested adapter becomes an assigned adapter, and no zoning changes are required.
- Select the unrequested adapter for deletion. In this case, when you save your changes, the storage administrator receives zoning instructions to remove the host WWPN for this unrequested adapter.
- Replace one of the assigned adapters with the unrequested adapter. This action can be useful if one of the assigned adapters is pending (not zoned yet).

Chapter 9. Summary of tasks for managing systems, adapters, and partitions

DPM tasks are available starting with HMC/SE Version 2.13.1. Chapter 9, "Summary of tasks for managing systems, adapters, and partitions," on page 83 provides an alphabetical summary of DPM tasks and other tasks that you might use to work with a DPM-enabled system, partitions, storage groups, and adapters.

- For more information about each task, see the online help on the HMC or SE.
- To use specific tasks, you need to log into the HMC or SE with a specific default user ID, or with a user ID that a system administrator has authorized to the task through customization controls in the **User Management** task. For information about authorization requirements for DPM tasks, see Appendix A, "DPM task and resource roles," on page 183.
- These tasks can be accomplished programmatically as well, through the HMC Web Services application programming interfaces (APIs) for DPM. For information about the DPM APIs, see the appropriate edition of *Hardware Management Console Web Services API*, which is available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.

Table 3. Summary of key HMC/SE tasks and displays for working with DPM-enabled systems, partitions, and adapters

Task name	Icon	On HMC or SE	Description
Configure Partition Links		HMC	Use the **Configure Partition Links** task to create and manage partition links, each of which interconnects two or more partitions that share the same network configuration and reside on the same system. Depending on the version of DPM that is installed on the system, you can create and manage one or more of the following partition link types: FICON CTC, HiperSockets, or SMC-D. **Note:** Support for HiperSockets is available in prior releases of DPM; however, starting with DPM R5.2, this task becomes the primary task for creating and managing HiperSockets network connections. For more information, see Chapter 16, "The HiperSockets user experience with DPM R5.2," on page 123.
Configure Storage		HMC	Use the **Configure Storage** task to initially connect a system to storage devices, request storage resources for one or more partitions to use, and to view or modify the current storage configuration. This task is available for use only when the DPM R3.1 storage management feature or a later DPM version is applied to the system.

Table 3. Summary of key HMC/SE tasks and displays for working with DPM-enabled systems, partitions, and adapters (continued)

Task name	Icon	On HMC or SE	Description
Customize Scheduled Operations		Both	Use the **Customize Scheduled Operations** task to customize a schedule for selected DPM-enabled systems. Scheduled operations are helpful for situations where automatic, delayed, or repetitious processing of system operations is necessary. A scheduled operation is started at a specified time, without operator assistance to perform the operation. A schedule can be set for one operation or repeated many times.
Delete Partition		HMC	Use the **Delete Partition** task to delete the definition associated with one or more selected partitions on aDPM-enabled system.
Disable Dynamic Partition Manager		SE only	Use the **Disable Dynamic Partition Manager** task to disable DPM, remove all partitions, and unconfigure all adapters from the system.
Dump (Partition)		HMC	Use the **Dump** task to initiate a partition dump by booting a stand-alone dump program on a DPM-enabled system.
Enable Dynamic Partition Manager		SE only	Use the **Enable Dynamic Partition Manager** task to enable DPM for the system. For systems prior to the IBM z16 (3931), you also use this task to identify the dedicated OSA-Express 1000BASE-T Ethernet adapters for system management (OSM). Starting with DPM R5.0 and 3931 systems, these OSM adapters are no longer required.
Getting Started with Dynamic Partition Manager		HMC	Use the **Getting Started with Dynamic Partition Manager** task for quick links to the **Manage Adapters** and **New Partition** tasks, along with step-by-step instructions for using the **New Partition** task in basic mode. The **Getting Started with Dynamic Partition Manager** task also provides an overview of DPM concepts, with links to additional reference information.
Integrated 3270 Console		HMC	Use the **Integrated 3270 Console** task to log on to a z/VM hypervisor that is running in a DPM partition.
Integrated ASCII Console		HMC	Use the **Integrated ASCII Console** task to log on to a Linux operating system.

Table 3. Summary of key HMC/SE tasks and displays for working with DPM-enabled systems, partitions, and adapters (continued)

Task name	Icon	On HMC or SE	Description
Manage Adapters		HMC	Use the **Manage Adapters** task to view and customize the adapters and devices of an DPM-enabled system. If the DPM R3.1 storage management feature or a later DPM version is applied to the system, use the **Configure Storage** task to manage storage adapters and devices. **Note:** Starting with DPM R5.2, although you can continue to view HiperSockets details through this task, other HiperSockets functions (create, edit, delete) in this task are disabled. The only exception: you can reassign the channel path identifier (CHPID) of the HiperSockets adapter through **Manage Adapters** > **Reassign Channel Path IDs**.
– Adapter Details		HMC	Use the **Adapter Details** task to view or modify the adapter settings of the selected adapter.
– Create Hipersockets Adapter		HMC	Use the **Create Hipersockets Adapter** task to create an adapter and switch for HiperSockets, which are virtual adapters that provide high-speed communications between partitions within a single system, without the need for any physical cabling or external networking connections. **Note:** Starting with DPM R5.2, this task is disabled. Use the **Configure Partition Links** task to create a HiperSockets partition link.
– Delete Hipersockets Adapter		HMC	Use the **Delete Hipersockets Adapter** task to delete only one selected HiperSockets adapter. **Note:** Starting with DPM R5.2, this task is disabled. Use the **Configure Partition Links** task to delete a HiperSockets partition link.
– Export WWPNs		HMC	Use the **Export WWPNs** task to export the world wide port names (WWPNs) of the host bus adapters for one or more partitions.
– Reassign Channel Path IDs		HMC	Use the **Reassign Channel Path IDs** task to change the channel path IDs that are assigned to DPM adapters. **Note:** Starting with DPM R5.2, although other HiperSockets functions (create, edit, delete) in the **Manage Adapters** task are disabled, you can continue to use this task to reassign the channel path identifier (CHPID) of the HiperSockets adapter for a HiperSockets partition link.

Table 3. Summary of key HMC/SE tasks and displays for working with DPM-enabled systems, partitions, and adapters (continued)

Task name	Icon	On HMC or SE	Description
– Reassign Devices		HMC	Use the **Reassign Devices** task to change the adapter, port, or switch for one or more devices. **Note:** Starting with DPM R5.2, this task is disabled for HiperSockets adapters. Use the **Configure Partition Links** task to reassign the devices that are associated with a HiperSockets partition link.
Manage Processor Sharing		HMC	Use the **Manage Processor Sharing** task to set processor weights, weight capping, and absolute capping for partitions with shared processors. You can also use this task to define one or more groups of partitions to set absolute capping limits.
Monitor tab under the Systems Management node			Use the **Monitor** tab to view the overall system monitoring data for the various components that make up a DPM-enabled system.
Monitor System Events		HMC	Use the **Monitor System Events** task to create and manage event monitors. An *event monitor* listens for events from managed objects, such as partitions, adapters, and other system resources or states. When an event is received, the monitor tests it with user defined time and text filters. If the event passes the tests, the monitor enables email to be sent to interested users.
New Partition		HMC	Use the New Partition task to create a new partition on an DPM system. The **New Partition** task offers two modes through which you can create a partition: basic and advanced. For a comparison of the two modes and the implications of switching between them, see "Selecting which New Partition task mode to use" on page 47. **Note:** Starting with DPM R5.2, you cannot create and manage network interface cards (NICs) for a HiperSockets adapter in the Network section of this task. Instead, use the **Configure Partition Links** task to attach a HiperSockets partition link to your partition, and review the default NIC and devices that are created for it.
Operating System Messages		HMC	Use the **Operating System Messages** task as an operating system console while the operating system or hypervisor in a partition is being initialized. To do so, the operating system or hypervisor must support console integration, which is an HMC facility.

Table 3. Summary of key HMC/SE tasks and displays for working with DPM-enabled systems, partitions, and adapters (continued)

Task name	Icon	On HMC or SE	Description
Partition Details		Both (view-only mode on SE)	Use the **Partition Details** task to view or modify an existing definition for a specific partition on an DPM system. Note that you cannot change the partition type through the **Partition Details** task. **Note:** Starting with DPM R5.2, you cannot create and manage network interface cards (NICs) for a HiperSockets adapter in the Network section of this task. Instead, use the **Configure Partition Links** task to attach a HiperSockets partition link to your partition, and review the default NIC and devices that are created for it.
Start		Both	Use the **Start** task to start a single DPM-enabled system, or to start one or more partitions on a DPM-enabled system.
Stop		Both	Use the **Stop** task to stop a single DPM-enabled system, or to stop one or more partitions on a DPM-enabled system.
System Details		Both	Use the **System Details** task to view and manage properties of the selected DPM-enabled system.

Part 4. Topics for system planners

Topics in this part provide the prerequisites for enabling DPM on a mainframe or LinuxONE system, information about supported functions, and the engineering changes (ECs) or machine change levels (MCLs) for upgrading to the latest DPM version. This part also includes migration instructions and information about I/O adapter configuration. These topics are appropriate for experienced system planners and other administrators who are familiar with mainframe or LinuxONE systems.

Topics covered in this part are:

Chapter 10. Prerequisites for using Dynamic Partition Manager

This topic lists the IBM Z and IBM LinuxONE (LinuxONE) products that can run in IBM Dynamic Partition Manager (DPM) mode, lists prerequisites, and provides additional configuration details.

The following IBM mainframe and LinuxONE systems can be configured to run in either standard Processor Resource/Systems Manager (PR/SM) mode or IBM Dynamic Partition Manager (DPM) mode. DPM uses PR/SM functions but presents a simplified user interface for creating partitions and managing system resources.

- IBM z16: machine types 3931 and 3932
- IBM z15: machine types 8561 and 8562
- IBM z14: machine types 3906 and 3907
- IBM LinuxONE Emperor 4: machine type 3931
- IBM LinuxONE Rockhopper 4: machine type 3932
- IBM LinuxONE III: machine types 8561 and 8562
- IBM LinuxONE Emperor II (Emperor II): machine type 3906
- IBM LinuxONE Rockhopper II (Rockhopper II): machine type 3907

The latest version of DPM is available starting with the Hardware Management Console / Support Element (HMC/SE) Version 2.15.0. For additional details, see "DPM versioning" on page 92. For information about using prior versions of DPM on other systems, see *IBM Dynamic Partition Manager Guide*, SB10-7170.

Required feature codes

To run one of these systems in DPM mode, your company must order the system with the features listed in Table 4 on page 91.

Table 4. Required feature codes for DPM

Machine type	Feature code	Description
3931 and 3932	0250	DPM feature **Note:** Starting with the IBM z16 (machine type 3931), the OSA-Express 1000 Base-T adapters for System Management (OSM) are no longer required to enable DPM mode on the system.
	Feature codes for at least one storage adapter	At least one FICON storage adapter is required to use FICON CTC partition links, which are introduced with DPM R5.2. This adapter must be configured in FICON (FC) mode, and can be either shared or dedicated. Feature codes for this support include 0427, 0428, 0436, 0437, 0461, and 0462.

Table 4. Required feature codes for DPM (continued)		
Machine type	**Feature code**	**Description**
8561 and 8562 **3906 and 3907** **2964 and 2965**	0016	Hardware for DPM feature
	Feature codes for OSA adapters (codes vary, depending on the system configuration)	Two dedicated OSA-Express 1000BASE-T Ethernet adapters are required for internal use by DPM, for primary and backup connectivity. For availability, the suggested practice is to locate the adapters on different I/O domains. The feature codes vary, depending on the OSA adapters that you are using for the DPM-enabled system. For example, you might use one OSA-Express5S (feature code 0417) and one OSA-Express6S (feature code 0426) to fulfill the requirement for two dedicated OSA adapters. For a list of the OSA adapters that are supported on a specific system, and their feature codes, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/. For system connectivity to data center networks, you must configure additional network adapters. For more information, see “About network adapters” on page 95.

DPM versioning

DPM is available through specific engineering changes (EC) or machine change levels (MCL) for the mainframe and LinuxONE systems that support it. MCLs are packaged and delivered in separate bundles for the HMC and SE. Table 5 on page 93 lists the available DPM versions and the corresponding bundle that must be applied to use any new functions or updates. The machine types indicate the systems on which you can apply the bundles.

Important:

- Before applying an MCL, upgrade the HMC to the latest HMC/SE version and level.
- Note that each DPM version requires the application of both an HMC MCL and an SE MCL. The suggested practice is to apply MCLs to the HMC first, then to apply the SE MCL. Until the SE MCL is applied, new functions or updates are not available even if you have applied the HMC MCL.

Table 5. Summary of DPM versions

DPM version / release	Machine type	HMC/SE version	Description
Version 5.2 (R5.2)	3931 and 3932	HMC/SE Version 2.16.0 (Driver 51) with the following bundles: • H21 • S28	DPM Release 5.2 introduces two new types of partition links: FICON CTC and HiperSockets. • FICON CTC partition links use Fibre Connection (FICON) channel-to-channel (CTC) connections to provide fast and efficient data transfer between partitions that reside on the same system. One advantage to using FICON CTC partition links is the ability to configure a z/VM Single System Image (SSI) cluster to reduce the complexity of adding and managing z/VM hypervisors. With an SSI cluster in place, you can configure Live Guest Relocation (LGR) to avoid planned outages by moving Linux virtual servers without disruption to their workloads. For more information, see "FICON CTC partition links" on page 26. • HiperSockets partition links use HiperSockets technology to provide high-speed communication between partitions that reside on the same system. Support for HiperSockets is available in prior releases of DPM; however, with R5.2, you need to use different HMC tasks to create, edit, and delete HiperSockets connections. – For more information about HiperSockets partition links, see "HiperSockets partition links" on page 28. – If you have been using HiperSockets with prior versions of DPM, see Chapter 16, "The HiperSockets user experience with DPM R5.2," on page 123.

Table 5. Summary of DPM versions (continued)

DPM version / release	Machine type	HMC/SE version	Description
Version 5.1 (R5.1)	3931 and 3932	HMC/SE Version 2.16.0 (Driver 51) with the following bundles: • H14 • S19	DPM Release 5.1 includes the following updates. • For most installed adapters, DPM assigns a default name in the form *adapter_type adapter_ID partial_location*. For rack mount configurations, the *partial_location* section of the default name begins with AI0*x*, where A is the frame identifier, and *x* is the number of the I/O drawer. For these configurations, this default adapter naming convention is reflected in the values displayed in the Name and Location columns of various tasks. • The **New Partition** task (both basic and advanced modes) contains enhancements to the Secure Boot options that administrators can select on the **Boot** page when the boot volume is part of a storage group. Administrators can modify the same Secure Boot selections through the **Partition Details** task. – Secure Boot support (also known as "validated boot") relies on public cryptographic keys that are contained in customer-supplied digital certificates from the Linux distributor. – The operating system executables can reside on an extended count key data (ECKD) direct-access storage device (DASD) volume in a FICON storage group. – Only through the advanced-mode **New Partition** task and the **Partition Details** task, you can specify additional boot settings for a FICON boot volume, such as the boot record location and the boot loader type. • On the **Dump** task, you can select the **Secure Boot** option for a signed dump program when you initiate a partition dump. To view the digital certificates that apply when the dump program is booted, go to the Boot section of the **Partition Details** task. As with operating system executables, the dump program also can reside on a DASD volume in a FICON storage group. Also, additional dump program parameters are available for customization. For more information about Secure Boot options, see Chapter 14, “Validating boot images of operating systems,” on page 119.

Table 5. Summary of DPM versions (continued)			
DPM version / release	**Machine type**	**HMC/SE version**	**Description**
Version 5.0 (R5.0)	3931	HMC/SE Version 2.16.0 (Driver 51) with the following bundles: • H03 • S04a	DPM Release 5.0 (R5.0) introduces *partition links*, which interconnect two or more partitions that share the same network configuration and reside on the same system. With the introduction of partition links, DPM supports Version 2 of Shared Memory Communications - Direct Memory Access (SMC-D) for communication between partitions on the same system. The following list briefly summarizes new and changed tasks that support the use of partition links. • A new HMC task, **Configure Partition Links**, provides system administrators with a simplified interface for creating, editing, and deleting partition links. • Administrators also can view information about partition links through the **Manage Adapters** and **Partition Details** tasks. • The **New Partition** task (both basic and advanced modes) also contains a new section for partition links; however, this section is read-only because you can add an existing partition to a partition link only through the **Configure Partition Links** task. Also, for the IBM z16 and later systems, the OSA-Express 1000 Base-T adapters for System Management (OSM) are no longer required to enable DPM mode on the system. References to these OSM adapters no longer display in the HMC/SE V2.16.0 tasks **Enable Dynamic Partition Manager** and **System Details**.
Version 4 (multiple releases)	8561 and 8562	HMC/SE Version 2.15.0 (Driver 41)	For descriptions of the support added with each Version 4 release, see the versioning topic in *IBM Dynamic Partition Manager Guide*, SB10-7176. The Version 4 releases include: R4.3 R4.2 R4.1 R4.0
Version 3 (multiple releases)	3906 and 3907	HMC/SE Version 2.14 (Driver 36)	For descriptions of the support added with each Version 3 release, see the versioning topic in *IBM Dynamic Partition Manager Guide*, SB10-7170. The Version 3 releases include: R3.2 R3.1 R3.0

About network adapters

In addition to the dedicated OSA-Express 1000BASE-T Ethernet adapters that are required by DPM feature code 0417, you must configure additional network adapters for system connectivity to data center networks. Several types of network adapters enable communication through different networking transport protocols. For a DPM-enabled system, these network adapters include the following:

- Open Systems Adapter-Express (OSA-Express) adapters, which provide direct, industry-standard Ethernet LAN connectivity through various operational modes and protocols. OSA adapters can provide connectivity between partitions on the same system, as well as connectivity to external LANs.

- HiperSockets, which are virtual adapters that provide high-speed communications between partitions within a single system, without the need for any physical cabling or external networking connections.
- Remote Direct Memory Access (RDMA) over Converged Ethernet (RoCE) Express adapters. These adapters provide high speed, low latency data transfer over Ethernet networks.

The supported OSA and RoCE adapters vary, depending on the system. For a list of the network adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

DPM automatically detects OSA and RoCE adapters that are installed in the system. Use the HMC **Manage Adapters** task to manage these adapters. To create a HiperSockets adapter, use one of the following methods, depending on the version of DPM that is installed on your system.

- Starting with DPM R5.2, use the **Configure Partition Links** task to create a HiperSockets partition link.
- With prior versions of DPM, use the **Manage Adapters** task to create a HiperSockets adapter.

About FICON and FCP storage adapters

Mainframe and LinuxONE systems use Fibre Channel connections (FICON) to provide high-speed data transfer to external storage devices. Through cables, FICON Express features (adapter cards) connect a DPM-enabled system to the devices in the storage area network (SAN). DPM automatically detects FICON Express adapters that are installed in the system. The supported FICON Express adapter cards vary, depending on the system configuration; for example, the z14 supports the FICON Express16S+, FICON Express16S, and FICON Express8S adapter cards. For a list of the storage adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

FICON adapter cards operate in different modes, which determine the type of storage devices that you can access. Typically, storage administrators configure the mode in which each FICON adapter card operates.

- Fibre Channel Protocol (FCP) mode provides access to Small Computer System Interface (SCSI) devices, through single- or multiple-channel switches. Support for FCP mode is available with all DPM versions.
  - Note that, because DPM runs all FCP adapters in N Port Identifier Virtualization (NPIV) mode, the SAN must support NPIV.
  - In releases prior to R4.3, DPM detects but does not display FCP tape drives, so administrators cannot directly manage them through DPM tasks on the HMC. Starting with DPM R4.3, however, administrators can use the **Configure Storage** task to configure and manage access to tape storage.
- FICON native (FC or FICON) mode provides access to extended count key data (ECKD) devices through point-to-point (direct) connections, or single- or multiple-channel switches. ECKD devices are more commonly known as direct-access storage devices (DASD). Support for FICON mode is available with DPM R3.1 and later DPM versions, with the following exceptions.
  - DPM supports the use of parallel access volumes, but only through the optional HyperPAV feature on the IBM System Storage DS8000 series.
  - DPM does not support the use of FICON channel-to-channel (CTC) or FICON tape drives.

Starting with DPM R3.1, the Hardware Management Console (HMC) **Configure Storage** task replaces the use of the **Manage Adapters** task to configure and manage FCP and FICONstorage adapters.

About NVMe storage adapters

Starting with DPM R4.2, your company can order IBM Adapter for NVMe1.1 features, which are available on IBM LinuxONE (LinuxONE) systems only. Non-Volatile Memory Express (NVMe) storage adapters use the PCI Express (PCIe) protocol to provide high-speed storage within a system.

Each NVMe adapter consists of two pieces of hardware: an IBM-supplied carrier card installed in a system I/O drawer, and the solid state drive (SSD) that customers purchase. Although you can use the **Configure Storage** task and the **Manage Adapters** task to view information about NVMe storage adapters, you cannot use those tasks to configure them; reconfiguration requires properly removing the carrier card and its SSD from the drawer and reinstalling them in a different physical location, as instructed by a service representative.

About partition links

Partition links interconnect two or more partitions that share the same network configuration and reside on the same system. The following list describes the types of partition links that you can create and manage through the **Configure Partition Links** task. Note that the DPM release that is installed on the system determines which types you can create and use.

FICON CTC
Starting with DPM R5.2, you can create FICON CTC partition links, which use Fibre Connection (FICON) channel-to-channel (CTC) connections to provide fast and efficient data transfer between partitions that reside on the same system. A FICON CTC partition link can connect only partitions that reside on the same system. These partitions use the partition link only for data transfer among the group of partitions; a FICON CTC partition link does not provide access to storage devices. For more information, see "FICON CTC partition links" on page 26.

HiperSockets
Starting with DPM R5.2, you can create HiperSockets partition links, which use HiperSockets technology to provide high-speed communication between partitions that reside on the same system. Support for HiperSockets is available in prior releases of DPM; however, with R5.2, you need to use different HMC tasks to create, edit, and delete HiperSockets connections.

- For more information about HiperSockets partition links, see "HiperSockets partition links" on page 28.
- If you have been using HiperSockets with prior versions of DPM, see Chapter 16, "The HiperSockets user experience with DPM R5.2," on page 123.

SMC-D
Starting with DPM R5.0, you can create SMC-D partition links, which enable communication between partitions on the same system through the Shared Memory Communications - Direct Memory Access (SMC-D) Version 2 technology, which provides high-bandwidth, low-latency TCP/IP traffic over internal shared memory (ISM) devices for improved performance.

For more information, see "SMC-D partition links" on page 29.

Specific operating system versions are required for SMC-D Version 2:

- Red Hat Enterprise Linux (RHEL) 8.4 or later
- SUSE Linux Enterprise Server (SLES) 15 SP3 or later
- Ubuntu Server (KVM or LPAR DPM): 21.04 LTS or later
- z/VM V7.1 or later

Also, the `smc-tools` package must be installed on the Linux distribution, and the applications running on each Linux distribution must be configured to use `AF_SMC` sockets.

For more information, see the following topics or resources:

- For a more detailed description of SMC-D partition links, see "SMC-D partition links" on page 29.
- For more information about the **Configure Partition Links** task and the authorization required to use it, see the HMC online help for that task.
- For more information about the `smc-tools` package and Shared Memory Communications - Direct Memory Access (SMC-D) support with Linux distributions, see the Usage and References topics at https://linux-on-z.blogspot.com/p/smc-for-linux-on-ibm-z.html

Requirements for the hypervisor or operating system

Partitions on a DPM-enabled system support the following operating systems and hypervisors:

- The following minimum distribution levels of Linux on IBM Z and LinuxONE:
  - Red Hat Enterprise Linux (RHEL) 6 or later
  - SUSE Linux Enterprise Server (SLES) 11 or later
  - Ubuntu Server (KVM or LPAR DPM): 16.04 LTS or later

  For recommended Linux on IBM Z and LinuxONE distribution levels, see the IBM tested platforms at: https://www.ibm.com/support/pages/linux-ibm-z-tested-platforms

  For information about installing and running a Linux distribution on an IBM Z or LinuxONE server, see the Linux on IBM Systems topics in IBM Documentation, at: https://www.ibm.com/docs/en/linux-on-systems?topic=linuxone-library-overview
- z/VM V7.1 or later, with the following limitations:
  - On a DPM-enabled system, z/VM can host only Linux guests.
  - Because DPM exclusively provides dynamic input/output (I/O), administrators cannot use z/VM to run Hardware Configuration Definition (HCD) and Hardware Configuration Manager (HCM).
  - To boot and install z/VM in a partition, administrators must use one of the following HMC **New Partition** or **Partition Details** boot options and z/VM installation methods. Note that, depending on the system, a DVD drive might not be available on the HMC. In this case, you can use an alternate HMC media drive or use an electronic deliverable instead of a DVD.
    - Select the **Hardware Management Console removable media** boot option for the partition, and then use the **DVDPRIME** command with the **dvd** option to install z/VM. Note that, when you use this option, installation can take up to several hours to complete.
    - Select one of the FTP or **ISO image** boot options for the partition, and then use the **DVDPRIME** command with the **server** option to install z/VM through an FTP server.

    For more information about partition boot options and the z/VM installation process, see Chapter 5, “Operating systems and hypervisors,” on page 33. For information about z/VM, see the product documentation. The z/VM library is available in IBM Documentation at https://www.ibm.com/docs/en/zvm

Where to find hardware planning and corequisite software information

Use the following links to find the most recent hardware planning and corequisite software information.

- For hardware updates, go to IBM Resource Link® (http://www.ibm.com/servers/resourcelink) and click **Tools** on the navigation panel. Then click **Machine information** under **Servers**, and enter your enterprise number, customer number, or machine serial number for the host system (CPC). You must register with IBM to search machine information.
- For software updates, go to IBM Support (https://www.ibm.com/support/pages/ibmsearch) and enter one of the following preventive service planning (PSP) bucket values in the Search field, depending on the machine type and model that you are using.

  IBM Z

  - For an IBM z16: 3931DEVICE or 3932DEVICE
  - For an IBM z15: 8561DEVICE or 8562DEVICE
  - For an IBM z14: 3906DEVICE or 3907DEVICE

  IBM LinuxONE

  - For an IBM LinuxONE Emperor 4: 3931DEVICE
  - For an IBM LinuxONE Rockhopper 4: 3932DEVICE

- For an IBM LinuxONE III: 8561DEVICE or 8562DEVICE PSP bucket
- For an IBM LinuxONE Emperor II: 3906DEVICE
- For an IBM LinuxONE Rockhopper II: 3907DEVICE

Chapter 11. Migrating DPM configuration data to a new system

This topic describes the migration considerations or actions that you need to take when you migrate your Dynamic Partition Manager (DPM) environment from an existing system to a new system.

If you configured partitions and adapters on an existing IBM Z or IBM LinuxONE (LinuxONE) system with DPM enabled, you can migrate the configuration information for those resources to a new DPM-enabled system.

The tasks that you need to complete vary, depending on whether your company is acquiring the new system through a miscellaneous equipment specification (MES) frame upgrade, or through a complete system replacement.

MES frame upgrade
When you acquire a new system through an MES frame upgrade, you are getting a new system that reuses the serial number, I/O worldwide port number (WWPN), and actual hardware parts (such as I/O cages, adapters, and so on) from an existing system. Only specific migration paths are supported for an MES frame upgrade.

Through the MES frame upgrade, most reconfiguration is automated through the system installation and start-up process itself, in part by DPM. However, you do need to complete several post-installation checks, including the modification of some partition definitions. For instructions, see “Migration instructions for an MES frame upgrade” on page 101.

System replacement
In this case, you are getting a completely new system to replace an existing system. This new system has its own serial number and, in most cases, the I/O WWPN is also different from the WWPN of the prior system.

When you replace an existing system with a new system, you need to write a script that uses the Hardware Management Console (HMC) Web Services API to export the DPM configuration from the existing system, and to import the configuration to the new system. You can use any programming language or tool that you currently use to issue the HMC Web Services API. Note that only specific migration paths are supported. For instructions, see “Migration instructions for a system replacement” on page 105.

Migration instructions for an MES frame upgrade

When you acquire a new system through a miscellaneous equipment specification (MES) frame upgrade, your IBM service representative copies configuration data from the existing system to the new system, and starts the Support Element (SE) on the new system. During the start process, DPM automatically configures new adapters and reconfigures existing adapters and partitions to fit the new system. However, because some information is not available on the new system, DPM cannot completely reconfigure all objects that are carried forward from the existing system. Follow this set of instructions to complete the reconfiguration of your DPM on the new system.

Before you begin

- Before working with your service representative on the MES upgrade, make sure that you apply the latest available firmware for DPM on the existing system. For more information about DPM firmware updates, see the following topics:
  - “DPM versioning” on page 92
  - “Where to find hardware planning and corequisite software information” on page 98
- Table 6 on page 102 indicates whether a specific DPM migration path is supported for an MES frame upgrade.

– Each DPM version corresponds to particular machine types; for more information about DPM versions and releases, see “DPM versioning” on page 92. Your service representative can provide the existing and new machine types for which MES frame upgrades are supported.
– Downgrades from one version or release to a prior version or release are not supported options. For example, you cannot downgrade from Version 3 Release 1 (R3.1) to Version 2 Release 1 (R2.1), or from R3.2 to R3.1.
– Migrating to the latest release of a given version is the only supported option; for example, you cannot migrate from DPM R2.0 to R3.1 because R3.2 is the latest Version 3 release.

Table 6. Supported DPM migration paths for MES frame upgrades

From ↓ / To →	DPM R3.2	DPM R4.0 or later	DPM R5.0
DPM R2.0	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups)
DPM R2.1	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups)
DPM R3.1	No	Yes	Yes
DPM R3.2	—	Yes	Yes
DPM R4.3	No	—	Yes

About this task

As part of the MES frame upgrade process, your service representative saves upgrade data that resides on the SE of the existing system; that data is restored on the new hardware when the SE for the new system is first started. After the data is restored, DPM automatically updates its configuration data by detecting new adapters, updating existing adapter properties, updating partition definitions, and so on. For example, if you reuse a specific adapter on the new system but install it in a different I/O cage, DPM updates the adapter properties to reflect the new location.

The updates that DPM makes are listed in a hardware message for the new system. This message includes the following information:

- A list of partitions that were defined as having reserved resources on the prior system. Because DPM cannot guarantee that the same resources are available on the new system, DPM deletes the reserved property from the partition definition.
- A list of partitions that were using accelerator adapters. This list is included only for an MES frame upgrade to DPM R4.0 or later. Accelerator adapters are not supported on the systems on which you can run DPM R4.0 or later, so DPM deletes the accelerator virtual functions from the partition definition.
- A list of partitions that were defined with the boot option of ISO image. ISO images are not part of the configuration data that can be copied over to a new system, so DPM changes the partition definition to specify a boot option of None.
- A list of the physical channel IDs (PCHIDs) that DPM converted for adapters that moved to a new location. This list maps the prior PCHID value and the new PCHID value for moved or replaced adapters.

Use this message to help you complete the post-installation steps in this procedure. Figure 44 on page 103 shows a sample hardware message for the automated DPM process.

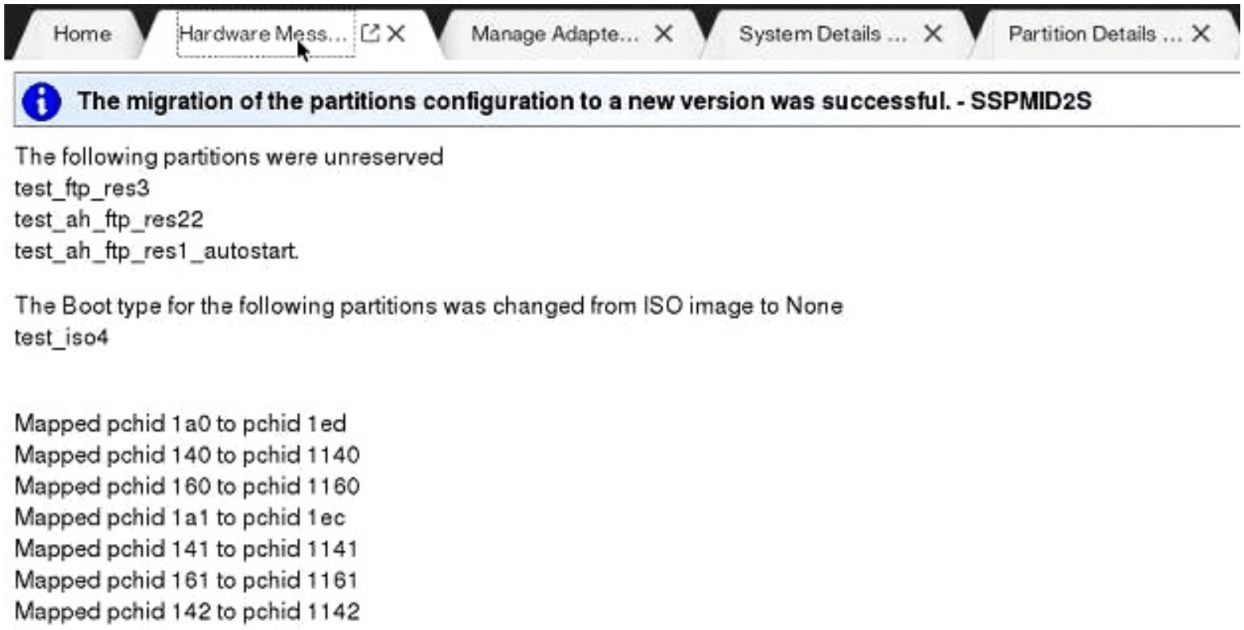

Figure 44. Sample hardware message that shows the results of a successful DPM conversion of migrated configuration information

Procedure

1. If you are using two new dedicated OSA-Express 1000BASE-T Ethernet adapters (feature 0417) on the new system, configure these new system management (OSM) adapters.

   If the new system is an IBM z16 (machine type 3931) or later system, skip to step "2" on page 103 because the OSA-Express 1000 Base-T adapters for System Management (OSM) are no longer required to enable DPM mode. For earlier systems, however, these two adapters are required for internal use by DPM, for primary and backup connectivity. For availability, the suggested practice is to locate the adapters on different I/O domains.

   On the SE for the new system, using the default SERVICE user ID or a user ID that is assigned to the Service Representative Tasks role, complete the following steps.

   a) Open the **System Details** task.

   b) Select the **Management Networks** tab.

   c) Choose a new adapter from both of the OSM drop-down lists.

   d) Click **Apply** to save your changes.

2. On an HMC through which you can manage the new system, open the **Hardware Messages** to view the updates that DPM has made.

   a) In the **System Management** view, select the new system.

   b) From the pop-up menu next to the system name, select **Daily**, then select **Hardware Messages** to display hardware messages for this system.

   c) If necessary, scroll through the list of messages to the date when the system was first started, or look for the message text: `The migration of the partitions configuration to a new version was successful.`

   d) Select the message and click **Details** to display the results of the automated process. Keep this tab open for reference as you complete the remaining steps in this procedure.

3. Review and, if necessary, modify the migrated adapters. For any adapter with a status value of Exceptions, evaluate the exceptions and determine what action might be required.

a) From the **Systems** tab in the **System Management** view, open the pop-up menu next to the system name, select **Configuration**, then select **Manage Adapters**.

b) On the **Adapters** tab, sort the **Status** column to show all adapters for which the value Exceptions is displayed, and review those adapters to determine what action to take.

If the Number of Partitions column indicates that one or more partitions have devices that are backed by an adapter that was removed (that is, they are not installed on the new system), you need to reassign those devices to a different adapter. Depending on the adapter type, these devices can be network interface cards (NICs), host bus adapters (HBAs), or virtual functions (VFs). To reassign devices, complete the following steps.

i) Click on the **Devices** tab and sort the table by adapter name, and select the devices that are assigned to an adapter that was removed.

ii) Select **Reassign Devices** from the **Actions** list.

iii) On the **Reassign Devices** window, select the new backing adapter for the devices, and click **Reassign**.

iv) Repeat these steps as necessary, until all devices are assigned to an adapter that is currently installed on the new system.

When the SE for the new system is rebooted, the adapters that were removed are deleted from the DPM configuration.

4. Review and modify the migrated partitions that are listed in the hardware message.

a) From the **System Management** view, click the **Partitions** tab to display the partitions for the new system.

b) If necessary, sort or scroll the list to find the partition names that are listed in the hardware message.

c) Select one of the listed partitions, open the pop-up menu next to the partition name, and select **Partition Details**.

- For a partition that was reserved on the prior system, complete the following steps.

i) Select or scroll to the **Processors** section, and adjust the processor type, mode, and number of virtual processors as necessary. Review the Processors bar chart to determine how many processors are available on this system, and how many are already in use or reserved for other partitions.

ii) Select or scroll to the **Memory** section, and adjust the initial and maximum amounts of memory that are assigned to the partition. Review the Installed Memory bar chart to determine how much memory is available on this system, and how much is already in use or reserved for other partitions.

iii) Select or scroll to the **General** section, and select the **Reserve resources...** check box.

- For a partition that had a boot option of ISO image, complete the following steps.

i) Select or scroll to the **Boot** section, and select **ISO image** from the **Boot from** list.

ii) Upload an ISO file that is located on your workstation file system.

d) When you finish updating the partition definition, click **Apply** to save your changes.

e) Repeat these steps, as necessary, for each migrated partition that is listed in the hardware message.

5. Review any new or existing storage groups in the DPM configuration on the new system.

Open the **Configure Storage** task to the Storage Overview and check the fulfillment state of each storage group. Take any actions that might be required to change the state to Complete. For more information, see the online help for the task or go to "Viewing and managing storage groups and tape links" on page 165.

Results

The DPM configuration on the new system is complete.

What to do next

You can start the partitions on the new system.

Migration instructions for a system replacement

When you replace an existing system with a new system, you need to write a script that uses the Hardware Management Console (HMC) Web Services API to export the DPM configuration from the existing system, and to import the configuration to the new system. You can use any programming language or tool that you currently use to issue the HMC Web Services API. Note that only specific migration paths are supported.

Before you begin

- Table 7 on page 105 indicates whether a specific DPM migration path is supported for a system replacement.
  - Each DPM version corresponds to particular machine types; for more information, see "DPM versioning" on page 92.
  - Downgrades from one version or release to a prior version or release are not supported options. For example, you cannot downgrade from Version 3 Release 1 (R3.1) to Version 2 Release 1 (R2.1), or from R3.2 to R3.1.
  - Migrating to the latest release of a given version is the only supported option; for example, you cannot migrate from DPM R2.0 to R3.1 because R3.2 is the latest Version 3 release.

Table 7. Supported DPM migration paths for a system replacement

From ↓ / To →	DPM R3.2	DPM R4.3	DPM R5.2
DPM R2.0	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups, and HiperSockets adapters converted to HiperSockets partition links)
DPM R2.1	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups, and HiperSockets adapters converted to HiperSockets partition links)
DPM R3.0	No; this path is only an upgrade on the same machine type.	Yes (with HBAs converted to FCP storage groups)	Yes (with HBAs converted to FCP storage groups, and HiperSockets adapters converted to HiperSockets partition links)
DPM R3.1	No; this path is only an upgrade on the same machine type.	Yes	Yes (with HiperSockets adapters converted to HiperSockets partition links)
DPM R3.2	—	Yes	Yes (with HiperSockets adapters converted to HiperSockets partition links)

Table 7. Supported DPM migration paths for a system replacement (continued)				
From ↓	**To →**	**DPM R3.2**	**DPM R4.3**	**DPM R5.2**
DPM R4.3		No	—	Yes (with HiperSockets adapters converted to HiperSockets partition links)

- When you migrate from DPM R4.3 or an earlier version to DPM R5.2, each HiperSockets adapter that existed on the earlier system is converted into a HiperSockets partition link, which includes a list of the partitions that were using the HiperSockets adapter, as well as the network interface cards (NICs) assigned to each partition and their associated device numbers. However, permissions on the original HiperSockets adapter are not carried over to the new system, so more users might have access to the HiperSockets partition links.

  With earlier versions of DPM, access to HiperSockets adapters is controlled through the following permissions: HiperSockets adapter object, Adapter Details task, Create HiperSockets Adapter task, and Delete HiperSockets Adapter task. In contrast, with DPM R5.2, access to HiperSockets partition links is controlled through partition link object and task permissions: Partition Link object, Create Partition Link task, Partition Link Details task, and Delete Partition Link task.

  – If, on the prior system, your security administrators controlled access to HiperSockets adapters only through the default roles of All System Managed Objects and System Programmer Tasks, no change is required after the migration to DPM R5.2. All of the partition link permissions are included in those two default roles.

  – If your security administrators previously used HiperSockets object and task roles to control access, they need to review that access configuration and recreate it on DPM R5.2, using the partition link object and task permissions. For more information about controlling access to partition links, see the *Authorization requirements* topic in the HMC online help for the **Configure Partition Links** task.

  Also, if any Secure Service Container partitions on the prior system used a HiperSockets connection to access the Secure Service Container web interface, you must reconfigure that connection to use an Open Systems Adapter-Express (OSA) adapter.
- When you migrate from DPM R3.0 or an earlier version to DPM R3.2 or a later version, each host bus adapter (HBA) that a partition uses is converted into a dedicated FCP storage group. A storage group is a logical group of storage volumes that share certain attributes; a storage group provides access to storage resources starting with DPM R3.1. To ensure that this conversion is successful, make sure that the storage administrator has complied with the following SAN zoning and masking requirements:

  – All world wide port names (WWPNs) that are used by partitions must be added to the zoning of all switches.

  – All WWPNs that are used by partitions must be added to the host-mapping of the storage subsystems that provide the logical unit numbers (LUNs) for the storage group.
- Make sure that you have enabled the use of the HMC Web Services API on both the source and the target system. You can enable the use of the API through the HMC **Customize API Settings** task. For information about the authorization requirements and syntax of specific APIs, see the appropriate edition of *Hardware Management Console Web Services API*, which is available on **IBM Documentation**. Go to https://www.ibm.com/docs/en/systems-hardware, select **IBM Z** or **IBM LinuxONE**, then select your configuration, and click **Library Overview** on the navigation bar.
- To perform this procedure, choose a user ID that has authorization to access all of the DPM configuration data that you want to export from the existing system. If you perform the steps in this procedure with a user ID that has access to only specific DPM partitions or adapters, only the configuration data for those resources is exported.

  – The suggested choice is the default SERVICE user ID. API access is not enabled for the SERVICE user ID by default, so you must authorize API access for the SERVICE user ID through the HMC **User Management** task.

  - If you choose a user ID other than the default SERVICE user ID, make sure that user ID has the following permissions.
    - API access
    - Object permission to both the source and target systems
    - Task permission to **Import Dynamic Partition Manager Configuration**.
- If you have controlled user access to DPM resources, and want to transfer those authorizations, use the **Save/Restore Customizable Console Data** task to save the data from the source system and restore it on the target system.
- Install the latest version of the open-source command-line tool **zhmc**, which is available at https://github.com/zhmcclient/zhmccli. Review the accompanying release information and change history. For installation and usage instructions, select the Readme topic to access the instructions in the Documentation topic.

About this task

Through this procedure, you are exporting DPM configuration data that includes the objects and properties of the DPM-enabled source system, its adapters, and the auto-start partition list and capacity groups, if any. The configuration data also includes the objects and properties of partitions and their virtual adapters: network interface cards (NICs), host bus adapters (HBAs), virtual functions, and cryptos.

- If you are migrating from DPM R3.1 or later, the configuration data also includes storage groups and templates, as well as defined FICON connections, such as sites, subsystems, fabrics, volumes, and paths.
- If you are migrating from DPM R4.3 or later, the configuration data also includes FCP tape links.

When you migrate from any supported version of DPM to a later version, adapter IDs are changed. Additionally:

- When you migrate from DPM R4.3 or an earlier version to DPM R5.2, each HiperSockets adapter that existed on the earlier system is converted into a HiperSockets partition link. Although you can still view HiperSockets adapters through the **Manage Adapters** task, you need to use the **Configure Partition Links** task to review the new HiperSockets partition links and modify them, if necessary. To do so, you must have a customized user ID with the predefined System Programmer Tasks role or equivalent permissions.
  - For more information about controlling access to partition links, see the *Authorization requirements* topic in the HMC online help for the **Configure Partition Links** task.
  - For general information about partition links, see "Partition links" on page 25.
- When you migrate from DPM R3.0 or an earlier version to a target system with DPM R3.2 or later, each HBA that a partition uses is converted into a dedicated FCP storage group. You need to review these adapter ID changes and new storage groups, and modify them, if necessary.
  - To understand the differences between storage access with DPM R3.0 or an earlier version and storage access with DPM R3.2 or later, see Figure 45 on page 108.
  - For more information about storage management starting with DPM R3.1, see Part 6, "Topics for storage administrators," on page 139.

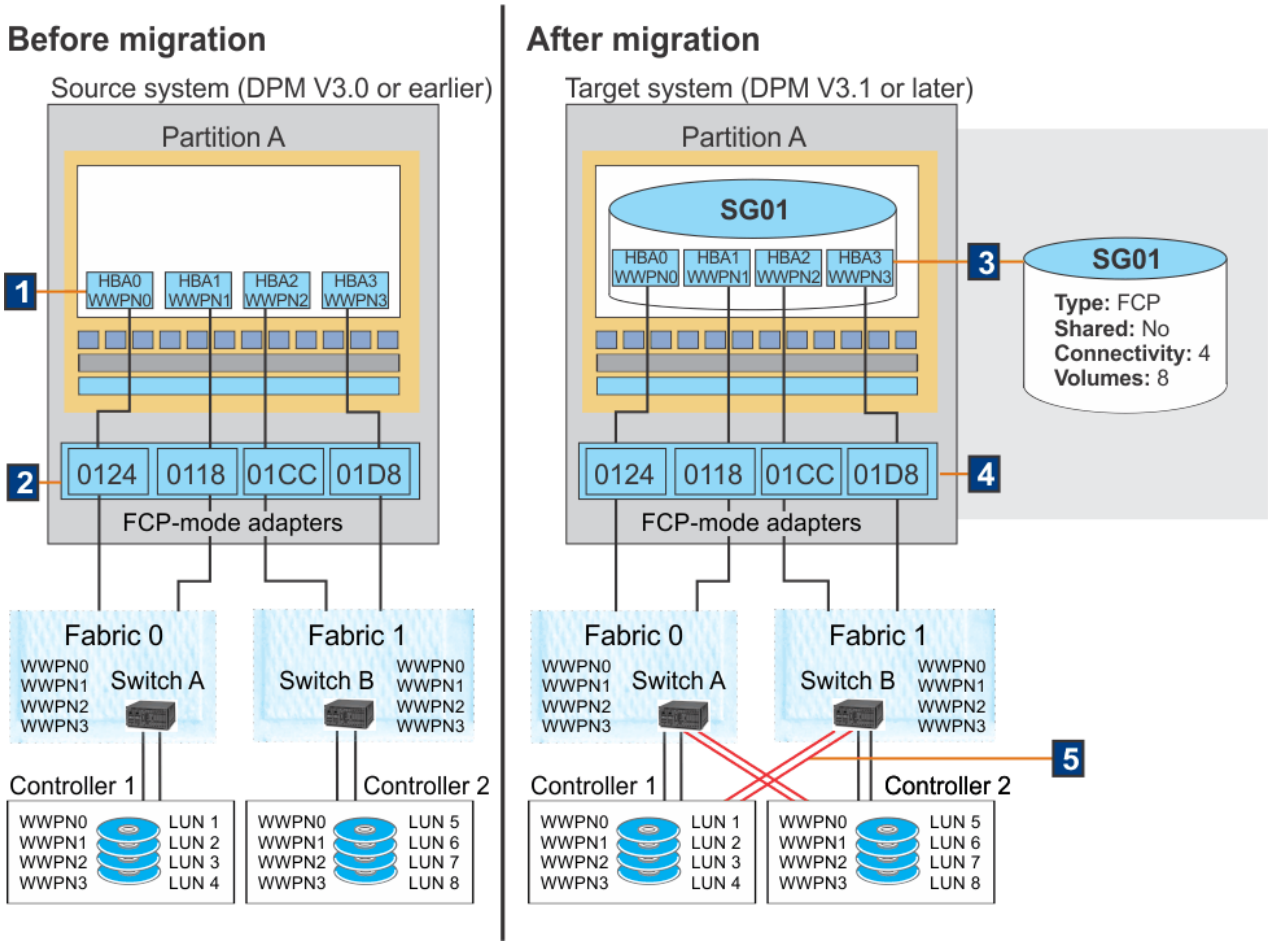

Figure 45. Partition access to storage when migrating from an early DPM version to DPM R3.1 or later

In Figure 45 on page 108:

1. On the source system, an administrator defines storage resources for Partition A by creating four HBAs, each with its own backing FCP-mode adapter. When the partition definition is saved, DPM generates WWPNs that the administrator exports and gives to the storage administrator to complete zoning and LUN masking tasks for the storage subsystem configuration.
2. The backing adapters are configured on the source system and are physically connected to a storage subsystem through a switch. In this example, adapter 0124 is connected to Controller 1 through Switch A in Fabric 0. Adapter 0118 is also connected to Controller 1 through Switch A in Fabric 0. Similarly, adapters 01CC and 01D8 are connected to Controller 2 through Switch B in Fabric 1.

   Partition A uses the WWPNs to access specific volumes on each storage subsystem. This configuration gives Partition A access to eight storage volumes.
3. During the migration process, DPM creates a dedicated (not shared) FCP storage group, SG01, and attaches it to Partition A. The HBAs and WWPNs that were defined for Partition A on the source system become part of the infrastructure for the storage group. Through the storage group, Partition A on the target system has access to the same eight volumes.
4. Note that the adapter IDs that were in use on the source system are copied to the target system. You can change the adapter IDs by providing an adapter mapping for the migration process in step "3" on page 109.
5. Note that, on a target system with DPM R3.1 or later, switches must be connected to all storage controllers that provide LUNs for a storage group. Because storage group SG01 uses volumes on both Controller 1 (LUNs 1-4) and Controller 2 (LUNs 5-8), Switch A must be connected to both Controller 1 and Controller 2, and Switch B also must be connected to both controllers.

Procedure

1. After installing the latest version of the open-source command-line tool **zhmc**, use the tool to retrieve the existing DPM configuration.
   a) To view detailed instructions about the flags and options that you need to use, invoke `zhmc cpc dpm-export --help`
   b) After deciding which flags and options to use, invoke `zhmc cpc dpm-export`, specifying those flags and options.
2. On the HMC through which you are managing the target system, check the system status. To successfully import the DPM configuration, the target system must be in one of the following states: Active, Service Required, Degraded, or Exceptions.
3. Use the tool to import the DPM configuration that you retrieved in step "1.b" on page 109.
   a) To view detailed instructions about the flags and options that you need to use, invoke `zhmc cpc dpm-import --help`

      The tool provides means to control the import process; for example, to map the IDs of adapters in the source system to new IDs in the target system. If you do not provide a mapping, DPM uses a one-to-one mapping of adapters on the source system to adapters on the target system.
   b) After deciding which flags and options to use, invoke `zhmc cpc dpm-import`, specifying those flags and options.

   If the request is successful, the API returns HTTP status code 204. Otherwise, use the HTTP status code and reason codes for troubleshooting.
4. Restart the target system.

Results

The DPM configuration has been imported to the target system.

If you migrated from DPM R4.3 or an earlier version to DPM R5.2

- For each HiperSockets adapter that existed on the source system, DPM creates a HiperSockets partition link, which includes a list of the partitions that were using the HiperSockets adapter, as well as the network interface cards (NICs) assigned to each partition and their associated device numbers. For each partition in the partition list, the number of NICs in the HiperSockets partition link matches the number of NICs that were defined for use with the HiperSockets adapter on the source system.
- The new HiperSockets partition link is attached to each partition in the partition list.

If you migrated from DPM R3.1 or later to a target system with a later DPM version

If you are using an auto-start list to start partitions on the target system, and one or more of those partitions are booted from a storage volume, the start process might fail if the attached storage group is not yet in the Complete fulfillment state. To reduce the possibility of partition start failures, DPM assigns highest priority to storage groups that contain at least one boot volume, so that automatic discovery of the logical unit numbers (LUNs) begins as quickly as possible on the target system.

If you migrated from DPM R3.0 or earlier to a target system with DPM R3.2 or later

- For each partition on the source system that has HBAs assigned for access to storage, DPM creates a dedicated FCP storage group and reuses the HBAs and WWPNs for that storage group. The new storage group is attached to the same partition on the target system.
- If the partition definition specified an HBA, port, and LUN for the **Storage (SAN)** boot option, the new storage group contains a storage volume that is mapped to the same port and LUN. If the partition does not use a boot volume, the storage group that DPM creates does not contain any storage volumes.
- For each new storage group, DPM sets the Connectivity attribute to the number of distinct adapters that were in use by the HBAs for the partition on the source system. For example, the Connectivity attribute for storage group SG01 in Figure 45 on page 108 is set to 4 because of the four adapters that were selected to back the HBAs.

- DPM starts automatic discovery of the LUNs that are configured for the WWPNs assigned to each storage group.
  - If no LUNs are discovered (that is, no zoning and masking has been done), DPM sets the fulfillment state of the storage group to Checking migration. For any storage groups in this fulfillment state, DPM attempts LUN discovery every 10 minutes.
  - If a discovery attempt results in the same set of LUNs that are detected for all WWPNs over the required number of adapters (as defined by the Connectivity attribute for the storage group), DPM automatically accepts the volumes and sets the fulfillment state of the storage group to Complete. For any storage groups in this fulfillment state, DPM attempts LUN discovery every 24 hours.
  - If a discovery attempt results in LUNs that are detected for all WWPNs, but not all WWPNs are configured for the same set of LUNs over the required number of adapters (as defined by the Connectivity attribute for the storage group), DPM sets the fulfillment state of the storage group to Pending with mismatches. For any storage groups in this fulfillment state, DPM attempts LUN discovery every 10 minutes.

What to do next

- If your security administrators used HiperSockets object and task roles to control access to the HiperSockets adapter on the source system, they need to review that access configuration and recreate it on DPM R5.2, using the partition link object and task permissions. For more information about controlling access to partition links, see the *Authorization requirements* topic in the HMC online help for the **Configure Partition Links** task.
- If any Secure Service Container partitions on the source system used a HiperSockets connection to access the Secure Service Container web interface, you must reconfigure that connection to use an Open Systems Adapter-Express (OSA) adapter. To do so, open the **Partition Details** task for the Secure Service Container partition, and go to the Network section to define a new network interface card that is associated with an OSA adapter.
- Go to **Storage Overview** in the **Configure Storage** task to check storage groups and adapter assignments. If necessary, you can modify the storage group names and other details, or reconfigure system adapters through **Storage Cards**.

  Check the fulfillment state of the storage groups to determine what actions you might need to take.
  - If the fulfillment state does not change from Checking migration to either Complete or Pending with mismatches, have the storage administrator fix the configuration in the storage subsystem. Then open the **Connection Report** on the Storage Details page for the storage group, and select the **Update report** icon () so that DPM rechecks the storage group connections and changes the fulfillment state.
  - For a fulfillment state of Pending with mismatches, go to the **Volumes** tab on the Storage Details page for the storage group. All mismatched volumes are displayed at the top of the Volumes table, and are marked with a warning icon (). Volumes are considered mismatched when one or more of the following conditions are true.
    - The volumes are zoned and masked equally for all of the WWPNs. For these volumes, system administrators have the option of either deleting or keeping the mismatched volumes in the storage group. They can select one or more volumes to keep or delete.
    - The volumes are masked and zoned only for a subset of WWPNs. For these volumes, storage administrators must correct the zoning and masking configurations for the WWPNs.

  For more information about fulfillment states and possible corrective actions, see "The Storage Group details page" on page 166 (this information is also available in the online help for the Storage Group details page).
- If any partitions have multiple HBAs that are backed by the same adapter, consider modifying the storage group to make sure that the required number of HBAs are retained if the storage group is

detached and then reattached to the same or another partition. For example, suppose that your source system has one partition with five HBAs that are backed by only two adapters.

1. During the migration process, DPM creates the dedicated FCP storage group, retains all five HBAs that are defined for the partition, and sets the Connectivity attribute of the storage group to 2, which is the number of distinct adapters that were in use by the five HBAs.
2. After the migration, an administrator detaches the storage group from the partition.
3. If an administrator then reattaches the storage group to the same partition, or attaches it to a different partition, DPM uses only the current Connectivity attribute setting to determine how many HBAs to create when the storage group is reattached. In this case, DPM creates only two HBAs, not five.

If the partition needs additional HBAs, you need to modify the storage group attributes to either change the Connectivity attribute setting, or specify additional connections. To do so, go to **Storage Overview**, select the storage group, and select **Modify Storage Group**.

- If you have imported configuration data for any Secure Service Container partitions, use the **Partition Details** task to check the following information.
  - Go to the **General** section to reset the default master user ID, the password, or both.
  - Go to the **Boot** section to check the install location for the appliance that the partition hosts. If necessary, reinstall the appliance.

Important:

- After you have successfully migrated to DPM R3.1, use the **Backup Critical Data** task on the Support Element.
- When you detach an FCP storage group from a partition, DPM does not preserve the HBAs, device numbers, or backing adapters that were in use for that storage group. Consequently, if you reattach the storage group to the same partition, the device numbers and the backing adapters of the HBAs are not guaranteed to be the same as they were before the detachment. The same condition is true if you attach the FCP storage group to a new partition: the device numbers and the backing adapters of the HBAs are not guaranteed to be the same as they were when the storage group was attached to a different partition.

  If the operating system image for the partition resides on a boot volume in the storage group that you reattach, the operating system might not start when the partition is restarted. (Operating systems that are started from a storage volume usually have a preconfigured device number and a path to the volume.) To avoid this situation, administrators must review the device numbers and the backing adapters of the HBAs, after reattaching the storage group and before restarting the partition. If necessary, the administrators must change the device number to match the preconfigured device number for the operating system, and make sure that the preconfigured device number is assigned to the backing adapter that was assigned to the HBA before the detachment. For more information, see “Instructions: Detaching and reattaching an FCP storage group” on page 76.

Chapter 12. Adapter configuration

DPM automatically discovers any adapters that are installed in the processor frame, and assigns names to them, using a default naming convention. Before any administrators create and start partitions that use these adapters, use the appropriate HMC task to review details about the adapters, and make any adjustments that might be necessary.

- For FICON Express storage adapters, use the **Configure Storage** task to configure storage adapters as either FCP or FICON, and to specify which adapters connect the system to storage devices.
- To view any installed Non-Volatile Memory Express (NVMe) storage adapters, use the **Configure Storage** task. Note that you cannot use this task to configure NVMe adapters; reconfiguration requires properly removing the carrier card and its SSD from the drawer and reinstalling them in a different physical location, as instructed by a service representative.
- To view details and modify network or crypto adapters, use the **Manage Adapters** task.
- If HiperSockets are required on the system, you need to define them. To create a HiperSockets adapter, use one of the following methods, depending on the version of DPM that is installed on your system.
  - Starting with DPM R5.2, use the **Configure Partition Links** task to create a HiperSockets partition link. For instructions and authorization requirements, see the online help for the **Configure Partition Links** task.
  - With prior versions of DPM, use the **Manage Adapters** task to create a HiperSockets adapter. For instructions, see the online help for **Manage Adapters** > **Create HiperSockets Adapter**.

Default naming convention

For most installed adapters, DPM assigns a default name in the form *adapter_type adapter_ID partial_location*.

- For cryptographic adapters, DPM uses a more specific adapter type: CCA, EP11, or Accel.
- For adapters that are associated with SMC-D partition links, the default adapter name consists of the adapter type (SMC-D), followed by the virtual channel path identifier (VCHID) that is associated with the partition link.
- For rack mount configurations, the *partial_location* section of the default name begins with AIO*x*, where A is the frame identifier, and *x* is the number of the I/O drawer.

Table 8 on page 113 provides examples of the default names that DPM assigns to installed adapters. In the table, PCHID refers to the physical channel path identifier and, for some adapter types, Location includes jack and slot information. The first entry in the table is a sample Crypto card installed in a rack mount configuration.

Note that the sample card types do not necessarily apply to the latest system. For a list of the network adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

Table 8. Sample default names for installed adapters

Type	Crypto type	PCHID	Card type	Location	Default name
Crypto	CCA coprocessor	0130	Crypto Express7S	AIO1-LG17	CCA 0130 AIO1-17
Crypto	CCA coprocessor	01B8	Crypto Express7S	Z15B-LG18	CCA 01B8 Z15B-18
Crypto	EP11 coprocessor	01BC	Crypto Express7S	Z15B-LG19	EP11 01BC Z15B-19
Crypto	Accelerator	01C0	Crypto Express6S	Z15B-LG20	Accel 01C0 Z15B-20

Table 8. Sample default names for installed adapters (continued)					
Type	**Crypto type**	**PCHID**	**Card type**	**Location**	**Default name**
FCP	—	0171	FICON Express 32S	Z22B-D211-J.01	FCP 0171 Z22B-11
FCP	—	0161	FCP Express 32S	Z22B-D230-J.01	FCP 0161 Z22B-30
FICON	—	013C	FICON Express 16S	Z22B-D119-J.01	FICON 013C Z22B-19
NVMe	—	0160	NVMe	A23B-LG12	NVMe 0160 A23B-12
OSD	—	018C	OSA-Express6S	Z15B-D104-J.01	OSD 018C Z15B-04
OSD	—	0144	OSA-Express7S 25GbE	Z22B-D121-J.01	OSD 0144 Z22B-21
RoCE	—	0184	10GbE RoCE Express	Z15B-LG02J.01-LG02J.02	RoCE 0184 Z15B-02
RoCE	—	014C	25GbE RoCE Express	Z22B-LG23J.01-LG23J.02	RoCE 014C Z22B-23
SMC-D	—	—	ISM	—	SMC-D 07C0
zEDC	—	0188	zEDC Express	Z15B-LG03	zEDC 0188 Z15B-03

To help Linux administrators select the appropriate adapters for their partitions to use, consider either renaming the adapters with more descriptive names, or add a description to each adapter. If your company has an established naming convention for adapters, you can change the adapter names to follow that convention. To change an adapter name or add a description, open the **Manage Adapters** task. On the **Adapters** tab, select an adapter and right-click on its name to display the task menu, and click **Adapter Details**, as shown in Figure 46 on page 114.

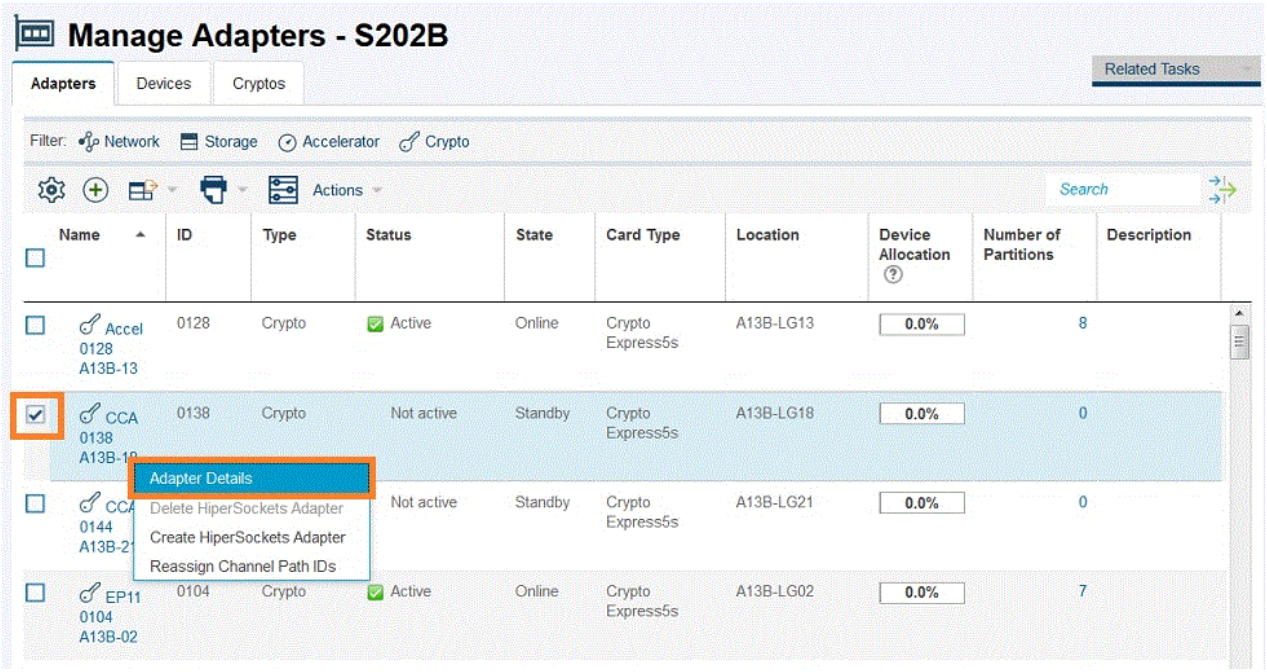

Figure 46. Sample screen of the Manage Adapters task

The Adapter Details window opens. The details vary, depending on the adapter type, but all have Name and Description text boxes for you to use, if you want to modify the name or add a description. Figure 47 on page 115 shows the adapter details for a cryptographic adapter. After you modify the name or add a description, click **Apply** to save your changes.

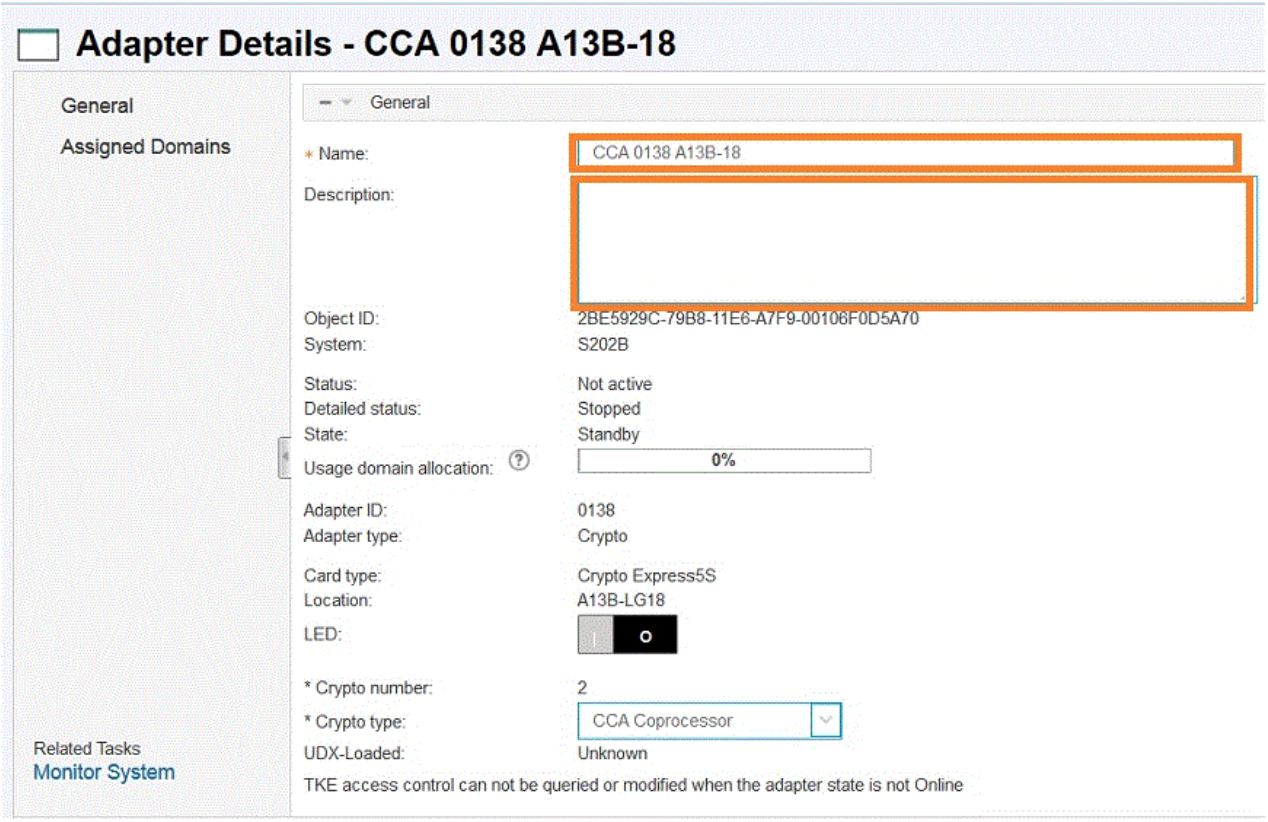

Figure 47. Sample screen of the Adapter Details window, with Name and Description fields highlighted

Chapter 13. Secure Execution for Linux feature

With the IBM Secure Execution for Linux feature, you can deploy multiple secure, isolated virtual environments on a single system. Secure Execution isolates and protects any guests that run on a hypervisor by restricting host access to guest workloads and data. It protects the confidentiality and integrity of guest data from both internal and external attacks, but does not protect against a denial of service.

When you order the IBM Secure Execution for Linux feature, IBM either installs the required global and host key bundles on a new machine before delivery, or electronically sends them to your company for the service representative to import to an already installed system. For a new machine with the feature and keys installed, Secure Execution is enabled on the system, and hypervisors that are configured to use the feature can successfully do so. For an existing system at your site, however, you first need to complete the following steps before Secure Execution is enabled and ready for use.

1. Order the feature.
2. Install the feature, using the **Perform Model Conversion** task.
3. Import the key bundles.

Importing the key bundles requires logging in to the Support Element using the SERVICE user ID or an ID with equivalent permissions, and opening the **System Details** task to the General section. In that section, **Manage Keys** opens the **Manage Secure Execution Keys** task, through which you can import the keys. On either the HMC or SE, you can view details about each key, including the hashes for the existing global or host key. If your user ID has the System Programmer Tasks role, you can clear the global or host key, which immediately prevents further usage by any partition on the system, and deletes the corresponding key bundle file from the system.

For more information about the IBM Secure Execution for Linux feature, see *Introducing IBM Secure Execution for Linux 1.1.0*, SC34-7721, which is available in IBM Documentation at: https://www.ibm.com/docs/en/linux-on-systems?topic=overview-introducing-secure-execution-linux.

- To determine whether a system has this feature installed, open the **System Details** task to the General section, and check the Secure Execution indicator. This indicator is also available on the **Systems** tab on the HMC **Systems Management** view, but the Secure Execution column on that tab is not displayed in the predefined default table view. To display the Secure Execution column, select the **Manage Views** icon in the work pane table toolbar to customize the table view.
- To configure Linux for secure execution, see the product documentation for the Linux distribution that you are using as a hypervisor. This feature supports Linux (KVM) hypervisors.
- To determine whether the Linux hypervisor that runs on a partition is configured for secure execution, go to the **General** section of the **Partition Details** task and check the value displayed for the Secure Execution field.

Chapter 14. Validating boot images of operating systems

When you select a storage group as the location of the operating system or hypervisor image to be hosted in a partition, you can select Secure Boot options to enable DPM to validate that the Linux operating system executables on a boot volume originate from a trusted source, and have not been altered without authorization. Use the Boot section of either the **New Partition** or **Partition Details** task to select the appropriate options.

The Secure Boot options are available only when you select the **Storage Group (SAN)** option in the "Boot from" menu. The system and partition meet specific requirements that vary, depending on the DPM release.

DPM R4.0 to R5.0

With these releases, DPM verifies that the software signature matches the signature from the distributor, using trusted public keys that reside in the hardware and are identical for all partitions and systems. If the signatures do not match, the boot process fails.

This option is enabled only when:

- The partition has a partition type of **Linux**.
- The system that hosts the partition supports the Secure Boot for Linux function.
- You are booting the Linux operating system from a volume in an FCP or NVMe storage group.

DPM R5.1

With this release, DPM validates the digital signature of the Linux operating system image using the public cryptographic keys that are contained in customer-supplied digital certificates from the Linux distributor. A security administrator can import digital certificates and manage them through the **Secure Boot Certificate Management** task.

Note: If you have already used the hardware public keys for a specific partition (the Secure Boot option available with DPM R4.0-R5.0), DPM continues to use those hardware keys until you assign one or more digital certificates to the partition; after that certificate assignment, for this partition only, the hardware keys are no longer valid.

This option is enabled only when:

- The partition has a partition type of **Linux** or **z/VM**. Note, however, that for a partition with the **z/VM** type, the certificates apply only when booting the Linux guests, not when booting the z/VM hypervisor itself.
- You are booting the Linux operating system from a volume in an FCP, FICON, or NVMe storage group.

The boot process fails if one or more of the required certificates have expired. The suggested practice is to replace or remove expired certificates. Periodic hardware messages indicate when a certificate is approaching or has passed its expiration date.

Chapter 15. Enabling FCP tape support for machine types 3906 and 3907

FCP tape support requires Hardware Management Console (HMC) hardware with Version 2.15.0 and the minimum H20 service bundle applied. If you want to exploit the FCP tape support for workloads that run on machine type 3906 or 3907 systems that are managed by HMCs with Version 2.14.1, you need to upgrade the firmware for at least one of those Version 2.14.1 HMCs to Version 2.15.0 with correct service bundle. This upgrade is firmware only; a hardware upgrade is not required.

If you already have Version 2.15.0 HMCs because you ordered them for your 8561 or 8562 systems, you can use those HMCs to manage the machine type 3906 and 3907 systems as well. In this case, you do not have to upgrade any HMCs; installing the minimum H20 service bundle is sufficient.

Otherwise, if the HMCs that you are using have Version 2.14.1 firmware, work with a service representative (or with the assistance of the support system) to upgrade the firmware level of at least one HMC.

1. Upgrade all HMCs to Version 2.15.0 with the H20 service bundle for driver 41.
2. If a subset of the HMCs that manage the earlier systems cannot be upgraded to driver 41, install the H37 service bundle for driver 36 to avoid feature incompatibilities. Even after installing this service bundle, make sure that you **do not use** these remaining Version 2.14.1 HMCs to manage the 3906 or 3907 systems that are connected to FCP tape libraries.
3. Apply the S50 service bundle for driver 36 to the Support Elements (SEs) of 3906 and 3907 systems through which you want to connect to FCP tape libraries in the storage area network (SAN).

Chapter 16. The HiperSockets user experience with DPM R5.2

DPM Release 5.2 (R5.2) introduces a new type of partition link that is based on HiperSockets technology. *Partition links* interconnect two or more partitions that share the same network configuration and reside on the same system. HiperSockets are virtual adapters that provide high-speed communications between partitions within a single system, without the need for any physical cabling or external networking connections. A HiperSockets partition link enables partitions that reside on the same system to use HiperSockets technology for transferring data.

Support for HiperSockets is available in prior releases of DPM; however, with R5.2, you need to use different HMC tasks to create, edit, and delete HiperSockets connections. With previous releases of DPM, administrators used a combination of the **Manage Adapters** task, the **New Partition** task, and the **Partition Details** task to create and manage HiperSockets connections. Starting with R5.2, you create and manage HiperSockets through the **Configure Partition Links** task, which provides a simplified and streamlined user experience.

Although you can continue to view HiperSockets details through the **New Partition**, **Partition Details**, and **Manage Adapters** tasks, other HiperSockets functions (create, edit, delete) in those tasks are disabled. The only exception: you are able to reassign the channel path identifier (CHPID) of the HiperSockets adapter through **Manage Adapters** > **Reassign Channel Path IDs**.

When DPM R5.2 is installed on your system and the Support Element is restarted, any HiperSockets connections that were defined on a prior DPM release are automatically converted into HiperSockets partition links. Each HiperSockets partition link is populated with a list of the partitions that were using the HiperSockets adapter, as well as the network interface cards (NICs) assigned to each partition and their associated device numbers. However,

- Permissions on the original HiperSockets adapter are not carried over to the new system, so more users might have access to the HiperSockets partition links. In this case, your security administrator needs to set up equivalent user permissions for the new HiperSockets partition links. For potential migration actions, see “Migration instructions for a system replacement” on page 105.
- If any Secure Service Container partitions use a HiperSockets connection to access the Secure Service Container web interface, you must reconfigure that connection to use an Open Systems Adapter-Express (OSA) adapter. To do so, open the **Partition Details** task for the Secure Service Container partition, and go to the Network section to define a new network interface card that is associated with an OSA adapter.

Part 5. Topics for network administrators

Topics in this part provide information about network-related concepts and tasks that are specific to working with DPM-enabled systems.

Topics covered in this part are:

Chapter 17. Configuring FICON connections for use with FICON CTC partition links

Starting with DPM R5.2, you can create FICON CTC partition links, which use Fibre Connection (FICON) channel-to-channel (CTC) connections to provide fast and efficient data transfer between partitions that reside on the same system. The system on which the partitions reside must have FICON connections that are available to use as paths for the partition link. To view existing or configure new FICON connections (paths), you can use a link in the **Configure Partition Links** task to go to **FICON CONNECTIONS**, which is part of the **Configure Storage** task.

To open the **Configure Storage** task, you can use a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role. Through **FICON CONNECTIONS**, you can build or modify a visual copy of the storage hardware devices in the SAN and their FICON connections to this system. This configuration can contain at most two physical sites where storage devices are located. The primary site is always where the DPM-enabled system is physically located. The visual copy includes a System box that contains a link called **Connections**, through which you can view or manage not only connections to storage subsystems and switches but, starting with DPM R5.2, also FICON network connections between partitions that reside on the same system.

When you select the **Connections** link in the System box, the **Connections** page opens to display a searchable table with an entry for each connection that is defined for the system. If the table is empty, select **Add new connection** to add a new connection between the system (adapter) and a storage subsystem; between a system (adapter) and a switch; or between two adapters on the same system. After you add these connections, you can use them as the foundation for storage groups that provide partitions with access to storage subsystems, or for FICON CTC partition links that interconnect partitions that reside on the same system.

Figure 48 on page 127 shows a sample table that lists already configured FICON connections, along with specific properties for each connection. The connection usage value and the existence of a fabric (switch) determine which properties are included in the table. If an existing connection is in use, its table entry contains a lock icon in the leftmost column; in this case, you might be able to use the action icon to modify the connection usage, but you cannot delete the connection.

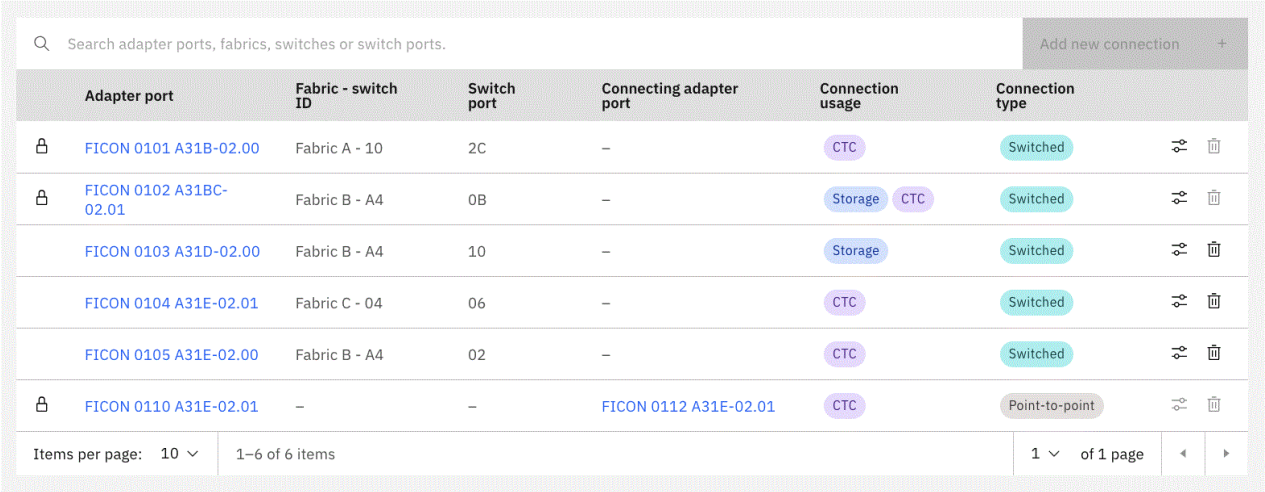

Figure 48. Sample screen capture of the searchable table on the Connections page

The table includes the following properties.

Adapter port
Specifies the user-supplied or DPM-assigned default name of an adapter that you selected for a connection.

Fabric - switch ID
Specifies the unique name of the fabric in which a switch resides, with the two-digit identifier of the switch. This value is shown only for switched connections.

Switch port
Specifies the two-digit identifier of the switch port. This value is shown only for switched connections.

Connecting adapter port
Specifies the user-supplied or DPM-assigned default name of an adapter that you selected as the connecting adapter for a connection. This value is shown only for point-to-point connections with a connection usage value of CTC.

Subsystem
Provides the name of the storage subsystem. This column is displayed only when the connection usage is defined as Storage.

Connection usage
Specifies the intended use for the adapter. This value determines where the adapter can be connected and used.

Storage
The FICON adapter port can be connected to a switch or directly to a storage subsystem. A direct connection to a storage subsystem is allowed only when no fabrics are defined for your system configuration.

CTC
The FICON adapter port can be connected to a switch or directly to another FICON adapter port. You can use this connection only as a path for a FICON CTC partition link. For more information about this type of partition link, see “FICON CTC partition links” on page 26.

Storage and CTC
The FICON adapter port can be connected only to a switch. You cannot define a connection usage of Storage and CTC unless a fabric with at least one switch is defined for your system configuration.

Connection type
Specifies the type of connection, which is either Switched or Point-to-point.

- A switched connection uses one adapter port that is physically connected to a switch.
- A point-to-point connection uses two adapter ports that are directly, physically connected to each other (that is, they are not connected through a switch).

Action icons
Each table row includes a modify icon (two horizontal lines with open circles) and a delete icon (trash can). If an existing connection is in use, its table entry contains a lock icon in the leftmost column; in this case, you might be able to use the action icon to modify the connection usage, but you cannot delete the connection.

For more information about configuring FICON connections, see the online help topic for **FICON CONNECTIONS** in the **Configure Storage** task.

Chapter 18. Customizing the network boot server environment

Many companies use a preboot execution environment (PXE) to boot, install, and deploy hypervisors and operating systems. To use your company's network boot server, you might need to make some configuration changes to match the DPM implementation for the network boot server environment. Use the information in this procedure to customize your existing configuration files to work with the DPM NetworkBoot function.

Before you begin

- A network boot server environment usually consists of a Dynamic Host Configuration Protocol (DHCP) server, a Trivial File Transfer Protocol (TFTP) server and, optionally, a Domain Name System (DNS) server. These network boot server environments are based on the Intel Preboot eXecution Environment specification and specific Internet Engineering Task Force (IEFT) requests for comments (RFCs) related to networking.

  Before you complete the steps in this procedure, your installation must set up a DHCP server and a TFTP server, according to the IEFT RFCs. These servers can reside on the same or on different systems within the network. Note that the configuration examples in this procedure work for Internet Systems Consortium (ISC) DHCP servers; the configuration statements for other DHCP servers are different.
- When communicating with network boot servers, DPM sends the universally unique identifier (UUID) of the partition in DHCP option 61, so the DHCP server must be configured to use that option and UUID in class or pool definitions.

  You need to know the UUID of the partition, and the UUIDs of any other partitions for which you want to use the network boot server to install the hypervisor or operating system. To determine the UUID, open the **Partition Details** task for a specific partition, and find the value listed for Object ID in the General section.

  To indicate that a request comes from an IBM Z or IBM LinuxONE (LinuxONE) system, DPM also sends an identifier in DHCP option 93. This **`client-arch`** option has a fixed value of 32. You can use this option to tailor the processing related to a request from an IBM system.

Procedure

1. Create a configuration file for the DHCP server (for example: `/etc/dhcp/dhcpd.conf`), for IPv4 addresses.
   a) Specify the following options.

   ```
   allow booting;
   allow bootp;
   ```

   b) In the subnet specification for your network boot server environment, add one of the following statements, substituting the IPv4 address of your TFTP server for the variable *ipv4_addr*.

   ```
   option tftp-server-name <ipv4_addr>;
            OR
   next-server <ipv4_addr>
   ```

   c) Complete one of the following options.

   Option 1

   i) Define a class with a match for the option **`dhcp-client-identifier`**. This class can be used for program selection.

   ```
   class "NetworkBoot" {
           match if option dhcp-client-identifier = "df7f2566-05aa-11e6-
   ```

```
a31d-9abe94227999";
}
```

ii) Define a pool that includes both the dynamic address range and the boot configuration to load for all members of the class defined in the previous step. For example:

```
pool {
        allow members of "NetworkBoot";
        option bootfile-name           "NetworkBoot.PCI_D22H_004";
        filename                "NetworkBoot.PCI_D22H_004";
        range 192.168.1.10 192.168.1.30;
     }
```

- To specify the boot configuration, you can use either **option bootfile-name** (as shown in the previous example), or the **filename** keyword.
- For the boot configuration, specify the file name, optionally preceded by a relative path.
- The boot configuration has to be located under the "file-root" directory of the TFTP server, as described in step “2” on page 130.

Option 2

Specify the dynamic address range and the boot configuration to load globally for your subnet. Use the same statements as described for the pool definition in Option 1.

d) Optional: Create a configuration file for the DHCP server (for example: `/etc/dhcp/dhcpd6.conf`), for IPv6 addresses.

The DHCP server configuration for IPv6 is similar to that for IPv4, only with different keywords. The key difference is the use of a URL to specify the boot configuration; for example:

```
option dhcp6.bootfile-url "tftp://[[2001:0db8:0000:0000:0202:b3ff:fe1e:8329]/
NetworkBoot.RHEL-7.0";
```

2. Verify the structure of the file-root directory of the TFTP server.

The file-root directory of the TFTP server is the top-level directory, where the TFTP server loads and stores files. It is specified by the `-s` *`file root`* option to **tfpd**. This directory contains the files associated with the program components to be loaded, as specified in the boot configuration. The supported program components are:

kernel
A required component; the kernel of the program to load.

initrd
A required component; a RAM disk for the program to load.

append
An optional component; additional parameters to the command line of the program to load.

To work with the DPM NetworkBoot function, the files associated with the kernel and initrd program components must reside under the file-root directory of the TFTP server. The file names can be preceded by a relative path.

The following examples illustrate boot configuration files. (Note that the examples are formatted to fit on this page, so line breaks might not match the formatting required for a boot configuration file.)

Example: Boot configuration file for an automated KVM server installation

```
~ # cat /tftpboot/kvm.DPM
PROMPT 1
DEFAULT linux
TIMEOUT 60
label linux
        kernel=s390x/kernel.kvm.s390x
        initrd=s390x/initrd.kvm.s390x
        append=ro systemd.show_status=0 ramdisk_size=40000 cio_ignore=all,!condev,
            !0.0.eb00-0.0.eb02,!0.0.7000,!0.0.7100
rd.zfcp=0.0.7000,0x500507680210d2ce,0x0000000000000000
rd.zfcp=0.0.7100,0x500507680220d2ce,
            0x0000000000000000
rd.znet=qeth,0.0.eb00,0.0.eb01,0.0.eb02,layer2=1,portno=1,portname=DUMMY
ip=192.0.2.0::198.51.100.0:255.255.255.0:zkvm231:enccw0.0.eb00:none
```

```
nameserver=203.0.113.0
            searchdomain=z0plex.com vnc
vncpassword=pw4demo RUNKS=1 inst.repo=http://203.0.113.0/kvmibm
            inst.auto=http://203.0.113.0/kvmibm/auto/zkvm231.ks rd_NO_LUKS
rd_NO_LVM rd_NO_MD rd_NO_DM LANG=en_US.UTF-8
```

Example: Boot configuration file for an Ubuntu network installation system

```
~ # cat /tftpboot/ubuntu.DPM
PROMPT 1
DEFAULT linux
TIMEOUT 60
label linux
        kernel=s390x/kernel.ubuntu.s390x
        initrd=s390x/initrd.ubuntu.s390x
        append=ro locale=C DEBCONF_DEBUG=5 s390-netdevice/choose_networktype=qeth
            s390-netdevice/qeth/choose=0.0.eb00-0.0.eb01-0.0.eb02 s390-netdevice/qeth/
port=1
            s390-netdevice/qeth/layer2=true netcfg/use_autoconfig=false
            netcfg/disable_dhcp=true
netcfg/get_ipaddress=192.0.2.30 netcfg/get_netmask=255.255.255.0
            netcfg/get_gateway= 192.0.2.0 netcfg/get_nameservers=198.51.100.0
netcfg/get_hostname=zkvm251 netcfg/get_domain=z0plex.com network-console/password=lin390
            network-console/password-again=lin390
preseed/url=http://192.0.2.24/auto/ubuntu.preseed ro systemd.show_status=0
            ramdisk_size=40000
```

For these examples of boot configuration files, the file structure under the file-root directory of the TFTP server must look as follows:

```
~ # ls -al /tftpboot/s390x/
total 83524
drwxrwxr-x 2 atftp root      4096 15. Sep 12:41 .
drwxrwxr-x 5 atftp users     4096 21. Jul 19:12 ..
-rwxr-xr-x 1 atftp root  26113392 22. Feb 2016  initrd.kvm.s390x
-rwxr-xr-x 1 atftp root  30881788 21. Apr 21:02 initrd.sles121.s390x
-rwxr-xr-x 1 atftp root  10605354 21. Apr 14:46 initrd.ubuntu.s390x
-rwxr-xr-x 1 atftp root   3859968 25. Jan 2016  kernel.kvm.s390x
-rwxr-xr-x 1 atftp root  10245888 21. Apr 21:02 kernel.sles121.s390x
-rwxr-xr-x 1 atftp root   3687400 21. Apr 14:46 kernel.ubuntu.s390x
~ #
```

3. On the HMC, complete the following steps to specify the network boot server as the method of booting the operating system or hypervisor for the partition.
   a) Define a network interface card (NIC) to connect the partition to the network on which the network boot server resides.

      This NIC must be associated with either an OSA port or a HiperSockets adapter. How you define the NIC depends the adapter card type.

      - For a NIC that is associated with an OSA adapter, use the Network section of the **Partition Details** task.
      - For HiperSockets adapter, use one of the following tasks, depending on the DPM version that is installed on the system.

        DPM R5.2
        Use the **Configure Partition Links** task to either create a new or use an existing HiperSockets partition link. Add the partition to the list of partitions that can use the partition link; this action automatically creates a NIC for the partition. Next, go to the **Define devices** section to review information about the NIC and its device numbers.

        DPM R5.1 and earlier versions
        Use the Network section of the **Partition Details** task to create the NIC.

   b) In the Boot section of the **Partition Details** task on the HMC:
      i) Select the **Network server (PXE)** option from the "Boot from" menu list.
      ii) Select the NIC for the adapter that connects the partition to the network on which the network boot server resides.
   c) Click **OK** to create the partition or to save your changes.

4. Edit the configuration file for the DHCP server to contain the Object ID value of each partition that is to be a client of the network boot server.

   The following sample shows the option `dhcp-client-identifier` specified in a partial DHCP server configuration file.

```
  pool {
                option bootfile-name        "NetworkBoot.DPM";
                filename               "NetworkBoot.DPM";
                range 192.0.2.0 192.0.2.4;
              }
host zkvm251 {
    option dhcp-client-identifier "df7f2566-05aa-11e6-a31d-9abe94227999";
    fixed-address 192.0.2.9;
    option bootfile-name        "kvm.DPM";
    filename       "kvm.DPM";
  }
```

Results

The network boot server environment is ready for use, and you can successfully start the partitions that use the **Network server (PXE)** boot option to load and initialize the operating system or hypervisor.

Chapter 19. Securing FTP operations

On a DPM-enabled system, administrators can use their choice of protocol for file transfers: standard FTP, FTP Secure (FTPS), and Secure File Transfer Protocol (SFTP). Standard FTP requires an FTP server to be on the same network as your DPM-enabled system. In contrast, with FTPS or SFTP, you can keep your system on an isolated network for maximum security.

FTPS and SFTP work through a proxy feature on the Hardware Management Console (HMC) through which you manage your DPM-enabled system. To use these secure protocols, you must first prepare at least one of the HMCs through which you manage the Support Element of the DPM-enabled system. For instructions, see “Setting up FTPS” on page 133 or “Setting up SFTP” on page 133.

Setting up FTPS

FTPS uses the Secure Socket Layer (SSL) protocol to secure data through certificates that authenticate the FTP servers. To use the FTPS protocol, complete the following steps to import an FTPS server certificate.

1. Open the **Certificate Management** task, click the arrow for the **Advanced** list, and select **Manage Trusted Signing Certificate** from the list.
2. On the **Manage Trusted Signing Certificate** page, click the arrow for the **Import** list, and select **From Remote Server**.
3. On the **Import Remote Certificate** page, provide an IP/Host address and a valid port number, then click **OK**.
4. Confirm the request. When processing completes, view the resulting message to determine whether the operation was successful.
5. Repeat, as necessary, on other managing HMCs. When you acquire the appropriate SSL certificates, you can use the FTPS or SFTP selections that are available for all the tasks that support FTP or removable media as options to import or export files.

Setting up SFTP

SFTP uses the Secure Shell (SSH) protocol to secure data through SSH keys that authenticate the FTP servers. To use the SFTP protocol, complete the following steps to import SSH server keys.

1. Open the **Manage SSH Keys** task.
2. In the Address field, provide the SFTP server ID or host name, and click **Add** to add the SSH key.
3. When processing completes, view the resulting message to determine whether the operation was successful.
4. Repeat, as necessary, on other managing HMCs. When you acquire the appropriate SSH keys, you can use the FTPS or SFTP selections that are available for all the tasks that support FTP or removable media as options to import or export files.

Chapter 20. Using VLAN IDs to secure network communications

When you create a network interface card (NIC) for a partition, that partition can receive all traffic that flows across the adapter to which the NIC is assigned. If you want to limit that traffic to a particular virtual local area network (VLAN), you can specify a VLAN identifier (ID) for each NIC. This *VLAN enforcement* capability can help you avoid data security issues.

DPM provides VLAN enforcement only for partitions with a type of **Linux** or **z/VM**, and only when you select an OSA-Express or HiperSockets adapter for the NIC. By specifying a VLAN ID, you are configuring the network adapter to send only packets that are tagged with the same ID, or untagged packets, to the partition and the operating system or hypervisor that it hosts. The operating system or hypervisor must tag and untag the packets.

How you specify a VLAN ID depends on the adapter type:

- For an OSA-Express adapter, use the Network section of the **New Partition** task in advanced mode, or through the **Partition Details** task.
- For a HiperSockets adapter, the task you use depends on the version of DPM that is installed on the system. Starting with DPM R5.2, use the **Configure Partition Links** task to specify a VLAN ID for NICs that are associated with a HiperSockets partition link. For prior DPM versions, use the Network section of the **New Partition** task in advanced mode, or the Network section of the **Partition Details** task.

For example, consider the configuration in Figure 49 on page 135, which shows eight partitions, each hosting a guest operating system. Each of these partitions has a NIC through which it accesses one of two adapters that are connected with a crossover cable.

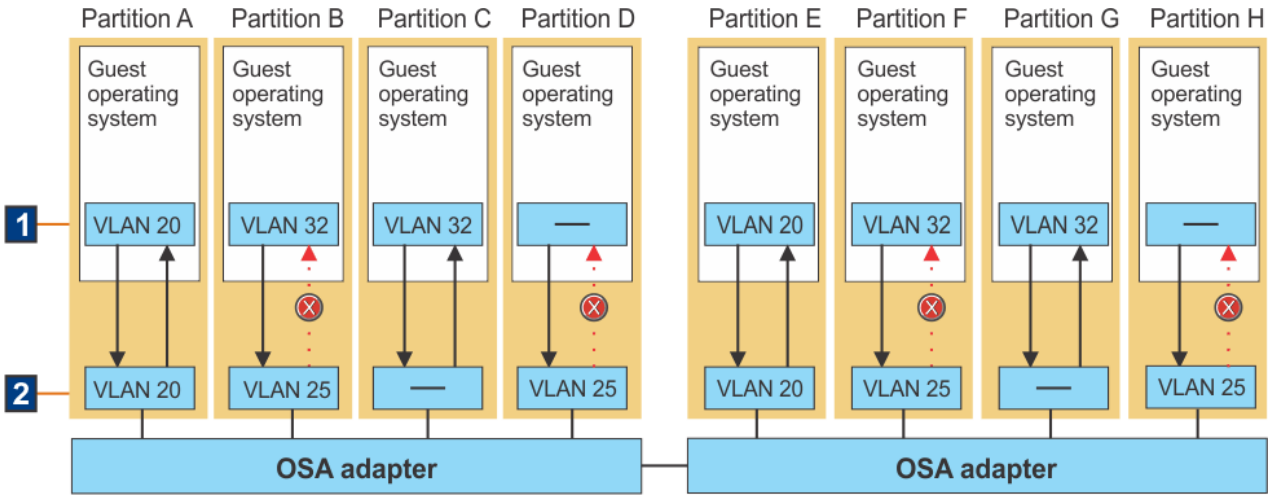

Figure 49. Sample VLAN configuration in partitions and guest operating systems

1. All but two of the guest operating systems have a configuration file that contains a specific VLAN ID:
   - The operating systems on partitions A and E are configured to use VLAN 20.
   - The operating systems on partitions B, C, F, and G are configured to use VLAN 32.
   - The operating systems on partitions D and H do not have a VLAN ID configured.
2. Each of the partitions has a NIC, but only six of the partitions have a NIC that is configured with a specific VLAN ID.
   - Partitions A and E have NICs that are configured with VLAN ID 20, which matches the ID value that is configured on their guest operating systems. In this case, VLAN enforcement is in effect, and the guests on those partitions are able to both send and receive network traffic on VLAN 20.

- Partitions B and F have NICs that are configured with VLAN ID 25, but their guest operating systems are using a different VLAN ID value of 32. In this case, VLAN enforcement is in effect. However, because the VLAN ID values do not match, the guests on these partitions cannot receive any network traffic on VLAN 32. To correct this communication problem, the VLAN ID values in both the partition definitions and the operating system configuration files must match.
- Partitions C and G have NICs that are not configured with any VLAN ID, so VLAN enforcement is not in effect. In this case, the guest operating systems can receive network traffic on any VLAN, even though they are configured to send and receive network traffic on VLAN ID 32.
- Partitions D and H have a NIC that is configured with VLAN ID 25, but their guest operating systems do not have any configured VLAN ID value. In this case, VLAN enforcement is in effect and the guests on these partitions cannot receive any network traffic. To correct this communication problem, VLAN ID 25 must be configured on both of the operating systems.

In addition to configuring a VLAN ID, you also can specify a unique media access control (MAC) address to identify a NIC. To specify a MAC address, you can use the **New Partition** task (advanced mode), the **Partition Details** task, or the **Configure Partition Links** task for a HiperSockets partition link.

- You can specify a MAC address for any type of partition, but only when you select an OSA-Express or HiperSockets adapter for the NIC. If you do not specify a value, DPM automatically generates a unique MAC address for the NIC.
- To display these MAC addresses on the operating system, you need to use a version of the Linux operating system that supports the specification or generation of MAC addresses through firmware. See the Red Hat, SUSE, or Ubuntu product information page to determine which RHEL, SLES, or Ubuntu Server version provides this support. (On an operating system without this support, the operating system's network device driver overwrites any MAC addresses with addresses that it generates.)

The following sample procedure shows how to configure VLAN enforcement for an OSA-Express adapter.

1. For an existing partition, open the **Partition Details** task; for a new partition, open the **New Partition** task and, if necessary, switch to advanced mode. Note that changing a NIC for an existing, active partition is considered a disruptive task, so you might want to stop the partition first.
2. In the **General** section, make sure that the partition type is either **Linux** or **z/VM**.
3. In the **Network** section, either select an existing NIC or create a new one. On the **NIC Details** or **New Network Interface Card** page, complete the following steps:
   a. In the Adapter Ports and Switches table, verify that the selected adapter port or switch is an OSA-Express adapter.
   b. Enter a value in the **VLAN ID** field. The valid range of VLAN IDs is 1 - 4094.
   c. Verify that the **VLAN Type** field displays VLAN Enforcement.
   d. Optionally, specify a MAC address that is both locally administered and unicast, which consists of six groups of two lower-case hexadecimal digits, separated by colons; for example: `12:34:56:78:9a:bc`. DPM checks the validity and uniqueness of the value that you supply, and issues a message if it finds an error.
   e. Click **OK**.
   f. In the **Network** section, verify your changes in the NICs table.
4. Click **OK** to save your changes. (If the partition is active, the Confirm Disruptive Action dialog opens; review the action and supply any confirmation values and your password, as necessary. Then click **Save** to continue.)

   When your changes are successfully saved, the **Validation** window lists the device number and the VLAN ID for each new NIC that you defined.
5. If you are modifying an existing partition through the **Partition Details** task, click **Save** to save your changes. Otherwise, for a new partition, finish going through the remaining sections of the **New Partition** and click **Finish** to create the new partition.
6. To complete the setup for VLAN enforcement, you must specify the same VLAN ID in the network configuration files for the operating system or hypervisor.

For example, the following network configuration script, `ifcfg-Vnic-OSD`, in the `/etc/sysconfig/network-scripts` folder on a KVM hypervisor, contains the information that is required to start the VLAN on the guest operating system. Note the device number and the VLAN ID that are highlighted; these values must match the device number and VLAN ID specified for the NIC in the **Partition Details** task.

```
NAME=Vnic-OSD
IPADDR=192.0.2.0
PHYSDEV=enccw0.0.5010
VLAN=yes
DEFROUTE=no
MTU=1500
NETMASK=255.255.255.0
BOOTPROTO=none
DEVICE=Vnic-OSD
TYPE=vlan
ONBOOT=no
VLAN_ID=700
IPV6INIT=no
```

Note that you can use a very similar procedure to configure VLAN enforcement for a HiperSockets adapter when a DPM version prior to R5.2 is installed on the system. Starting with DPM R5.2, use the **Configure Partition Links** task to create a new or edit an existing HiperSockets adapter and configure VLAN enforcement. For instructions, see the online help for the **Configure Partition Links** task. Make sure that you complete the setup for VLAN enforcement by specifying the same VLAN ID in the network configuration files for the operating system or hypervisor, as illustrated in step “6” on page 136.

Part 6. Topics for storage administrators

The **Configure Storage** task provides the controls through which you can configure and manage the storage resources for a DPM-enabled system. Through this task, system and storage administrators collaborate to connect a system to devices in the storage area network (SAN) through a simplified, visual, and automated process that does not require extensive knowledge of mainframes or LinuxONE systems. Administrators also use the **Configure Storage** task to request and fulfill storage resources for use by partitions on a DPM-enabled system.

In effect, the **Configure Storage** task replaces the use of the **Manage Adapters** task to configure and manage storage adapters. Although multiple systems can share the same storage resources, note that the scope of this task is *one single system only*.

Topics in this part provide information about storage-related concepts and tasks that are specific to working with DPM-enabled systems. These topics apply to supported types of Fibre Connection (FICON) extended count key data (ECKD) direct-access storage devices (DASD), and Fibre Channel Protocol (FCP) Small Computer System Interface (SCSI) disk storage devices and FCP tape storage devices.

Chapter 21. The Configure Storage task: a simplified and improved approach to storage management

Starting with R3.1, DPM introduced a simplified and improved way of configuring and managing storage. For an introduction to storage management through the HMC **Configure Storage** task, see the following topics.

A simplified, visual process for connecting storage to one system

To accomplish the initial setup of storage resources for a DPM-enabled system, system and storage administrators use the **CONNECT TO STORAGE** wizard of the **Configure Storage** task. For access to external storage devices, the initial setup includes defining the protocol of the adapter cards that are installed in the system I/O drawers, and building a visual copy of the storage hardware devices in the SAN and their FICON connections to this system. These hardware devices include disk storage subsystems, fabrics, and switches. To make adapter card configuration easier to accomplish, the **Configure Storage Cards** page of the **CONNECT TO STORAGE** wizard displays a visual abstraction of each physical I/O drawer in the system.

A simplified, visual process for connecting storage to one system

An I/O drawer can contain different types of adapter cards, so DPM highlights only the slots containing an adapter card that can be used for connections to storage devices. For the **Configure Storage Cards** page, DPM automatically detects and displays all installed storage adapters, which include the following types.

- FICON Express adapter cards connect the system to devices in the storage area network (SAN) through Fibre Channel connections. Each FICON adapter card is configured to operate in a specific mode, which determines the type of external storage device that can be connected to the adapter card.
  - Fibre Channel Protocol (FCP) mode provides access to Small Computer System Interface (SCSI) devices, which include tape libraries as well as disk storage.
  - FICON native (FC or FICON) mode provides access to extended count key data (ECKD) devices (also known as direct-access storage devices, or DASD).
- Non-Volatile Memory Express (NVMe) storage adapters use the PCI Express (PCIe) protocol to provide high-speed storage within a system. These storage adapters are available on IBM LinuxONE (LinuxONE) systems only, when those systems have IBM Adapter for NVMe1.1 features installed.

Figure 50 on page 142 shows a sample visual display of one drawer on the **Configure Storage Cards** page.

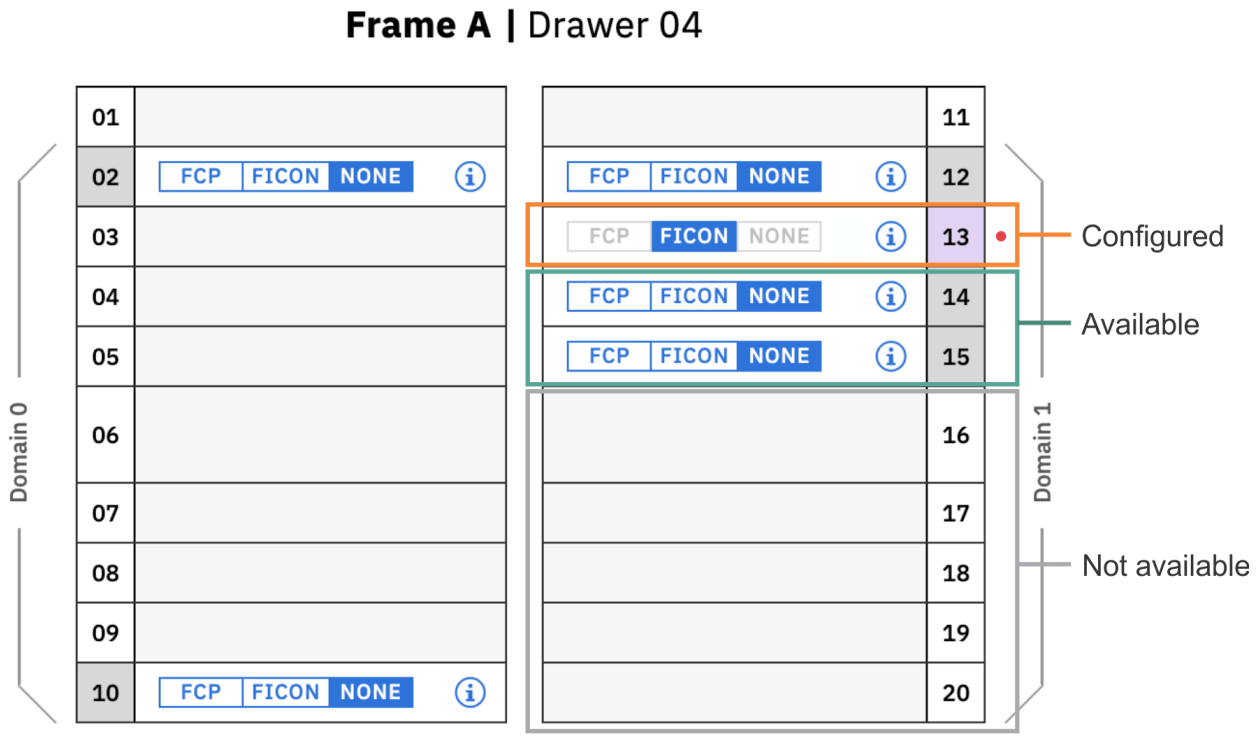

*Figure 50. Sample frame and card display on the **Configure Storage Cards** page*

In the **Configure Storage Cards** page shown in Figure 50 on page 142, the adapter cards that can you can configure contain selectable labels. You can manually configure cards by clicking the FCP or FICON label to select the protocol. Or, for an automated approach, you can use other controls on the page to provide a total number of FICON or FCP cards for DPM to automatically select and configure for optimal redundancy and availability. This automated approach is available only when the system is not yet physically attached to SAN hardware through cables. Red dots in the drawer display indicate the most recently configured FICON or FCP adapter cards.

Depending on the configuration of the system, you might need to use navigation controls to view all of the frames, drawers, and cards on the **Configure Storage Cards** page. For single-frame systems, use the scroll bar or expand/collapse controls to view adapters in the frame drawers. For multiple-frame systems, use the overview map to change the viewport display, as shown in Figure 51 on page 143.

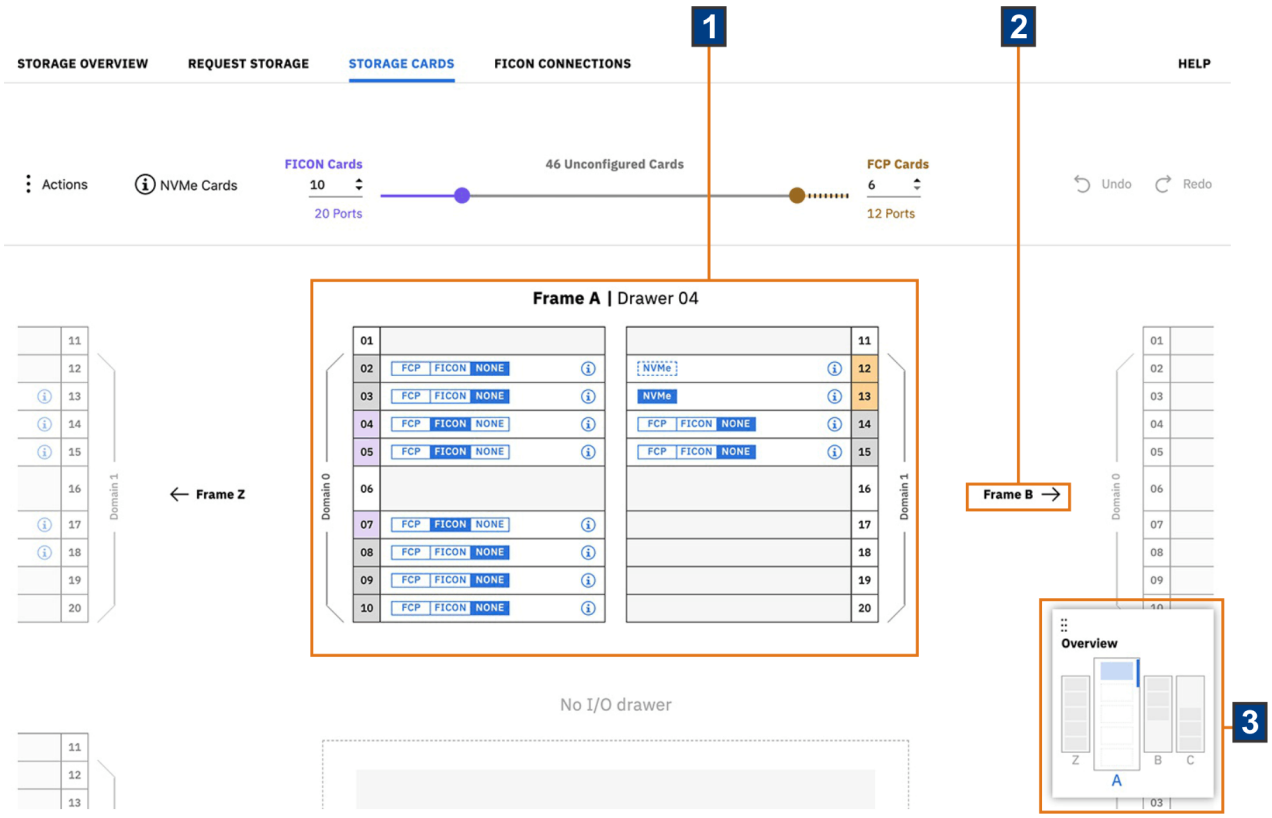

Figure 51. Overview map and other viewport navigational controls

1. Figure 51 on page 143 shows Frame A centered in the viewport.
2. Selectable frame buttons on either side of Frame A provide a way to change the viewport to either the previous or next frame in the system. These buttons are displayed only when the system is configured with additional frames to the left or right of the current frame.
3. The overview map shows how many frames are in the system, how many I/O drawers are in each frame, and highlights the I/O drawer that is currently displayed in the viewport. Red dots in the overview map indicate recent changes to a specific frame that contains an I/O drawer with storage adapter cards. To change the display, select a different frame in the overview map or use the frame buttons. Scroll up or down to view the drawers within the current frame.

Note that, in Figure 51 on page 143, Frame A contains NVMe cards as well as FICON and FCP adapter cards. If the system has one or more IBM Adapter for NVMe1.1 features, the frame display also indicates the current location of any installed NVMe carrier card. Although you can view NVMe cards in the page display, you cannot configure them.

After configuring FICON or FCP adapter cards, the next step is to configure the FICON storage devices in the SAN that are or will be connected to the DPM system, such as disk storage subsystems, fabrics, and switches. (Do not define tape libraries as part of the FICON connections in this step; DPM generates the required connections to tape storage through tape links instead.) As it does for adapter cards in an I/O drawer, the **Configure Storage** task also provides a simplified, visual approach to building a replica of FICON storage devices in the SAN.

The **Configure FICON Connections** page of the **CONNECT TO STORAGE** wizard provides a basic visual layout of the storage configuration, along with hover help to guide you through the process of defining a replica of the storage hardware that is or will be connected to the system. This configuration can contain at most two physical sites where storage devices are located. The primary site is always where the DPM-enabled system is physically located.

Highlighted controls on this page make it easy to add more storage subsystems, fabrics, and switches to match the physical hardware configuration of the SAN. Links within the boxes open windows through

which you define the connections between specific devices. After you define these connections, lines in the display indicate which devices are connected, and the number of connections.

If the DPM-enabled system is not yet physically attached to SAN hardware through cables, DPM provides several automated options for this configuration process; for example, storage administrators have the option of having DPM select port connections. However, if the system is already cabled, you need to supply information that reflects the physical connections that are already in use.

As you progress through the **CONNECT TO STORAGE** wizard, DPM generates the virtual configuration that is required to connect the system to the physical SAN hardware; this virtual configuration is equivalent to the contents of an Input/Output Configuration Program (IOCP) file for the system. Completing the **CONNECT TO STORAGE** wizard produces the following results:

- Fully configured adapter cards on the DPM-enabled system.
- Fully enabled FICON connections that link the system to physical elements in the SAN.
- An exportable file of an FCP and FICON adapter cabling plan that you can use to physically connect the system to SAN hardware. The file is in Comma Separated Values (CSV) format that you can view in a spreadsheet application. For a sample file, see Appendix B, “Sample System Cabling Plan,” on page 187.

Integrated requests and notifications

System administrators and storage administrators work together to connect a system to storage, and to create and fulfill storage groups for partitions to use. The **Configure Storage** task provides integrated controls to help you collaborate with co-workers. For example, if you do not have authorization or need help to complete the initial storage setup for a system, you can click a button to invite a storage administrator to complete the configuration.

To facilitate the collaboration between system administrators and storage administrators, DPM automatically generates detailed requests for system administrators to send, and provides inline notification of results when the storage administrator has fulfilled the request. For integrated requests and notifications, storage administrators (recipients) must have an email address associated with their user IDs, and Simple Mail Transfer Protocol (SMTP) settings must be defined. Users who send email through the **Configure Storage** task do not require an assigned email address because DPM can generate one based on the user name, but the suggested practice is to assign email addresses for senders as well, so recipients know which person sent the email.

To take advantage of the integrated requests and notifications, your installation must define email addresses for users, and set up the Simple Mail Transfer Protocol (SMTP).

- For information about setting up email addresses, see “Authorizing users of the Configure Storage task” on page 151.
- For information about setting up SMTP, see the online help for the **Monitor System Events** task.

Access to FICON and FCP disk storage through storage groups

Administrators use the **Configure Storage** task to configure access to Fibre Connection (FICON) extended count key data (ECKD) direct-access storage devices (DASD), and Fibre Channel Protocol (FCP) Small Computer System Interface (SCSI) disk storage devices.

After the initial storage configuration is complete and the system is connected to physical storage hardware by cables, system administrators can enable partitions to access and use those resources by creating storage groups. A *storage group* is a logical group of storage volumes that share certain attributes. One attribute is the type; another is shareability, which indicates whether the storage group is defined as either dedicated for use by only one partition, or shared by multiple partitions.

To create a storage group, open the **Configure Storage** task and select one of the following options: **REQUEST STORAGE** or **CREATE STORAGE GROUP**. (The option that you can select depends on the authorization of your user ID.) Using this task does not require extensive knowledge of mainframes or LinuxONE systems; however, a storage administrator must fulfill any requests for storage. You can create

one or more storage groups through a single request by defining one storage group and specifying the number of duplicates.

When you submit a request for one or more storage groups, DPM automatically generates the world wide port names (WWPNs) that are allocated to virtual storage resources when the storage group is attached to a partition. Also, DPM automatically generates a request that you can send as email to one or more storage administrators to fulfill through the storage subsystem management interface.

To access storage, attach one or more storage groups to a partition, through either the **New Partition** task or **Partition Details** task. Figure 52 on page 145 shows several storage groups with key attributes, and information about the physical devices that an administrator has configured to fulfill them.

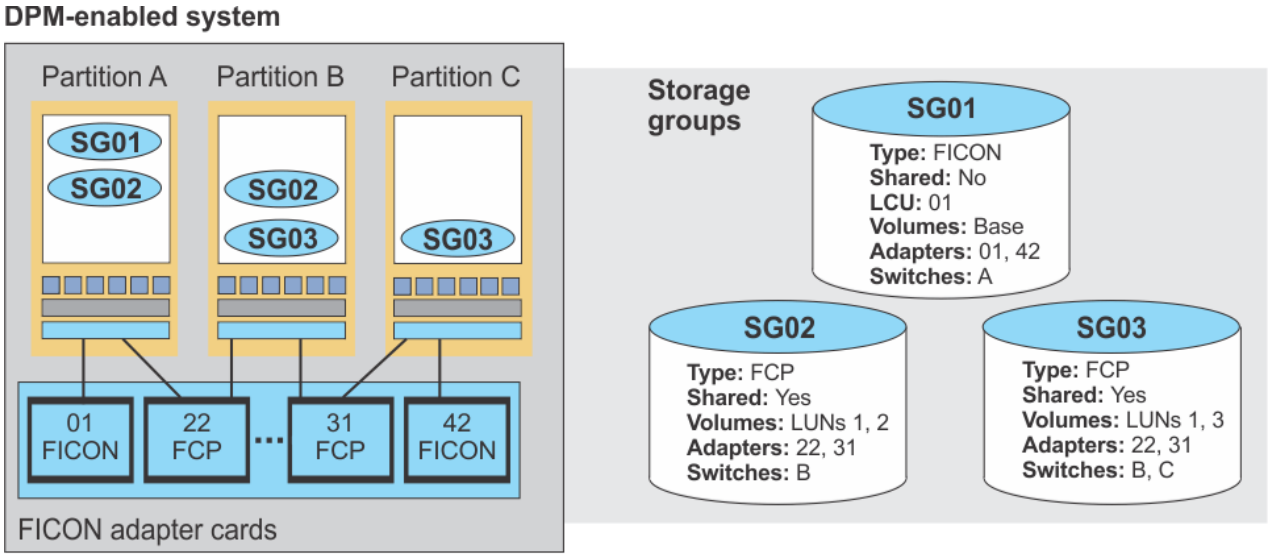

Figure 52. Sample FICON and FCP storage groups that are attached to partitions on the system

In Figure 52 on page 145, the ovals in the partitions indicate which storage groups are attached to each partition.

- Partition A can access storage group SG01, which consists of a set of FICON base volumes that are dedicated for use by only one partition. Partition A accesses these volumes through FICON-mode adapter card 01 and switch A.
- Partitions A and B share storage group SG02, which consists of FCP disks that both partitions can access through FCP-mode adapter card 22 and switch B.
- Similarly, partitions B and C share storage group SG03, which consists of FCP disks that both partitions can access through FCP-mode adapter card 31 and cascaded switches B and C.

Access to FCP tape storage through tape links

Administrators use the **Configure Storage** task to configure access to Fibre Channel Protocol (FCP) Small Computer System Interface (SCSI) tape storage devices. After system adapters are configured as FCP mode, and the system is connected to physical storage hardware by cables, system administrators can enable partitions to access and use those resources by creating tape links.

A *tape link* defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN. These connection attributes include storage resources such as system adapters, world wide port names (WWPNs), and the number of partitions that can share the connection. This connection is ready for use after the storage administrator completes zoning tasks through tools for managing SAN switches. *Zoning* is the process of grouping two sets of WWPNs into one zone: the host WWPNs for the system and the target WWPNs for the tape drives in a tape library. This grouping enables communication between the system and the tape library, while preventing communication with other systems or SAN devices.

To create a tape link, select **REQUEST TAPE LINK** or **CREATE TAPE LINK**. (The option that you can select depends on the authorization of your user ID.) Creating a tape link can be as easy as providing a name for the tape link, and checking the default value for the number of connecting paths. In this case, the storage administrator selects the tape library and the system adapters to use for the tape link.

Figure 53 on page 146 provides a graphical illustration of the physical and logical resources that are required for a tape link, and the process flow for requesting or creating one.

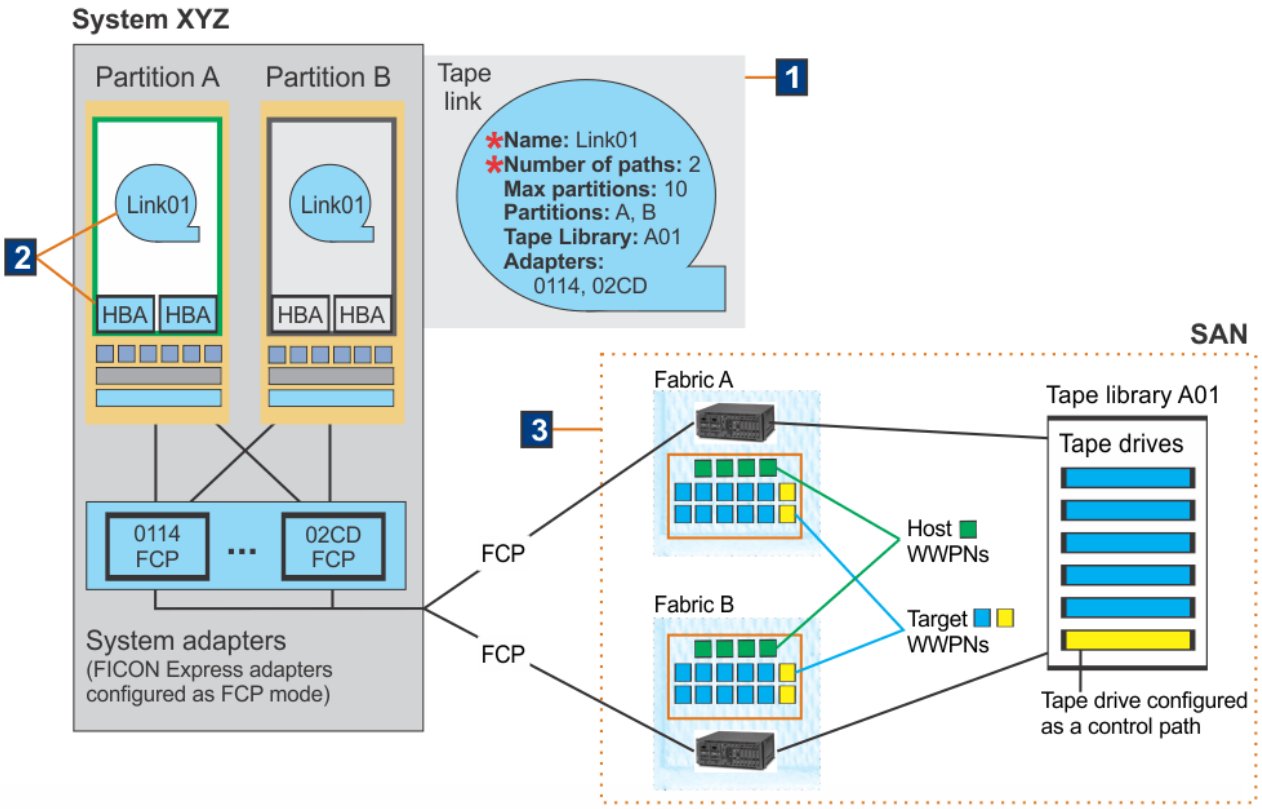

Figure 53. A tape link connects one or more partitions to one FCP tape library in the SAN

In Figure 53 on page 146:

1. You can request or create a tape link by providing a name for the tape link, and checking the default value for the number of connecting paths. You can change this value to increase the number of connecting paths (decreasing the value to 1 is possible, but not a suggested practice).

   If you want additional control over the resources, you can optionally select specific partitions to which DPM attaches your tape link; set the maximum number of partitions that share the tape link; select a tape library; and select the system adapters.

   If you select a tape library, DPM preselects adapters that are connected to the tape library already, and that provide optimal redundancy. Optimal redundancy for adapters is based on the following factors, which are listed in priority order from highest to lowest: on the location in the I/O drawers, on the drawer domain, on the current allocation, and on the connection to SAN fabrics. (If no adapters meet those criteria, DPM assigns placeholders for the storage administrator to select.)

   After you confirm your request:

   - DPM automatically generates the WWPNs that storage administrators use to fulfill the tape link request.
   - DPM also generates zoning instructions for the storage administrators who receive the request.
2. After you send your request, DPM creates the tape link, sets its fulfillment state to Pending, and starts to run automated background checks every 10 minutes to determine when the required storage

resources for this tape link are available. In these background checks, DPM tries to detect the tape drives (logical units or LUNs) for the WWPNs that are assigned to this tape link.

Also, if you selected any specific partitions as part of your request, DPM asynchronously attaches the tape link to those partitions, automatically generating the virtual host bus adapters (HBAs) that the partitions need for access to the tape library. This attachment process might take some time, depending on the status and number of the selected partitions. The attachment to stopped partitions is relatively quick, but attachment to active partitions can take longer because driving dynamic I/O updates takes some time.

3. To complete the connection from the system to the tape library, the storage administrator uses the generated instructions to configure the SAN devices. To properly configure a tape link connection to a tape library, the storage administrator:
   - Selects the tape library and the number of tape drives that are accessible through the tape link.
   - Ensures that one tape drive in the library is configured as a control path.
   - Zones the host and target WWPNs in each fabric.

Depending on the zoning and the status of assigned resources, the fulfillment state for the tape link can change to Complete, Incomplete, or Pending with mismatches. Only when the fulfillment state of the tape link changes to Complete, DPM performs dynamic I/O operations to complete the connection to the tape library for started partitions, such as Partition A. For stopped partitions, such as Partition B, DPM performs dynamic I/O operations only when the stopped partition is started.

More information about fulfillment states is available through the **Tape Link details** page and its associated online help; this information includes possible user actions to resolve potential problems. To access the **Tape Link details** page, go to the **Storage Overview** page, scroll to the Tape Links table, and select the table row of the tape link that you want to review.

Access to NVMe storage through storage groups

Administrators use the **Configure Storage** task to view any installed Non-Volatile Memory Express (NVMe) storage adapters, which are available on IBM LinuxONE (LinuxONE) systems only. Each NVMe adapter consists of two pieces of hardware: an IBM-supplied carrier card installed in a system I/O drawer, and the solid state drive (SSD) that customers purchase. IBM service representatives install the NVMe SSDs in the carrier cards after the system is delivered to the customer site.

Through **Connect Storage** and **Storage Cards** in the **Configure Storage** task, you can view NVMe adapters in the visual display of system frames and I/O drawers, and view specific details about each adapter; for example, you can tell whether the carrier card has an SSD installed. You cannot use this task to reconfigure NVMe storage adapters; reconfiguration requires properly removing the carrier card and its SSD from the drawer and reinstalling them in a different physical location, as instructed by a service representative. However, you can download an exportable file of the NVMe adapter plan, which lists details about the installed adapters. The file is in Comma Separated Values (CSV) format that you can view in a spreadsheet application. For a sample file, see Appendix C, “Sample NVMe adapter plan,” on page 189.

System administrators can enable partitions to access and use NVMe storage by creating one or more NVMe storage groups, and attaching them to the partitions.

- To create an NVMe storage group, open the **Configure Storage** task and select one of the following options: **REQUEST STORAGE** or **CREATE STORAGE GROUP**. (The option that you can select depends on the authorization of your user ID.)
  - You can create a storage group containing one or more available NVMe SSDs that are installed in carrier cards. You can define these SSDs as either boot or data volumes. You can create only one NVMe storage group at a time.
  - Because NVMe storage groups do not require the involvement of a storage administrator, DPM automatically creates the storage group, which is immediately ready for use.
  - Note that you cannot use a template to define an NVMe storage group.

- To enable partitions to access NVMe storage, use the **New Partition** task or **Partition Details** task to attach available NVMe storage groups. You can attach one or more NVMe storage groups, and select an SSD volume in an attached NVMe storage group as the boot volume for an operating system or hypervisor. If you plan to boot an operating system or hypervisor from a volume in an NVMe storage group, check the product documentation for the operating system or hypervisor to make sure that it supports booting from NVMe storage.

  Only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared. A partition that has attached NVMe storage groups can also have attached FICON and FCP storage groups, and FCP tape links.

Storage group templates

To make storage requests even easier to complete, administrators can create a template for requesting a FICON or FCP storage group. Templates can reflect typical usage patterns (production, staging, test); standardize storage for specific user groups; or document company requirements or restrictions that might be in place for storage use.

With templates in place, users can select an available template and, with minimal changes, quickly submit a request for a new storage group. They can modify the template contents. (Note that you cannot use a template to define an NVMe storage group.)

To create and manage storage templates, you can use a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role. You also can use the default SERVICE user ID, but using a customized user ID is the suggested practice. When you open the **Configure Storage** task, the options displayed on the **Configure Storage** page depend on the authorization of your user ID. To work with templates, select **REQUEST STORAGE**, **CREATE STORAGE GROUP**, or **MANAGE TEMPLATES**.

Automatic detection and assignment of FICON and FCP adapters

DPM automatically discovers any adapters that are installed in the processor frame, and assigns names to them, using a default naming convention. When you use the **Configure Storage** task to configure the installed FICON Express adapter cards, DPM highlights only the slots containing an adapter card that you can use for connections to storage devices.

- When you enter the number of FICON or FCP cards to be configured, DPM automatically selects a combination of the unconfigured cards to satisfy the request. This combination is *redundant*; that is, the configured cards of each type are spread across domains and drawers to ensure availability, in case of a card or drawer failure. You can override these selections by selecting the appropriate protocol label in each card: FICON or FCP. Selecting NONE resets the adapter card to the unconfigured state. Depending on the type of adapter card and its cabling, you might not be able to change the protocol through these labels. For these adapter card types, the protocol labels are disabled.
- If the DPM-enabled system is not yet physically attached to SAN hardware through cables, DPM provides several automated options for configuring the FICON connections to storage devices in the SAN. For example, when you are defining the adapter ports that connect a system to switches or storage subsystems, you can select the Auto-connect icon () to have DPM automatically configure redundant ports.

When you use the **Configure Storage** task to create a FICON or FCP storage group, DPM automatically assigns configured FICON or FCP adapters to the storage group. In prior DPM releases, you had to directly assign adapters through the **New Partition** or **Partition Details** task. In contrast, with DPM R3.1 or later releases, adapters are assigned through the storage group, when you attach it to a partition. For FCP storage groups only, you have the opportunity to change the assigned adapters when you attach an FCP storage group to a partition. FCP adapter reassignment is available through the **Partitions** tab in Storage Group details in the **Configure Storage** task, and the **Storage** section of the **New Partition** and **Partition Details** tasks.

Device number allocation for FICON storage groups

When you create a request for a dedicated or shared FICON storage group, you have the option of assigning device numbers to the requested volumes. If you do not assign device numbers, DPM automatically assigns them when the storage group is attached to a partition.

At that time, DPM looks for device numbers that are already in use by existing partitions, if any, and avoids assigning any conflicting numbers.

Storage Overview and details

The **Configure Storage** task includes a storage overview through which you can view information about all of the storage groups on a DPM-enabled system.

The **Storage Overview** page includes the Storage groups table, which contains one row for each storage group, and the Tape links table, which contains one row for each tape link. To view more details about a specific storage group or tape link, click anywhere in a table row to open the Storage Group details page or Tape Link details page. The fulfillment state indicates whether the storage group or tape link is available for use.

If no storage groups or tape links exist, the table includes a selectable tile through which you can request or create a new storage group or tape link.

Depending on the permissions that are associated with your user ID, you can select actions (such as modify or delete) for a specific storage group or tape link. The connection report for a selected FCP or FICON storage group can be useful for diagnosing configuration problems. Similarly, the **ENVIRONMENT** tab display on the Tape Link details page can also pinpoint zoning problems and other connection errors.

Chapter 22. Setting up storage resources for the first time

When your company orders a system with the required DPM features, IBM service representatives install the system and enable DPM, so it is ready for use when the system is powered on. Administrators use the **Configure Storage** task to initially configure the devices in the storage area network (SAN) that are or will be connected to the DPM system.

The following topics provide more information about planning for and using the **Configure Storage** task to set up storage resources for a DPM-enabled system.

Authorizing users of the Configure Storage task

Use this procedure to create a new user for a system administrator who can also perform functions that are usually restricted to storage administrators. This new user has access permissions to all functions that are available through the **Configure Storage** task. When you create a new user, you can assign an email address so the new user can, if necessary, participate in the request, invitation, and notification functions that are integrated into the **Configure Storage** task.

Before you begin

Log in to the HMC with the default ACSADMIN user ID, or a user ID defined through the **User Management** task with equivalent permissions.

About this task

To open the **Configure Storage** task, administrators can use a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role. You also can use the default SERVICE user ID, but using a customized user ID is the suggested practice.

Some functions in the **Configure Storage** task require the use of the Storage Administrator Tasks and Storage Administrator Objects roles. For access to all functions in the **Configure Storage** task, log in with a user ID that is authorized to the task through either the predefined System Programmer Tasks role plus the Storage Administrator Tasks and Objects roles, or an equivalent customized role. Also, object access permission to all storage adapters is required to configure storage cards, and object access permission to all FICON adapters is required to configure FICON connections.

Procedure

1. In the HMC navigation pane, select **HMC Management** or **Tasks Index** and select the link to open the **User Management** task.

   The User Management dashboard is displayed.
2. Select the New User action icon.

   The New User wizard opens to the Welcome page.
3. Select **Next** to open the Name page, and complete the following steps.

   a) For Create Option, select **New**.

b) For User Details, provide a name and optional description. The suggested practice is to also specify an email address in the **Email address** field, so the new user can participate in the request, invitation, and notification functions that are integrated into the **Configure Storage** task.

c) Select **Next** to go to the next page.

4. On the Authentication page, select an authentication type and provide any additional required details. Then select **Next** to go to the next page.
5. On the Roles page, select the following storage administrator roles.
   - Storage Administrator Objects
   - Storage Administrator Tasks
   - System Programmer Tasks

   By default, selecting these roles gives the new user permission to all subtasks available through the **Configure Storage** task, as well as permission to the required object types, such as Defined CPC, FCP Storage Group, FICON Adapter, and so on.
6. Select **Next** to go to the next page.
7. On the Summary page, review the information for the new user, and select **Finish**.

Results

The new user has the task and role permissions that are required to complete all actions that are available through the **Configure Storage** task. The new user also can send or receive requests or invitations, and receive notifications about work that has been completed through the **Configure Storage** task.

Connecting a system to external storage devices in the SAN

Review this topic to become familiar with the steps in the **Connect to Storage** wizard, through which administrators set up the initial storage configuration for a DPM-enabled system. When you use the **Connect to Storage** wizard, it provides hover help to guide you through the process of defining a replica of the storage hardware in the storage area network (SAN) that is or will be connected to the system. If you need more guidance, detailed instructions are available through the online help for the **Configure Storage** task.

For connections to tape storage in the SAN, use the **CONNECT TO STORAGE** wizard only to define system adapters as FCP adapters. Do not define FCP tape libraries as storage subsystems in the FICON Connections section of the wizard. Instead, create a tape link, which defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN. For more information, see “Requesting tape storage for partitions to use” on page 160.

Before you start the initial storage configuration

Before you open the **Configure Storage** task on the HMC, review the following information.

- DPM automatically discovers any adapters that are installed in the processor frame, and assigns names to them, using a default naming convention. Consider using the **Manage Adapters** task to review the installed storage card adapters, and make any adjustments that might be necessary.
- For integrated requests and notifications, storage administrators (recipients) must have an email address associated with their user IDs, and Simple Mail Transfer Protocol (SMTP) settings must be defined.
  - For information about setting up email addresses, see “Authorizing users of the Configure Storage task” on page 151.
  - For information about setting up SMTP, see the online help for the **Monitor System Events** task.
- To open the **Configure Storage** task, you must have a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role. You also can use the default SERVICE user ID, but using a customized user ID is the suggested practice. Also, object access permission to all storage adapters is required to configure storage cards, and object access permission to all

FICON adapters is required to configure FICON connections. For instructions to authorize users, see "Authorizing users of the Configure Storage task" on page 151.

- If the system has one or more IBM Adapter for NVMe1.1 features, you cannot configure those adapters through this task, but you can view them: DPM detects any NVMe carrier card and its solid state drive (SSD) and displays them in the frames and drawers where they are installed. From the **Configure Storage Cards** page, you also can download an exportable file of the NVMe adapter plan, which lists details about the installed adapters. The file is in Comma Separated Values (CSV) format that you can view in a spreadsheet application.

An overview of the initial FCP and FICON storage configuration process

When you open the **Configure Storage** task, DPM detects whether the storage configuration has been started; if not, the **Connect to Storage** wizard opens automatically.

This configuration process does require administrators to know high-level information about the physical elements of the SAN, such as the names of storage subsystems, the types of devices and communication protocols, intended use, and so on. This information is usually available through a system plan for the company's physical IT site. Starting with the system plan, system and storage administrators use the **Connect to Storage** task to define the initial FCP and FICON storage configuration, which consists of the following activities.

Step 1. Define storage adapter cards as FCP or FICON mode

The first task is defining the protocol of theFICON Express adapters that are installed in the system I/O drawers. DPM automatically detects the installed adapters, which you can define as either FICON or FCP devices. Based on the number of cards that you specify, DPM automatically selects a combination of the unconfigured cards, but you can override these selections, if necessary. Figure 54 on page 153 shows a partial **Configure Storage Cards** page that contains the visual representation of one I/O drawer with FCP, FICON, and unconfigured storage adapter cards. Blank slots are either empty or contain other types of adapter cards (for example, network or crypto adapter cards). Red dots indicate the most recent changes to storage adapter cards in the drawer.

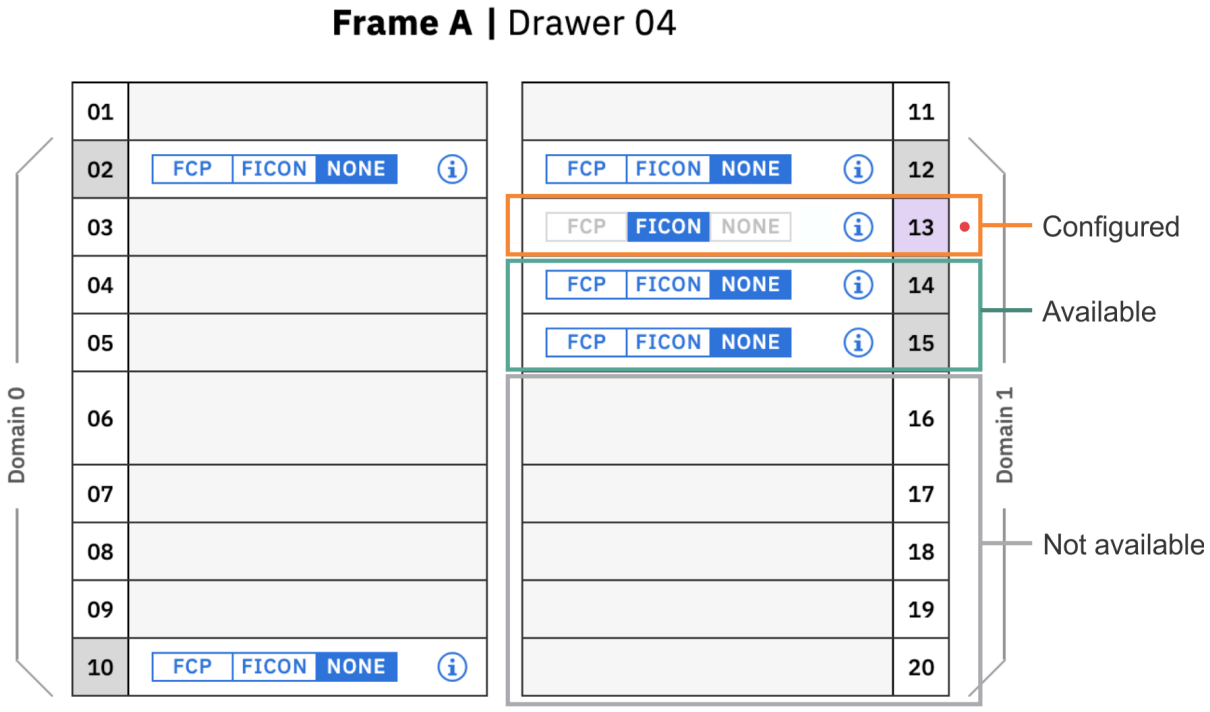

*Figure 54. Sample frame and card display on the **Configure Storage Cards** page*

Depending on the configuration of the system, the I/O drawers with storage adapter cards can be spread across multiple frames. For multiple-frame systems, the **Configure Storage Cards** page

provides an interactive overview map through which you can easily navigate between frames to view the I/O drawers and cards installed in the system. Red dots in the overview map indicate recent changes to a specific frame that contains an I/O drawer with storage adapter cards.

Step 2. Build a visual copy of the SAN hardware configuration

The second task is building a visual copy of the storage hardware devices in the SAN and their FICON connections to this system. This configuration can contain at most two physical sites where storage devices are located. The primary site is always where the DPM-enabled system is physically located. (**Reminder:** in this step, do not define any FCP tape libraries as storage subsystems.)

System administrators can define physical elements, such as switches, fabrics, and disk storage subsystems, but storage administrators are required to define port connections and logical control units (LCUs). If you invite a co-worker to help finish the configuration, DPM automatically generates an invitation that you can send to one or more storage administrators.

If the DPM-enabled system is not yet physically attached to SAN hardware through cables, DPM provides several automated options for this configuration process; for example, storage administrators have the option of having DPM select port connections. However, if the system is already cabled, you need to supply information that reflects the physical connections that are already in use.

Planning considerations for your SAN configuration

Use the following information for planning purposes. Note that these details are also available in the online help for the **Configure Storage** task.

Suggested practice for configuring storage adapter cards

On the **Configure Storage Cards** page, you configure FICON Express adapters as either FICON or FCP mode by either specifying a number of each mode type, or configuring each card manually. The suggested practice is to specify numbers of each type, so that DPM automatically selects a combination of the unconfigured cards to satisfy your request. This combination is *redundant*; that is, the configured cards of each type are spread across domains and drawers to ensure availability, in case of a card or drawer failure. You can override these selections by selecting the appropriate protocol label in each card: FICON or FCP. Selecting NONE resets the adapter card to the unconfigured state. Depending on the type of adapter card and its cabling, you might not be able to change the protocol through these labels. For these adapter card types, the protocol labels are disabled.

How many adapters you specify depends on your system plan; for example, if this system is expected to host test rather than production workloads, you might specify fewer adapter cards. Redundancy might be less important for a test workload, as well.

Conventions and maximums for configuring FICON connections

On the **Configure FICON Connections** page, you need to define the storage hardware that is or will be connected to this DPM-enabled system. The hardware that you define on this page must match the planned or actual configuration of storage subsystems and switches in the SAN.

Note: Starting with DPM R5.2, the user interface for defining system connections to SAN hardware is redesigned to include defining connections for use with FICON CTC partition links. For an overview of the new design, see Chapter 17, “Configuring FICON connections for use with FICON CTC partition links,” on page 127.

- As you provide names for physical storage elements, note that supported characters are alphanumerics, blanks, periods, underscores, dashes, or at symbols (@). Names cannot start or end with blank characters.
- Add physical storage elements to the primary site and, optionally, to a secondary site. To create the secondary site, you can clone the primary site any time after you add the first storage subsystem or switch to the primary site. DPM duplicates the primary site subsystems, fabrics, and switches, along with adapter ports and LCUs, but you must provide unique names and IDs for the storage subsystems and switches.
- Your SAN configuration can consist of point-to-point (direct) connections or switch connections, but not both.

- Fabric names must be unique among fabrics, and cannot exceed 32 characters. Switch IDs must be unique within a fabric, and consist of hexadecimal values in the range 01 - EF. You can create a maximum of 256 fabrics per site, and a maximum of 239 switches per fabric.

  The suggested practice is to define all fabrics as high integrity fabrics. A high integrity fabric is configured to use 2-byte link addresses, rather than 1-byte link addresses.

  – If you define a fabric as high integrity, you must ensure that the physical switches are configured to use 2-byte link addresses. A high integrity fabric is required when you configure cascaded switches.
  – Note that, after you save the FICON configuration, you cannot modify the high integrity fabric setting when LCUs are in use for switches in the fabric. If you need to modify the high integrity fabric setting, you must first remove all of the paths from the LCUs that are using that fabric, and then modify the high integrity fabric setting. After modifying the setting, you can restore the paths by adding them back to the LCUs.
- Storage subsystem names must be unique among storage subsystems, and cannot exceed 64 characters. You can create a maximum of 256 storage subsystems per site.
- For availability, connect each storage subsystem or switch to at least two adapter ports, each of which resides in a different frame and domain of the system.
- For availability, the suggested practice is to connect each storage subsystem to at least one switch per fabric, and at least two ports on each switch. You can define a maximum of 64 connections to switches on each subsystem. When you select adapter ports to connect the system to storage subsystems or switches, you can have DPM automatically select and balance connections for availability.
- LCU numbers must be unique within the storage subsystem; valid values are in the range 00 - FF. You can specify a maximum of 256 LCUs per storage subsystem. You can specify up to a combined total of 256 base and alias volumes for one LCU. When you add LCUs, DPM automatically selects paths to maximize redundancy and to reduce common points of failure.

Results of using the Connect to Storage wizard

Using the **Connect to Storage** wizard produces the following results:

- Fully configured adapter cards on the DPM-enabled system.
- Fully enabled FICON connections that link the system to physical elements in the SAN.
- An exportable file of an FCP and FICON adapter cabling plan that you can use to physically connect the system to SAN hardware. The file is in Comma Separated Values (CSV) format that you can view in a spreadsheet application. For a sample spreadsheet, see Appendix B, “Sample System Cabling Plan,” on page 187.

What to do next

- Use the **Request Storage** task to define storage resources, known as storage groups, for partitions to use. For more information, see “Requesting FICON or FCP storage for partitions to use” on page 155.
- If you need to modify this initial storage configuration at a later time, open the **Configure Storage** task and, depending on what you need to change, select **STORAGE CARDS** or **FICON CONNECTIONS**. Before making any modifications, review the planning considerations in “Modifying the storage configuration of the system” on page 178.

Requesting FICON or FCP storage for partitions to use

Review this topic to prepare for using the **Request Storage** task to create FICON or FCP storage groups for use by partitions on a DPM-enabled system. You can access the **Request Storage** task by selecting **REQUEST STORAGE GROUP** or **CREATE STORAGE GROUP** in the **Configure Storage** task. (The option that you can select depends on the authorization of your user ID.) Using this task does not require extensive knowledge of mainframes or LinuxONE systems; however, a storage administrator must fulfill

any requests for storage. If you need more guidance when you use this task, see the detailed instructions that are available through the online help for the **Configure Storage** task.

Before you create the request for a storage group

- If you want to request Non-Volatile Memory Express (NVMe) storage, see the topic "Requesting NVMe storage for partitions to use" on page 159.
- If you want to request access to FCP tape storage, see "Requesting tape storage for partitions to use" on page 160.
- Before you can successfully request storage, physical storage hardware (subsystems, switches, and so on) must be connected by cables, and storage cards must be configured.
- For integrated requests and notifications, storage administrators (recipients) must have an email address associated with their user IDs, and Simple Mail Transfer Protocol (SMTP) settings must be defined.
  - For information about setting up email addresses, see "Authorizing users of the Configure Storage task" on page 151.
  - For information about setting up SMTP, see the online help for the **Monitor System Events** task.
- To open the **Configure Storage** task, you must have a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role. You also can use the default SERVICE user ID, but using a customized user ID is the suggested practice. For instructions to authorize users, see "Authorizing users of the Configure Storage task" on page 151.

An overview of the Request Storage process for FCP and FICON storage groups

To request storage for partitions to use, you define one or more FCP or FICON storage groups. A *storage group* is a logical group of storage volumes that share certain attributes. FCP storage groups can be shared by multiple partitions, and multiple storage groups can be attached to one partition.

You can define FCP or FICON storage groups with or without the use of a template. By creating templates, administrators can predefine storage group attributes and volumes for one or more FCP or FICON storage groups. Templates can reflect typical usage patterns (production, staging, test); standardize storage for specific user groups; or document company requirements or restrictions that might be in place for storage use. You can select an available template and, with minimal changes, quickly submit a request for a new storage group.

The following steps describe the process of creating a storage group with or without the use of a template. Note that templates are based on the storage group type: FCP or FICON. An administrator can create one or more templates for each type, even if no storage adapter cards of that type are configured for the system.

Step 1. Specify the attributes for the storage group

On the **Specify Storage Attributes** page, define the attributes for the storage group.

- **Type:** FICON or FCP. This setting represents the type of storage devices that the storage group can use, and also controls the other attributes or default settings that are displayed on this page.
- **Shareability:** Shared or Dedicated. If you select **Dedicated**, then only one partition is able to use this storage group. If you select **Shared**, specify the number of partitions that can share this storage group. The maximum number of partitions is set automatically to the system limit.
- **Connectivity:** The the number of paths to be available for use by each operating system with access to this storage group. The number of paths that you can define varies, depending on the storage group type. For FCP, the limit is the total number of adapters that are configured as FCP on the system; for FICON, the limit is the number of adapters that are configured as FICON on the system, up to a maximum of eight. The number that you select affects overall bandwidth, performance, and redundancy.
- **Optimized for 2nd level virtualization**: Select this attribute when you want to enable the direct assignment of host bus adapters (HBAs) so an operating system or its guests can access an

FCP storage group. DPM distributes additional HBAs as equally as possible, taking into account both fabrics and adapters that will be assigned to this storage group, as indicated through the Connectivity attribute setting.

Although the controls in the **Configure Storage** task allow you to select this attribute only for a dedicated (not shared) FCP storage group, you can optimize 2nd level virtualization for separate partitions so they can share the same storage disks. For more information, see "Optimize 2nd level virtualization and share the same FCP disks across partitions" on page 158.

Step 2. Specify the size and type of each volume to be added to the storage group

On the **Add Storage Volumes** page, specify the size and type of each volume to be added to the storage group. If you are using a template for this storage request, the table on this page might contain predefined volumes that you can modify. Otherwise, this page initially contains a table heading with controls for defining a volume. The information you provide for this step varies, depending on the type of storage group: FCP or FICON.

1. For FCP, provide the capacity in gibibytes (GiB); for FICON, select a predefined model or custom size, and DPM automatically fills in the appropriate values for GiBs and cylinders.
2. For both FCP and FICON storage group volumes, specify the type as either **Data** or **Boot**.
3. Optionally, for FICON volumes only, you can assign device numbers. The suggested practice is to have DPM automatically assign device numbers to avoid conflicts; in this case, DPM assigns device numbers only when the storage group is first attached to a partition.
4. Optionally, you can provide a description of the FCP or FICON volume, and duplicate it by specifying the number of copies that you want.

Step 3. Name the storage group and, optionally, specify duplicates

On the **Name and Duplicate** page, specify the name of your new storage group. Optionally, provide a description and, if you want to easily duplicate the storage group, enter the number of duplicates and modify the names as necessary. For the name of the storage group, specify a value that is 1 - 64 characters in length. Supported characters are alphanumerics, blanks, periods, underscores, dashes, or at symbols (@). Names cannot start or end with blank characters. The name must uniquely identify the storage group from all other storage groups that are defined for this system.

If you request any duplicates, DPM uses the storage group name that you provided, and appends an underscore and sequential number to give each duplicate a unique name. You can edit the name of any duplicate, but all names must be unique.

Step 4. Send the storage group request to a storage administrator for fulfillment

DPM automatically generates a storage request for each storage group that you have requested. If your installation has configured SMTP, you can fill in the name of one or more storage administrators and submit the request. Otherwise, you can download or copy the generated request and send it to one or more storage administrators.

Results of using the Request Storage task

When you submit your request for one or more storage groups, DPM automatically generates the world wide port names (WWPNs) that are allocated to virtual storage resources when the storage group is attached to a partition.

After your request is received, the storage administrator uses storage management tools to select and configure the physical storage volumes that fulfill your request.

- For an FCP storage group, DPM periodically checks for the requested volumes, and updates their fulfillment status on the **Storage Overview** tab of the **Configure Storage** task. When the storage administrator completes the configuration through tools for managing storage subsystems, DPM changes the storage group status to Complete.
- For a FICON storage group, the storage administrator not only completes the configuration through tools for managing storage subsystems, but also maps the base volumes (which were created on the storage subsystem to fulfill your request) to volumes that you requested for the storage group. DPM changes the storage group status to Complete only after the volumes have been mapped through the

Map Volumes action in the **Configure Storage** task. The **Map Volumes** action is accessible only through the **Storage Details** page for a FICON group, and is accessible only to storage administrators who are using the default STORAGEADMIN user ID, or a user ID with equivalent permissions.

What to do next

- You can create another storage group or select **GO TO STORAGE OVERVIEW** to view the status of the requested storage groups. If you are viewing a page in the **Configure Storage** task when the fulfillment status for the storage group changes to Complete, you receive an online notification.
- If you have defined boot and data volumes that are the same size, and your storage administrator fulfills your storage request with a preinstalled boot volume, you need to make sure that the correct volume is identified as the boot volume. Using the preinstalled boot volume ID that you receive from your storage administrator, go to **Storage Overview**, select the storage group to open the Storage Group details page, look up the volume ID on the **VOLUMES** tab, and make sure that the type for the preinstalled volume is Boot. If it is not, select the **Modify** icon to change the volume type.
- Use the **Partition Details** task to attach one or more storage groups to an existing partition, or attach them when you create a new partition through the **New Partition** task. You can attach storage groups that are not fulfilled yet; however, DPM issues a warning if you try to start a partition or apply changes to an existing partition before the storage group is fulfilled. Although the partition can be started, the operating system and applications that run on it might not function properly because some storage is not available until the fulfillment status for the storage group changes to Complete.

Optimize 2nd level virtualization and share the same FCP disks across partitions

When you request storage for partitions to use, you can select the **Optimized for 2nd level virtualization** attribute when you want to enable the direct assignment of host bus adapters (HBAs) so an operating system or its guests can access an FCP storage group. Although the controls in the **Configure Storage** task allow you to select this attribute only for a dedicated (not shared) FCP storage group, you can optimize 2nd level virtualization for separate partitions so they can share the same storage disks.

For example, suppose that you have created two partitions, ZVM1 and ZVM2, in which you plan to install z/VM to host multiple Linux images, and you want both of these partitions to share the same set of 10 storage volumes. To accomplish this goal, you need to request two different FCP storage groups, and request that your storage administrator configure the same logical unit numbers (LUNs) in the storage controller for the two storage groups. To do so, perform the following steps.

1. Open the **Configure Storage** task and, depending on your user ID authorization, select either **REQUEST STORAGE** or **CREATE STORAGE GROUP**.
2. On the **Specify Storage Attributes** page, define the attributes for the storage group.
   - For **Type**, select FCP.
   - For **Shareability**, select Dedicated.
   - For **Connectivity**, specify the number of paths to be available for use by each operating system with access to this storage group.
   - Select **Optimized for 2nd level virtualization**, and specify the number of additional connections (HBAs) that can be assigned directly to the operating system or its guests.

   Select **NEXT** to continue.
3. On the **Add Storage Volumes** page, specify the capacity and type of volumes that you require. For this example, define 10 storage volumes. When you have finished defining the volumes, select **NEXT** to continue.
4. On the **Name and Duplicate** page:
   a. Provide a name for the first storage group; for example, FCP-STORAGE-1.
   b. Enter 1 as the number of duplicates and select **DUPLICATE**.
   c. Provide a unique name for the second storage group; for example, FCP-STORAGE-2.

d. Select **NEXT** to continue.

5. On the **Confirm** page, review the summary of your storage request; then select **NEXT** to continue.
6. Review the automatically generated storage request, and add instructions for the storage administrator to configure the same logical unit numbers (LUNs) in the storage controller for both storage groups. Then send it to one or more storage administrators for fulfillment.

   For FCP storage groups, DPM periodically checks for the requested volumes, and updates their fulfillment status on the **Storage Overview** tab of the **Configure Storage** task. When the storage administrator completes the configuration through tools for managing storage subsystems, DPM changes the storage group status to Complete.
7. Attach the storage groups and start the partitions. Note that you can perform these tasks before the storage groups are fulfilled.

   a. Open the **Partition Details** task for partition ZVM1, and go to the **Storage** section to attach FCP storage group FCP-STORAGE-1. Save your changes and close the task.

   b. Open the **Partition Details** task for partition ZVM2, and go to the **Storage** section to attach FCP storage group FCP-STORAGE-2. Save your changes and close the task.
8. Use the **Start** task to start the ZVM1 and ZVM2 partitions.

Requesting NVMe storage for partitions to use

Review this topic to prepare for using the **Request Storage** task to create a Non-Volatile Memory Express (NVMe) storage group for use by a partition on a DPM-enabled system. NVMe storage is available only when the system has one or more IBM Adapter for NVMe1.1 features. Depending on the authorization of your user ID, you can access the **Request Storage** task by selecting **REQUEST STORAGE** or **CREATE STORAGE GROUP** in the **Configure Storage** task. If you need more guidance when you use this task, see the detailed instructions that are available through the online help for the **Configure Storage** task.

Before you create an NVMe storage group

- If you want to request FICON or FCP disk storage, see the topic "Requesting FICON or FCP storage for partitions to use" on page 155.
- If you want to request access to FCP tape storage, see "Requesting tape storage for partitions to use" on page 160.
- To request a storage group through the **Configure Storage** task, you can use a customized user ID with authorization to the task, or a customized user ID with the System Programmer Tasks role. You can also use the default SERVICE user ID, but using a customized user ID is the suggested practice.
- If you plan to boot an operating system or hypervisor from a volume in an NVMe storage group, check the product documentation for the operating system or hypervisor to make sure that it supports booting from NVMe storage.
- If you plan to boot an operating system, hypervisor, or dump program from an NVMe SSD volume, note that NVMe namespace management is not supported, so you can boot programs only from namespace ID=1.

An overview of the procedure for creating an NVMe storage group

In contrast to FICON and FCP adapters that provide access to external storage devices in the storage area network (SAN), NVMe storage adapters provide high-speed storage within a system. Each NVMe adapter consists of two pieces of hardware: an IBM-supplied carrier card installed in a system I/O drawer, and the solid state drive (SSD) that customers purchase. IBM service representatives install the NVMe SSDs in the carrier cards after the system is delivered to the customer site.

To request NVMe storage for partitions to use, you define one or more storage groups that contain one or more SSD volumes. The following steps describe the process of creating an NVMe storage group.

Step 1. Specify the SSD volumes to add to the storage group
On the **Add Storage Volumes** page, review the entries in the Available Volumes table to determine which NVMe SSDs to add to the storage group. For each volume, the table includes the following information:

CAPACITY
Indicates the size of the SSD volume in gibibytes (GiB).

SERIAL NUMBER
Specifies the serial number of the SSD volume.

LOCATION
Specifies the physical location of the NVMe carrier card in the I/O drawer of the system.

Step 2. Optionally, change the attributes of each SSD volume
In the Available Volumes table, you can change the type, specify a device number, or enter a description of each volume that you want to add to the storage group.

- For Type, select either **Data** or **Boot**. Select **Boot** only if this volume is to contain bootable programs, such as the image of the operating system to be installed in a partition. You can specify only one type for each volume, but you can define more than one volume of each type for the storage group.
- Enter a unique, four-digit hexadecimal device number in the range 0001 - ffff for this volume; otherwise, DPM automatically assigns a device number when the storage group is first attached to a partition. To avoid conflicts, the suggested practice is to have DPM automatically assign device numbers.

Step 3. Add the SSD volume to the storage group
Select **ADD** in the table row of each SSD that you want to add to the NVMe storage group. After you select an SSD, the SSD entry moves to the Volumes to be added table.

Step 4. Name the storage group
On the **Name and describe** page, specify the name of your new storage group. Optionally, provide a description. For the name of the storage group, specify a value that is 1 - 64 characters in length. Supported characters are alphanumerics, blanks, periods, underscores, dashes, or at symbols (@). Names cannot start or end with blank characters. The name must uniquely identify the storage group from all other storage groups that are defined for this system.

Step 5. Create the storage group
On the **Confirm and create** page, review the summary of your storage group. When you are satisfied with the details on the **Confirm and create** page, select **CREATE** to create the NVMe storage group.

Results of using the Request Storage task for an NVMe storage group

DPM creates the NVMe storage group and changes the screen display to the **Storage Overview**, where you can view the new storage group in the list. Note that the fulfillment state is Complete so the new storage group is ready for use.

What to do next

- Use the **Partition Details** task to attach one or more storage groups to an existing partition, or attach them when you create a new partition through the **New Partition** task. Only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared.
- You can view and modify the details of the NVMe storage group and its volumes through the **Storage Group details** page in **Storage Overview**. Note that the modifiable attributes (type, device number, and description) specified for any NVMe SSD volume persist, even after you delete the volume from the storage group, or delete the storage group itself.

Requesting tape storage for partitions to use

Review this topic to prepare for creating a tape link for use by partitions on a DPM-enabled system. Depending on the authorization of your user ID, select **REQUEST TAPE LINK** or **CREATE TAPE LINK** to provide access for partitions to one FCP tape library in the storage area network (SAN). If you need more

guidance when you use this task, see the detailed instructions that are available through the online help for the **Configure Storage** task.

Before you create a tape link

- If you want to request FICON or FCP disk storage, see the topic "Requesting FICON or FCP storage for partitions to use" on page 155.
- If you want to request Non-Volatile Memory Express (NVMe) storage, see the topic "Requesting NVMe storage for partitions to use" on page 159.
- For information about using this task to manage tape libraries, see "Viewing and managing FCP tape libraries" on page 179.
- Before you can successfully request or create a tape link, physical storage hardware (subsystems, switches, and so on) must be connected by cables, and storage cards must be configured. If the **REQUEST TAPE LINK** or **CREATE TAPE LINK** option is disabled, none of the system adapter cards are configured as FCP. Select **STORAGE CARDS** to view and configure the available system adapters.
- For integrated requests and notifications, storage administrators (recipients) must have an email address associated with their user IDs, and Simple Mail Transfer Protocol (SMTP) settings must be defined.
  - For information about setting up email addresses, see "Authorizing users of the Configure Storage task" on page 151.
  - For information about setting up SMTP, see the online help for the **Monitor System Events** task.
- For **REQUEST TAPE LINK**, you can use a customized user ID with authorization to the task, or a customized user ID with the System Programmer Tasks role. You can also use the default SERVICE user ID, but using a customized user ID is the suggested practice..
- For **CREATE TAPE LINK**, you need a customized user ID with the System Programmer Tasks role, plus the Storage Administrator Tasks and Objects roles.

An overview of the procedure for creating a tape link

A *tape link* defines the attributes of a connection that one or more partitions can use to access one FCP tape library in the SAN. These connection attributes include storage resources such as system adapters, world wide port names (WWPNs), and the number of partitions that can share the connection. This connection is ready for use after the storage administrator completes zoning tasks through tools for managing SAN switches.

Creating a tape link can be as easy as providing a name for the tape link, and checking the default value for the number of connecting paths. In this case, the storage administrator selects the tape library and the system adapters to use for the tape link. The following steps describe how to create a tape link that has more attributes than the name and number of connecting paths.

Step 1. Specify the tape link name and optional description

On the **Name and partitions** page, specify the name of your new tape link and an optional description.

Tape link name

For the name of the tape link, specify a value that is 1 - 64 characters in length. Supported characters are alphanumerics, blanks, periods, underscores, dashes, or at symbols (@). Names cannot start or end with blank characters. The name must uniquely distinguish this tape link from all other tape links that are defined for this system.

Description (optional)

For the optional description, use up to the maximum of 200 characters.

Step 2. Optional: select partitions and set the maximum number of partitions

On the **Name and partitions** page, select partitions to which you want the tape link attached, or define the maximum number of partitions that can attach the tape link, or both.

- To identify the partitions to which you want DPM to attach the tape link:

1. Select **SELECT PARTITIONS** to open a dialog through which you can view details about available partitions on the system: the partition name; its current status (Active, Stopped, and so on); and the user-supplied description, if any.
2. Use the check box to select each partition, then select **ADD** to close the dialog and populate the partitions table on the **Name and partitions** page.

- To set the maximum number of partitions to which the tape link can be attached, use the spinner or type the number that you want to set as the maximum. If you select partitions to attach the tape link, this number adjusts to match the number of selected partitions.

  The maximum value can exceed the number of selected partitions, if any; however, the maximum value cannot exceed the system limit for concurrently active partitions. The text for this field indicates the limit for concurrently active partitions on your system.

Step 3. Optional: select a tape library
On the **Library and paths** page, select a tape library. To select a tape library, select an entry for a specific library in the Tape library list. If no tape libraries are shown, or you do not select a specific tape library, the storage administrator selects a tape library when fulfilling your request for the tape link.

Step 4. Check the number of connecting paths for the tape link
On the **Library and paths** page, decide whether to change the default number of connecting paths from the system to the tape library in the SAN. This connectivity setting has an impact on bandwidth, performance, and redundancy.

- The default value is 2, which you can change by using the "Number of connecting paths" slider, text entry field, or spin button.
- The maximum value is set to the number of system adapters that are currently configured as FCP adapters.

You can also select specific system adapters to use for this tape link.

- When you select a tape library, DPM preselects adapters that are connected to the tape library already, and that provide optimal redundancy. Optimal redundancy for adapters is based on the following factors, which are listed in priority order from highest to lowest: on the location in the I/O drawers, on the drawer domain, on the current allocation, and on the connection to SAN fabrics. (If no adapters meet those criteria, DPM assigns placeholders for the storage administrator to select.)
- You can use **Advanced path settings** to exchange any assigned adapters with other available adapters, to select an available adapter to fill in a placeholder row, or to replace an assigned adapter with a placeholder row. If you decide to select adapters yourself, note that the number of system adapters must match the number of connecting paths. For the best results, try to assign adapters that reside in different system I/O drawers and in different domains; that are not on the same card; and that are connected to different fabrics. Inline messages provide warnings if the selected adapters do not meet these criteria.

Step 5. Send the storage group request to a storage administrator for fulfillment
Depending on the authorization of your user ID, DPM automatically generates email that you can either send to a storage administrator for fulfillment, or use as a reminder of the zoning tasks that you need to complete for this tape link. Depending on the SMTP configuration, you can either make use of the integrated email and notifications, or download the generated request to send it manually.

Results of creating a tape link

DPM creates the FCP tape link, changes the screen display to the **STORAGE OVERVIEW** page, and displays a message confirming that the requested tape link was created. In the Tape Links table, the fulfillment state for the tape link remains as Pending until the following conditions are met:

- The storage administrator completes the configuration through tools for managing SAN switches. Note that, depending on the zoning and the status of assigned resources, the fulfillment state for the tape link can change to Complete, Incomplete, or Pending with mismatches.

- DPM asynchronously attaches the tape link to the partitions, if any, that you selected as part of your tape link request. This attachment process might take some time, depending on the status and number of the selected partitions. The attachment to stopped partitions is relatively quick, but attachment to active partitions can take longer because driving dynamic I/O updates takes some time.

  Only when the fulfillment state of the tape link changes to Complete, DPM performs dynamic I/O operations to complete the connection to the tape library for started partitions. For any stopped partition, DPM performs dynamic I/O operations only when the stopped partition is started.

What to do next

- To view more details about a specific tape link, click anywhere in a table row to open the Tape Link details page.
- To view, discover, or remove tape libraries from the DPM environment, select **REQUEST TAPE LINK** or **CREATE TAPE LINK**. For more information, see "Viewing and managing FCP tape libraries" on page 179.
- If you did not select any specific partitions as part of your tape link request, use the **Partition Details** task to attach one or more tape links to an existing partition, or attach them when you create a new partition through the **New Partition** task. Through those tasks, you can view but cannot attach tape links that are in a pending fulfillment state (Pending or Pending with mismatches). For more information, see the online help for the appropriate task.

Chapter 23. Managing storage resources after the initial configuration is complete

After the initial storage configuration for the system is complete, and storage groups and tape links are available for partitions to use, you can use the **Configure Storage** task to modify the system configuration, or to view and modify storage groups or tape links. You can also use either the **New Partition** task or **Partition Details** task to attach storage groups or tape links to a partition, or use the **Configure Storage** task to attach tape links to a partition.

For overviews of specific storage management tasks, see the following topics.

- "Viewing and managing storage groups and tape links" on page 165
- "Attaching storage resources to a partition" on page 174
- "Modifying the storage configuration of the system" on page 178
- "Viewing and managing FCP tape libraries" on page 179

Viewing and managing storage groups and tape links

Review this topic to become familiar with the content of the **Storage Overview** and **Storage Group details** and **Tape Link details** pages, through which administrators can view and modify storage groups and tape links. More detailed information is available through the online help for the **Configure Storage** task.

At-a-glance view of storage: the Storage Overview page

Use the **Storage Overview** to view information about all of the storage groups and tape links that are defined for a DPM-enabled system.

Depending on the permissions that are associated with your user ID, you can select actions (such as modify or delete) for a specific storage group or tape link. The default STORAGEADMIN user ID (or users with equivalent permissions) can complete a storage request by mapping volumes for a FICON storage group through the **Storage Group** details page.

Storage Groups table

The Storage Groups table contains the following information about each storage group.

NAME
: Specifies the user-defined name of the storage group.

TYPE
: Specifies the type of storage group: FICON, FCP, or NVMe.

PARTITIONS
: Specifies the number of partitions to which the storage group is attached.

SHAREABLE
: Specifies whether the storage group can be shared among partitions, or whether it is dedicated to only one partition.

TOTAL CAPACITY
: Specifies the total amount of storage in gibibytes (GiBs) that is assigned to the storage group.

DESCRIPTION
: Specifies the user-provided description, if any, of this storage group. The description can be up to 200 characters in length.

FULFILLMENT STATE
: Identifies the current state of the storage group. DPM runs a background check of storage resources for FCP storage groups and, if necessary, changes the fulfillment state. These checks are more frequent (every 10 minutes) for fulfillment states other than Complete (every 24 hours).

Users can manually start a background check by selecting the **Connection Report** icon to open the Connection Report, and selecting the **Update report** icon.

ACTIONS
In any table row, select the ellipsis (•••) to display a selectable list of actions that you can take for the storage group. The listed actions vary, depending on the type of storage group, and on the permissions that are associated with your user ID.

Tape Links table
The Tape Links table contains the following information about each tape link.

NAME
Specifies the user-defined name of the tape link.

TYPE
Specifies the type of tape link: FCP.

PARTITIONS
Specifies the number of partitions to which the tape link is attached.

SHAREABLE
Specifies whether the tape link can be shared among partitions, or whether it is dedicated to only one partition.

TAPE LIBRARY
Specifies the serial number of the tape library that partitions can access through this tape link. If the value is "Not specified", the storage administrator has not yet selected a tape library for this tape link.

DESCRIPTION
Specifies the user-provided description, if any, of this tape link. The description can be up to 200 characters in length.

FULFILLMENT STATE
Identifies the current state of the tape link. DPM runs a background check of storage resources for FCP tape links and, if necessary, changes the fulfillment state. These checks are more frequent (every 10 minutes) for fulfillment states other than Complete (every 24 hours).

ACTIONS
In any table row, select the ellipsis (•••) to display a selectable list of actions that you can take for the tape link. The listed actions vary, depending on the permissions that are associated with your user ID.

The Storage Group details page

Use the Storage Group details page to view or modify information about a specific storage group on a DPM-enabled system. The Storage Group details page consists of a summary, a set of action icons, and tabbed sections that you can select to change the lower portion of the page display.

The actions that are displayed depend on the fulfillment state of the storage group, the type of storage group, and the authorization of the user who is accessing the Storage Group details page. DPM runs a background check of storage resources for FCP storage groups and, if necessary, changes the fulfillment state. These checks are more frequent (every 10 minutes) for fulfillment states other than Complete (every 24 hours). Users can manually start a background check by selecting the **Connection Report** icon, and selecting the **Update report** icon (↻). Users can download the report contents for FICON storage group in Comma Separated Values (CSV) format (view in a spreadsheet application), and the report contents for an FCP storage group in JavaScript Object Notation (JSON) format (view in a browser or text editor).

For specific fulfillment states, various summary fields, tabbed sections, and table entries have a pending, incomplete, or warning icon to alert you to details that might need your attention or action. The following list describes the fulfillment state values.

Checking migration
An existing DPM configuration was either upgraded on the same system, or migrated to another system that has DPM R3.1 or a later DPM version applied. This fulfillment state indicates that DPM is checking the logical and physical elements that support a storage group it created during a system migration or firmware upgrade process.

In some cases, this check detects a storage group that cannot be fulfilled because logical unit numbers (LUNs) are not visible. For such cases, the fulfillment state does not change from Checking migration. For DPM to recheck the storage group and change the fulfillment state, the storage administrator must fix the configuration in the storage subsystem, and an administrator must open the **Connection Report** and select the **Update report** icon.

For more details about the migration process, see the appropriate topic in Chapter 11, “Migrating DPM configuration data to a new system,” on page 101.

Complete
The storage group is ready for use.

Incomplete
One or more volumes or adapters that are used for a storage group are marked as incomplete. DPM periodically checks the availability of storage volumes or adapters for storage groups, so resources that were functioning properly can become incomplete.

The **VOLUMES** or **ADAPTERS** tab, and specific table entries for the tab display, are marked with the incomplete icon ( ).

Pending
A system administrator has sent a request to create or modify a FICON or FCP storage group, but the storage administrator has not finished fulfilling that request through tools for managing storage subsystems. When a creation, modification, or deletion request is in progress, the affected summary fields, section tabs, and table entries are marked with the pending icon ( ).

Pending with mismatches
For an FCP storage group, a system administrator sent a request to create or modify that storage group, and the storage administrator fulfilled that request, but with an amount of storage that does not exactly match the original request. For an NVMe storage group, as part of a repair, one or more NVMe SSDs were replaced with SSDs of a different size. The **VOLUMES** tab has a pending icon ( ) next to it, and the table rows for mismatched volumes are marked with a warning icon ( ).

The tabbed sections provide more details related to the storage group. The tabbed sections vary, depending on the type of storage group. Note that the pending icons (or), incomplete icon ( ), and warning icon ( ) indicate details that might require your attention or action.

The following list describes the tabbed sections on the Storage Group details page.

VOLUMES
The **VOLUMES** tab display varies, depending on the type of storage group. For an FCP or NVMe storage group, the tab displays a single table that lists all volumes associated with the storage group. For a FICON storage group, the tab displays two tables: Base Volumes and Alias Volumes. Depending on the volume type, the table display includes the following information: storage subsystem, volume ID or UUID, capacity, type, device ID, and a user-supplied description, if any. The table also includes a link through which you can view information that you need to enable a partition's operating system or installer to access a specific volume.

The **VOLUMES** tab display also varies depending on the current fulfillment state of the storage group. “The Storage Group details page” on page 166 lists the fulfillment states, describes the table display, and provides possible actions you might take to resolve any issues. Note that, in some cases, more than one type of pending request might be in effect.

Table 9. Effect of fulfillment status on the Volume tab display

Fulfillment state	Volume tab display	Possible action
Checking migration This fulfillment state indicates that DPM is checking the logical and physical elements that support a storage group it created during a system migration or firmware upgrade process.	The display contains an empty Volumes table.	When DPM completes the check, it changes the fulfillment state to Complete or Pending with mismatches. In some cases, this check detects a storage group that cannot be fulfilled because logical unit numbers (LUNs) are not visible. For such cases, the fulfillment state does not change from Checking migration. For DPM to recheck the storage group and change the fulfillment state, the storage administrator must fix the configuration in the storage subsystem, and an administrator must open the **Connection Report** and select the **Update report** icon ().
Complete This fulfillment state indicates that DPM has successfully detected all of the logical and physical elements that support the volumes in this storage group. Note that DPM can mark a FICON storage group as Complete even if some requested alias devices were not included because of device number conflicts with base volumes.	The display contains a table entry with complete information for all volumes in this storage group.	None. If alias volumes are excluded from a FICON storage group, scroll to view the Alias Volumes table; if some alias volumes were not included, an inline message prior to the table indicates the number of alias volumes that were excluded, and provides a link through which you can open a new window to view and resolve specific device number conflicts.
Incomplete This fulfillment state indicates that one or more volumes are incomplete. Volumes can be marked as incomplete under the following conditions. • When DPM can no longer detect them in the FICON configuration. • When DPM found a problem when checking the results of a system migration or firmware upgrade process to the DPM R3.1 storage management feature or a later release. • When DPM detects that an NVMe adapter has become degraded or the NVMe SSD was incorrectly removed from its carrier card.	An incomplete icon () is displayed in the table entry of each incomplete volume.	To diagnose the problem for an FCP or FICON storage group, select the **Connection Report** action icon (). When an NVMe storage group is marked as Incomplete, go to the **HISTORY** tab and check entries in the Actions table to find more details about the specific error. • You can remove the volume that is marked with the incomplete icon, but you do not need to take any action as long as the NVMe storage group contains other volumes that are usable. The Incomplete fulfillment status and incomplete icons continue to be displayed for the SSD until a repair is completed under the direction of a service representative. • If you do not remove the volume and the NVMe SSD in error is later reinstalled or replaced, DPM detects the repair, and either changes the fulfillment state to Complete or to Pending with mismatches. Note that, if the SSD in error is replaced by a different SSD, DPM automatically changes the serial number of the volume.

Table 9. Effect of fulfillment status on the Volume tab display (continued)

Fulfillment state	Volume tab display	Possible action
Pending (creation request) When a creation request is in progress, this fulfillment state indicates that some information in the volume table is not available yet.	A pending icon ( ) marks incomplete table rows until DPM provides the information.	In the case of a FICON storage group, a storage administrator must select the Map Volumes action icon ( ) and complete that task before DPM can complete the table.
Pending (modification request) This fulfillment state indicates that a modification request is in progress for one or more volumes.	A pending icon ( ) marks the table entries for volumes to be modified. The CAPACITY column indicates not only the current volume size, but also the pending change.	None. When the modification request is satisfied, the pending icons are removed, and the CAPACITY column values are updated to show only the modified size.
Pending (deletion request) This fulfillment state indicates that a deletion request is in progress for one or more volumes.	A pending icon ( ) marks the table entries for volumes to be deleted, and the values in those table entries are crossed out.	None. When the deletion request is satisfied, the table entries are removed from the display.
Pending with mismatches This fulfillment state indicates that DPM has detected changes to the number, size, or accessibility of volumes in the storage group. The following items describe the various conditions under which DPM assigns this fulfillment state to an FCP or NVMe storage group. 1. DPM detected more volumes for an FCP storage group than the number that was originally requested. 2. DPM detected the correct number of volumes in an FCP storage group, but the volume sizes are either larger or smaller than originally requested. 3. DPM detected a volume but that volume is not accessible through all of the worldwide port numbers (WWPNs) that are available for use with an FCP storage group. 4. As part of a repair, an NVMe SSD was replaced by an SSD with a larger or smaller capacity.	All of the mismatched volumes are displayed at the top of the table, enclosed in a box. A warning icon ( ) is displayed in the CAPACITY column of each mismatched volume. Both the previous and current sizes are shown in the CAPACITY column, along with a message that explains the mismatch.	• The first two conditions for an FCP storage group can be resolved by selecting either **REQUEST DELETION** to remove the volumes or **KEEP IN GROUP**. Use the check boxes to select the mismatched volumes that you want to keep or delete. Note that you can modify the type or description of these mismatched volumes, and these changes are saved when you select **KEEP IN GROUP**. • The third condition for an FCP storage group can be resolved only by a storage administrator, through the storage management subsystem; checking the connection report can help identify the errors that need to be corrected. • For a replacement NVMe SSD that is not the same size as the removed SSD, you can either keep the replacement SSD as a volume in the storage group, or modify the storage group to remove the replacement SSD or add different SSDs.

PARTITIONS

The **PARTITIONS** tab lists the partitions to which the storage group is attached. If necessary, you can select one or more partitions in the table and detach the storage group from them by selecting **DETACH STORAGE GROUP**. This action can be disruptive when the partitions are in Active state, are in Paused state, or are using a volume in the storage group as a boot volume. In such cases, a warning, error, or informational message is displayed and you are prompted to confirm the detachment. Note that only one partition can use an NVMe storage group at any given time; an NVMe storage group cannot be shared.

The Partitions table on this tab includes the following information: partition name, current status, and a user-supplied description, if any.

- For an FCP storage group only, each row in the Partitions table can be expanded to show details about the host bus adapters (HBAs) that the partition is using to access storage. If necessary, you can select **CHANGE ADAPTERS** to review the adapters assigned to a storage group and remove or replace them with other adapters that are available for use by a partition. You can change an adapter only when an HBA with a backing adapter is available.
- You also have the option of changing the device number for HBAs. If you change the device number, specify a four-character hexadecimal device number. For FICON storage groups, volume device numbers must be in the range 0000 - ffff, and must be unique within a storage group and across all attached partitions and partition resources.

ADAPTERS

The **ADAPTERS** tab lists the adapters that are assigned to the storage group. The adapter attributes include the name, ID, type, location, and current allocation.

- If adapters are not yet assigned, the **ADAPTERS** tab has a pending icon ( ) next to it, and the Adapters table is empty. The total at the foot of the Adapters table lists how many adapters are assigned to the storage group.
- If an existing adapter becomes incomplete, the **ADAPTERS** tab has an incomplete icon ( ) next to it, and the table entry for that adapter is highlighted with the incomplete icon. If one or more adapters are incomplete, the fulfillment status of the storage group is Incomplete.

WWPN (displayed for FCP storage groups only)

The **WWPN** tab lists the worldwide port numbers (WWPNs) that are available for use. This tab is displayed only for an FCP storage group. The tab display contains two tables: one table that lists each WWPN that is in use by a partition, and one table that lists unused WWPNs. The tables include the following information: the WWPN, its current state and, if the WWPN is in use, the name of the associated partition and host bus adapter (HBA).

HISTORY

The **HISTORY** tab lists the actions that users have taken for this storage group. The most recent action is listed at the top of the History table. Information in the ACTION column not only briefly describes the activity, but also preserves details such as requests that were sent to storage administrators for fulfillment.

- When the storage group is attached to one or more partitions, some changes that are made to the storage group can require corresponding changes on the operating system that the partition hosts. In this case, use the link in the ACTION column entry to display a list of required updates.
- If the storage group is deleted, you can access the history details only for the next 30 days, by using the HMC Web Services API for DPM.

The Tape Link details page

Use the Tape Link details page to view or modify information about a specific tape link on a DPM-enabled system. The Tape Link details page consists of a summary, a set of action icons, and tabbed sections that you can select to change the lower portion of the page display. You also can use this page to delete a tape link, or to resend a zoning request.

The actions that are displayed depend on the fulfillment state of the tape link and the permissions that are associated with your user ID. DPM runs a background check of storage resources for FCP tape links and, if necessary, changes the fulfillment state. These checks are more frequent (every 10 minutes) for fulfillment states other than Complete (every 24 hours). In these background checks, DPM tries to detect the tape drives (logical units or LUNs) for the WWPNs that are assigned to this tape link. Users can manually start a background check by selecting the **Update tape link environment** icon ( ) on the **ENVIRONMENT** tab.

For specific fulfillment states, note that various summary fields, tabbed sections, environment elements, and table entries have a pending, incomplete, warning, or error icon to alert you to details that might need your attention or action.

The following list provides a summary of each fulfillment state. For more details about fulfillment states and possible actions that you can take to correct errors or mismatches, see Table 10 on page 171.

Complete
All of the storage resources listed in a create or modify request are available, properly configured and zoned, and DPM detects only those resources.

Incomplete
One or more storage resources for the tape link are marked as incomplete because the resource is missing, or in an error or degraded condition. Because DPM periodically checks the availability of storage adapters, switches, and tape libraries that are in use for a tape link, resources that were functioning properly can become incomplete.

Pending
One or more requested storage resources are not yet available or zoned correctly, or the tape link is not yet attached to all partitions that were specified in the original create request or a modify request.

Pending with mismatches
DPM detects system adapters that do not match the original create request or a modify request. Either the number of system adapters does not match the number of connecting paths, or the detected adapters do not match specific adapters that were assigned to the tape link.

The tabbed sections provide more details related to the tape link. Note that the following icons indicate details that might require your attention or action: pending icons (or), and incomplete icons ( ).

The following list describes the tabbed sections on the Tape Link details page.

ENVIRONMENT
The **ENVIRONMENT** tab displays the current zoning and other information about the system adapters, SAN fabrics and switches, the tape library and tape drives for an FCP tape link. You can update (or refresh) the display, which includes a 24-hour timestamp for the last update, in the format `yyyy.mm.dd hh:mm:ss`.

Table 10. Interpreting the ENVIRONMENT tab display for different tape link fulfillment states

Fulfillment state	ENVIRONMENT tab display	Possible action
Complete All of the storage resources listed in a create or modify request are available, properly configured and zoned, and DPM detects only those resources.	The display contains complete icons ( ) next to the three section headings, and connections between the elements are shown as solid black lines.	None.

Table 10. Interpreting the ENVIRONMENT tab display for different tape link fulfillment states (continued)

Fulfillment state	ENVIRONMENT tab display	Possible action
Incomplete The following conditions cause the fulfillment state for a tape link to be Incomplete. • One or more system adapters are unreadable, in an error state, or no longer detected. • An error occurred, or an unrequested reconfiguration of storage resources in the SAN affects the requested resources. • The storage administrator has not configured a tape drive as the control path to the requested tape library. For a tape link environment to be properly configured, all adapters that use the same fabric must have access through at least one control path to the same set of drives in the tape library. • The original tape link request included a specific library but a different library is detected, or more than one tape library is detected, through the current zoning. The tape link environment can include only one tape library. • The tape library can no longer be reached due to an error with cables or with the tape library itself.	The display contains incomplete icons () next to any section heading or individual elements (adapters, fabrics, or tape library) for which DPM detected an error. Also, connections between elements with errors are shown as solid red lines, with a slash (/) indicating where the connection is broken because of the error. If the errors are detected for system adapters or host WWPNs, an error icon is displayed next to the **ADAPTERS** or **WWPNS** tabs.	Hover your cursor over any incomplete icon to view more information about the specific error condition. • If an adapter is in error, go to the **ADAPTERS** tab and select the adapter name to open the Adapter Details page in the **Manage Adapters** task. The adapter details can determine how you can resolve the error. The simplest fix is replacing the adapter in error with a different available adapter, which you can do by selecting **Modify**. • If the errors are due to zoning in the SAN fabrics, cable or optic errors, multiple tape libraries, or errors with the tape library itself, select **Resend request** to notify one or more storage administrators so they can take the appropriate action.

Table 10. Interpreting the ENVIRONMENT tab display for different tape link fulfillment states (continued)

Fulfillment state	ENVIRONMENT tab display	Possible action
Pending One or more requested storage resources are not yet available or zoned correctly, or the tape link is not yet attached to all partitions that were specified in the original create request or a modify request. Remember that, for a tape link environment to be properly configured, all adapters that use the same fabric must have access through at least one control path to the same set of drives in the tape library. When the fulfillment state is Pending, DPM does not perform any dynamic I/O operations for partitions to which the tape link is attached.	The display contains pending icons ( ) next to any section heading or individual elements (adapters, fabrics, or tape library) when connections are expected but not yet available because of pending zoning or configuration tasks. • If zoning tasks are pending for system adapters or host WWPNs, a pending icon is displayed next to the **ADAPTERS** or **WWPNS** tab. • If the create or modify request included partitions to which the tape link is to be attached, and one or more asynchronous attachment processes are still in progress, a pending icon is displayed next to the **PARTITIONS** tab.	The Pending fulfillment state is generally a temporary state, but some tasks require time to complete. To determine whether those tasks are progressing, you can periodically select the **Update environment** button to refresh the tab display, and note the changes, if any. • If zoning tasks are pending for a longer time than you expect, you can select **Resend request** to remind one or more storage administrators of the pending tasks. • If tape link attachment operations are in progress, note that the attachment process might take some time, depending on the status and number of the selected partitions. The attachment to stopped partitions is relatively quick, but attachment to active partitions can take longer because driving dynamic I/O updates takes some time. If further investigation seems necessary, go to the **PARTITIONS** tab, view the partitions that are marked as pending, and select the partition name to open the **Partition Details** task.
Pending with mismatches DPM detects system adapters that do not match the original create request or a modify request. Either the number of system adapters does not match the number of connecting paths, or the detected adapters do not match specific adapters that were assigned to the tape link. When the fulfillment state is Pending with mismatches, DPM does not perform any dynamic I/O operations for partitions to which the tape link is attached.	The display contains pending with mismatches icons ( ) next to the Systems section heading, on one or more adapters in this section, and on the **ADAPTERS** tab. Also, connections between the mismatched system adapters, the SAN fabrics, and the tape library are shown as solid black lines.	You must resolve all of the mismatched adapters before you can make any other modifications to the tape link. You can resolve mismatches by modifying the assigned adapters. To do so, select **Resolve adapter mismatches** or the **Modify** icon for the tape link to change the page display to Modification mode.

PARTITIONS

The **PARTITIONS** tab lists the partitions to which the tape link is attached in table format. If the tape link has not been attached yet to one of the listed partitions, the **PARTITIONS** tab has a pending icon ( ), and another pending icon marks the table row for the specific partition.

To attach the tape link to more partitions, or to detach the tape link from one or more of the listed partitions, select the **Modify** icon for the tape link to change the page display to Modification mode. In this mode, you can change the maximum number of partitions to use the tape link, or

add or remove partitions from the Partitions table, which, in effect, starts tape link attachment or detachment operations when you save your changes.

For each partition, the Partitions table includes the name, which is a hyperlink through which you can open the **Partition Details** task; operating status; and description (if any). Each row in the Partitions table can be expanded to show details about the host bus adapters (HBAs) that the partition is using to access storage.

ADAPTERS
The **ADAPTERS** tab lists the system adapters that are either specified through the original create request for the tape link, or connected to the tape library for this tape link. The adapter attributes include the name, ID, type, location, and current allocation.

- If all adapters are not yet assigned, the **ADAPTERS** tab has a pending icon ( ) next to it, and the table entry for that adapter is marked with the same icon. The total at the foot of the Adapters table lists how many adapters are assigned to the tape link.
- If the adapters that are zoned do not match the adapters that were specified in the original create request, the **ADAPTERS** tab has a pending with mismatches icon ( ) and the tab display includes a table of Unrequested and zoned adapters, all of which are marked with the same pending with mismatches icon.

  Note: You must resolve all of the mismatched adapters before you can make any other modifications to the tape link. You can resolve mismatches by modifying the assigned adapters. To do so, select the **Modify** icon for the tape link to change the page display to Modification mode.
- If an existing adapter becomes incomplete, the **ADAPTERS** tab has an incomplete icon ( ) next to it, and the table entry for that adapter is marked with the same icon. You can replace such adapters through Modification mode.

WWPNS
The **WWPNS** tab lists the host worldwide port numbers (WWPNs) that are available for use. The tab display contains two tables: one table that lists each host WWPN that is in use by a partition, and one table that lists unused host WWPNs. The tables include the following information: the WWPN, its current state and, if the WWPN is in use, the name of the associated partition and host bus adapter (HBA).

HISTORY
The **HISTORY** tab lists the actions that users have taken for this tape link. The most recent action is listed at the top of the History table. Information in the ACTION column not only briefly describes the activity, but also preserves details such as requests that were sent to storage administrators for fulfillment. If the tape link is deleted, you can access the history details only for the next 30 days, by using the HMC Web Services API for DPM.

Attaching storage resources to a partition

Review this topic to become familiar with the steps to attach one or more storage groups or tape links to a partition on a DPM system. To attach a storage group or tape link to a partition, use either the **New Partition** task or the **Partition Details** task. For tape links, you can also attach a tape link to one ore more partitions through the **PARTITIONS** tab on the Tape Link details page; for more information, see the online help for the Tape Link details page in the **Configure Storage** task.

Before you attach a storage group or tape link to a partition

- To attach storage groups or tape links to an existing partition, use **Storage** section of the **Partition Details** task. To attach them to a new partition, use the Storage page or section of the **New Partition** task in basic or advanced mode. For a comparison of these modes, see “Selecting which New Partition task mode to use” on page 47.
- To open the **Partition Details** task or the **New Partition** task, use a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role.

- If the partition has or will have reserved resources, you can attach only fulfilled storage groups to it. To determine whether the partition has reserved resources, go to the General page of the **Partition Details** task or advanced-mode **New Partition** task, and look at the **Reserve resources** check box. (You cannot reserve partition resources through the basic-mode **New Partition** task.) After the storage groups are attached, no one can modify them.

An overview of the attachment process

The Storage section contains a Storage Groups table and a Tape Links table with controls that you can use to attach storage groups or tape links.

Step 1. Open the Attach Storage Groups or Attach Tape Links window
Select the plus icon in the table toolbar to open the **Attach Storage Groups** or **Attach Tape Links** window.

Step 2. Review and select one or more available storage groups
On the **Attach Storage Groups** window, select one or more storage groups listed in the Storage Groups table to attach to this partition.

- The suggested practice is to select storage groups that are in the Complete fulfillment state, but you can select any storage group except for those with a fulfillment state of Incomplete, or those that are already attached to the maximum number of partitions. If you do select groups in states other than Complete, some storage might not be available for use when you start the partition.
- Use the additional information in the Storage Groups table, as necessary, to decide which storage groups to attach. This information includes not only the storage group name, type, and fulfillment state, but also the number of partitions to which the storage group is already attached (if any), and the total capacity.

Step 2. Review and select one or more available tape links
On the **Attach Tape Links** window, select one or more tape links listed in the table to attach to this partition.

- The suggested practice is to select tape links that are in the Complete fulfillment state, but you can select any tape link except for those with a fulfillment state of Incomplete, or those that are already attached to the maximum number of partitions. If you do select links in states other than Complete, some storage might not be available for use when you start the partition.
- Use the additional information in the table, as necessary, to decide which tape links to attach. This information includes not only the tape link name and fulfillment state, but also the number of partitions to which the storage group is already attached (if any).

Step 3. Check the table entries for the storage groups or tape links that you selected
Check the entries for the storage groups or tape links that you selected, which are now displayed in the Storage Groups table or Tape Links table in the Storage section. If necessary, you can use the minus icon in the table toolbar to remove a storage group or tape link from the table.

- For FICON storage groups only, you can change the volume device numbers only when the device number input field is active. The factors that determine whether you can change the device number include not only the current state of the partition, but also whether the storage group is shared or dedicated, and whether it is already attached to other partitions.
- For FCP storage groups and FCP tape links only, you can expand the table entry to show the system-generated host bus adapters (HBAs) and their assigned adapters. You can change the device numbers that DPM automatically assigned to the HBAs when you selected the FCP storage group or FCP tape link. An error icon is displayed if you try to specify a device number that is already in use.
- For FCP storage groups only, the expanded display also includes a link through which you can open the FCP adapter assignment window, and remove or replace the adapters that DPM automatically assigned to the HBAs.

Step 4. Save the partition definition
When you have finished, review another section or click **OK** to save the partition definition.

Note that an operating system or hypervisor image can reside on a storage group volume; if you want to boot the image from a storage group, go to the Boot section of the **Partition Details** task or **New Partition** task. Choose the **Storage device (SAN)** boot option, and select a boot volume in an attached storage group.

Results of the attachment process

DPM saves the partition definition.

- For FCP or FICON storage groups, DPM generates the virtual storage resources (host bus adapters or FICON subchannels) that are required for partitions, and the operating systems that they host, to access the physical storage volumes in the SAN.
- For FICON storage groups, DPM assigns device numbers, avoiding conflicts with any other device numbers for network or crypto adapters.
- For FCP tape links, DPM asynchronously attaches each tape link to the partition, and generates the HBAs that are required for the partition, and its operating system, to access the physical tape library in the SAN. This attachment process might take some time, depending on the status of the partition. The attachment to stopped partitions is relatively quick, but attachment to active partitions can take longer because driving dynamic I/O updates takes some time.

  Only when the fulfillment state of the tape link changes to Complete, DPM performs dynamic I/O operations to complete the connection to the tape library for started partitions. For any stopped partition, DPM performs dynamic I/O operations only when the stopped partition is started.

What to do next

- If the partition is new or not active, use the **Start** task to start the partition.
- After starting a new partition or modifying the storage resources for an active or stopped partition, ensure that FICON and FCP storage groups are visible to the Linux operating system. The action you take depends on whether the partition is new (started for the first time), or existing (active or stopped). NVMe storage groups are automatically detected by the operating system, so you do not need to enter Linux commands to make that type of storage group available to the operating system. Similarly, the tape devices that are available through attached tape links are automatically detected by the operating system, so you do not need to enter Linux commands for tape devices either.

  For a new partition

  After you start the new partition, you might need to enter Linux commands to make the storage groups available to the operating system that the partition hosts. Typically, the operating system stores the FCP HBA or FICON volume configuration so it can automatically bring the devices online on the next reboot, so you need to take action only for the initial boot of the operating system.

  When attaching a storage group in Complete state

  – For an FCP storage group:

  - If the storage group contained the boot volume, the operating system brings online all of the HBAs for this storage group, and all volumes in the storage group are available. No action is required unless you have attached other storage groups.
  - If the storage group does not contain the boot volume, and the operating system is not configured to bring HBAs online automatically, you need to issue the **chccwdev** command to bring online all of the HBAs.

  – For a FICON storage group, the operating system brings online only the boot volume. You need to issue the **chccwdev** command to bring online all of the remaining volumes in the storage group that contains the boot volume, as well as the volumes in any other storage groups that you attached.

  When attaching an unfulfilled storage group that becomes Complete as the partition is running

  – For an FCP storage group:

- If adapters were assigned to HBAs while the partition is running, you need to use the **chchp** command to activate the channel paths for those new adapters.
- To access the volumes in the storage group, you need to issue the **chccwdev** command to bring online all of the HBAs.

– For a FICON storage group:

- If the adapters connecting the storage group to the storage subsystem were assigned while the partition is running, use the **chchp** command to activate the channel paths for those new adapters.
- All volumes are offline. You need to issue the **chccwdev** command to bring online all of the volumes in the storage group.

For an existing partition

If the partition is running, or when you restart a stopped partition, you might need to enter Linux commands to make any newly attached storage groups available to the operating system that the partition hosts. The actions required for FCP or FICON storage groups depend on the type and fulfillment state, and whether the storage group contained the boot volume for the operating system.

When attaching a storage group in Complete state when the partition is stopped

– For an FCP storage group:

- If the storage group contained the boot volume, the operating system brings online all of the HBAs for this storage group, and all volumes in the storage group are available. No action is required unless you have attached other storage groups.
- If the storage group does not contain the boot volume, and the operating system is not configured to bring HBAs online automatically, you need to issue the **chccwdev** command to bring online all of the HBAs.

– For a FICON storage group, the operating system brings online only the boot volume. You need to issue the **chccwdev** command to bring online all of the remaining volumes in the storage group that contains the boot volume, as well as the volumes in any other storage groups that you attached.

When attaching a Complete storage group to a running partition, or attaching an unfulfilled storage group that becomes Complete as the partition is running

– For an FCP storage group:

- If adapters were assigned to HBAs while the partition is running, you need to use the **chchp** command to activate the channel paths for those new adapters.
- To access the volumes in the storage group, you need to issue the **chccwdev** command to bring online all of the HBAs.

– For a FICON storage group:

- If the adapters connecting the storage group to the storage subsystem were assigned while the partition is running, use the **chchp** command to activate the channel paths for those new adapters.
- All volumes are offline. You need to issue the **chccwdev** command to bring online all of the volumes in the storage group.

To find the IDs that you need to use for the Linux commands, use the following tasks.

– HBA device numbers are available in the Host Bus Adapters (HBA) table when you expand the storage group table entry in the Storage section of the **Partition Details** task.

– Channel path IDs for FCP adapters are shown in the Host Bus Adapters (HBA) table when you expand the storage group table entry in the Storage section of the **Partition Details** task.

– Channel path IDs for FICON adapters are shown on the **ADAPTERS** tab of the Storage Group details; open the **Configure Storage** task and select the storage group in the **Storage Overview** to open the Storage Group details page.

- FICON volume device numbers are shown on the **VOLUMES** tab of the Storage Group details page; open the **Configure Storage** task and select the storage group in the **Storage Overview** to open the Storage Group details page.

Modifying the storage configuration of the system

After the initial storage configuration is completed, system and storage administrators can use the **Configure Storage** task to modify that configuration. Depending on what you need to change, open the task and select either **STORAGE CARDS** or **FICON CONNECTIONS**. These links open to pages that are almost identical to those of the **Connect to Storage** wizard, through which administrators initially configure storage for a DPM system. Note that you cannot use this task to configure Non-Volatile Memory Express (NVMe) storage adapters; reconfiguration requires properly removing the carrier card and its SSD from the drawer and reinstalling them in a different physical location, as instructed by a service representative.

Use the following information for planning purposes. Note that these details are also available in the online help for the **Configure Storage** task.

Planning considerations for modifying installed FCP or FICON storage adapter cards

The process of modifying installed storage adapters is very similar to Step 1 in "An overview of the initial FCP and FICON storage configuration process" on page 153.

- To use the **Configure Storage** task to modify storage adapter cards, open the task using a customized user ID with authorization to the task, or a customized user ID with the System Programmer Tasks role. You can also use the default SERVICE user ID, but using a customized user ID is the suggested practice Also, you must have object access permission to all storage adapters.
- Note that DPM does not allow the reconfiguration of any adapter card that is already in use.
  - An FCP adapter card cannot be reconfigured when it is in use by a storage group that is attached to a partition, regardless of the partition state; when it is in use by a tape link; or when it is used to reach a tape library. For an FCP adapter that cannot be reconfigured, you can determine which storage groups are using the adapter by completing the following steps:
    1. Select the information icon to open a display that contains a link to open the Adapter Details page.
    2. Select the link and review the Connections section to determine which storage groups or tape links are using the adapter.
  - A FICON adapter cannot be reconfigured when it provides a logical control unit (LCU) path to a switch or storage subsystem.

  FCP and FICON adapter cards that are in use are shown with disabled (gray) label selections for changing the current configuration.
- When you open the Storage Group details page for an FCP storage group, you can review the adapters assigned to a storage group and remove or replace them with other adapters that are available for use by a partition. However, if an FCP adapter is configured while the storage group is attached to an active partition, DPM cannot detect and list the new adapter as available for use by any partition. To make sure that you can choose a new adapter from a complete list of available adapters, use the instructions in "Instructions: Changing the adapters that are assigned to an FCP storage group" on page 77.

Planning considerations for modifying FICON connections

The process of modifying the visual copy of the storage hardware environment is very similar to Step 2 in "An overview of the initial FCP and FICON storage configuration process" on page 153. (**Reminder:** Do not define any FCP tape libraries as storage subsystems.)

Note: Starting with DPM R5.2, the user interface for defining system connections to SAN hardware is redesigned to include defining connections for use with FICON CTC partition links. For an overview of the new design, see Chapter 17, "Configuring FICON connections for use with FICON CTC partition links," on page 127.

- To use the **Configure Storage** task to modify FICON connections, open the task using a customized user ID either with authorization to the task, or with the predefined System Programmer Tasks role. You also can use the default SERVICE user ID, but using a customized user ID is the suggested practice. Also, you must have object access permission to all FICON adapters.
- If you need help to complete this configuration, you can use the **Invite** link on the **Configure FICON Connections** page to notify a co-worker about the remaining configuration tasks. DPM automatically generates an invitation that you can send, to which you can add your own greeting and more details, if necessary. For integrated invitations and notifications, users must have an email address associated with their user IDs, and Simple Mail Transfer Protocol (SMTP) settings must be defined.
  - Email addresses for users are assigned through the **User Management** task.
  - The SMTP server and port settings are defined through the **Monitor System Events** task.
- If you are modifying existing fabrics and switches, the following rules apply.
  - You cannot modify the high integrity fabric setting when LCUs are in use for switches in the fabric. If you need to modify the high integrity fabric setting, you must first remove all of the paths from the LCUs that are using that fabric, and then modify the high integrity fabric setting. After modifying the setting, you can restore the paths by adding them back to the LCUs.
  - You can delete a fabric from a site only when the fabric does not contain any switches.
  - You can delete a switch only when all of its existing connections (to an adapter port or to a storage subsystem) are not configured in any storage group.
  - You can disconnect a switch only when both of the following conditions are true.
    - No storage groups are using the switch port.
    - All LCUs that are using the switch port are not being used to fulfill a storage group.
- You can delete a storage subsystem from a site only when that storage subsystem does not contain any LCUs.
- If you are modifying existing adapter ports, note that you can disconnect an adapter port only when both of the following conditions are true.
  - No storage groups are using the adapter port.
  - All LCUs that are using the adapter port are not being used to fulfill a storage group.
- If you are modifying the paths for an existing LCU, the following rules apply.
  - Although you can add a path to or delete a path from an LCU that is being used by a storage group while it is attached to a partition, you cannot delete the last remaining path from an LCU that is in use.
  - You cannot add a path to an LCU in the primary site if doing so requires the use of a cascaded switch. Only the secondary site can have cascaded switches.

Viewing and managing FCP tape libraries

Use **REQUEST TAPE LINK** or **CREATE TAPE LINK** to view information about the tape libraries that are connected to this system. You can also use this task to send zoning instructions to storage administrators to start initial zoning, to update zoning, or to remove FCP tape libraries from the DPM environment.

Before you begin

- For **REQUEST TAPE LINK**, you can use a customized user ID with authorization to the task, or a customized user ID with the System Programmer Tasks role. You can also use the default SERVICE user ID, but using a customized user ID is the suggested practice.
- For **CREATE TAPE LINK**, you need a customized user ID with the System Programmer Tasks role, plus the Storage Administrator Tasks and Objects roles.

An overview of tape library actions

When you open the **Configure Storage** task and select either **REQUEST TAPE LINK** or **CREATE TAPE LINK**, the **Request tape link** or **Create tape link** page opens. The page display includes the FCP tape libraries table, which lists any tape libraries that DPM has discovered in the SAN. Above this table, the display includes either descriptive text or a time stamp indicating the last time, if any, that DPM discovered any correctly zoned FCP tape libraries. For discovered tape libraries, the table includes the tape library name (serial number), model, and state.

To display the table actions, select the ellipsis (•••) in the table header.

Start initial zoning
If the Tape libraries table is empty, select **Start initial zoning**, which causes DPM to generate an email with initial zoning instructions for a storage administrator. The instructions include the system management world wide port name (WWPN), which is a dedicated host WWPN that does not enable access to data in the tape library; its sole purpose is to enable DPM to discover (or detect) tape libraries in the SAN.

The instructions tell the storage administrator to complete the following zoning tasks in fabrics (switches) for *each* tape library to be connected to the system.

- Zone the system management WWPN with the target WWPN of at least one tape drive in the tape library.
- Configure the tape drive associated with the target WWPN as a control path.

When the initial zoning is complete, the time stamp and table content are updated.

Discover libraries
If the Tape libraries table has entries but does not list a specific tape library that you want find, or the time stamp is not recent, select **Discover libraries** to cause DPM to perform a one-time check of the current connections to tape libraries in the SAN. Depending on the number of system adapters that are defined as FCP storage adapters, and the number of target ports that are currently zoned, this discovery check could take some time.

Discover libraries is not available for selection until an administrator either requests initial zoning or requests a new tape link. When the **Discover libraries** check completes, the time stamp and table content are updated.

Available
At least one physical path reaches the tape library. (Note that you cannot delete a tape library that is in this state.)

Not available
No physical path, including the system management WWPN path, reaches the library. This state usually indicates a tape library that was correctly zoned and used for one or more tape links, but is no longer connected.

Remove libraries
To delete a tape library that you no longer want to use in your environment, use the following suggested procedure.

1. Delete all of the tape links that use the specific tape library. To delete tape links, you must have a user ID with the predefined System Programmer Tasks role, or an equivalent user ID with the same permissions.
   a. To quickly find a list of the tape links that you need to delete, go to **STORAGE OVERVIEW**, and sort the Tape links table rows by the value in the LIBRARY column.
   b. For each tape link to be deleted, check the **Tape Link details** page to determine whether any active partitions have attached the tape link. If so, use the **Stop** task to stop the active partitions.
   c. Select the **Delete** icon on the **Tape Link details** page to delete the tape link. The time required to successfully delete the tape link depends on the number of partitions that have attached the tape link.

d. Return to **STORAGE OVERVIEW**.

2. Select **REQUEST TAPE LINK** or **CREATE TAPE LINK** and use the **Remove libraries** action in the FCP tape libraries table to switch into table-edit mode. In this mode, a trash can icon is added to each table row.
3. Select the appropriate trash can icon to remove one or more tape libraries, and select **Save**. This action not only removes the table rows for the deleted tape libraries, but also results in an automatically generated email that contains instructions for a storage administrator to unzone the deleted libraries, including the system management WWPN.

Appendix A. DPM task and resource roles

Tasks and resources need to be made available or excluded based on the roles to which they are assigned. You may create your own specific task and resource roles which include specific tasks and resources; however, HMC user management provides default roles for your convenience. Appendix A, “DPM task and resource roles,” on page 183 identifies the DPM tasks along with default task roles. The table identifies the task roles in which a particular task is included. It also documents the resource roles that are required to complete a task.

The Details task has unique behavior with respect to roles. The Details task (view only) is always available for all resources accessible to a user ID. If a user ID has permission for the Details task, through an assigned task role, modifications may be made in the details task. Specific Details task permissions are assigned to default task roles as shown in Appendix A, “DPM task and resource roles,” on page 183.

For example consider user ID SIGMUND. SIGMUND has been given the Defined System Managed Objects resource role but not the System Programmer (SP) task role, which contains the Partition Details task. SIGMUND will still be able to launch details task for a partition, but the content of the task will be displayed read-only such that SIGMUND cannot modify to the resource.

All tasks that can be launched from the HMC workspace are marked in **bold**. Where there are both administrative and operator roles, such as SP and OP, any permissions given to the operator are also available for the administrator role. See Appendix A, “DPM task and resource roles,” on page 183 for the tasks mapping legend.

Table 11. DPM task roles mapping legend

Legend	Description
AA	Access Administrator Tasks
SP	System Programmer Tasks
OP	Operator Tasks
AOP	Advanced Operator Tasks
SER	Service Representative Tasks
SA	Storage Administrator Tasks
X	Required role to perform a task.
O	At least one of the roles is required to perform a task.
*	Denotes a task that is available through the Support Element (SE) only.

Table 12. DPM task roles mapping

DPM Tasks	Task Roles					
	AA	SP	OP	AOP	SER	SA
Configure Partition Links[1]						
- Create, modify, or delete a partition link		O			O	
- Attach a partition link to a partition		O			O	
- Detach a partition link from a partition		O			O	

Table 12. DPM task roles mapping (continued)

DPM Tasks	Task Roles					
	AA	**SP**	**OP**	**AOP**	**SER**	**SA**
Configure Storage		O			O	O[2]
- Create, modify, or delete a storage group or tape link		X				
- Attach a storage group or tape link to a partition		X				
- Detach a storage group or tape link from a partition		X				
- Change an HBA device number for an FCP storage group or an FCP tape link		X				
Delete Partition		O			O	
Disable Dynamic Partition Manager*					X	
Dump (Partition)		O	O	O	O	
Enable Dynamic Partition Manager*					X	
Getting Started with Dynamic Partition Manager	O	O	O	O	O	
Manage Adapters		O	O	O	O	
- Adapter Details		O			O	
- Create HiperSockets Adapter[4]		O			O	
- Delete HiperSockets Adapter[4]		O			O	
- Reassign Channel Path IDs		O			O	
- Reassign Devices[4]		O			O	
- Export WWPNs		O	O	O	O	
Manage Processor Sharing		O			O	
New Partition (basic mode)		O			O	
New Partition (advanced mode)		O			O	
- Controls		O			O	
Partition Details		O			O	
- Controls		O			O	
Start (start a single DPM system)		O			O	
Start (start one or more DPM partitions)		O	O	O	O	

Table 12. DPM task roles mapping (continued)

DPM Tasks	Task Roles					
	AA	**SP**	**OP**	**AOP**	**SER**	**SA**
Stop (stop a single DPM system)		O			O	
Stop (stop one or more DPM partitions)		O	O	O	O	
System Details		O			O	
- Configure System Management (OSM) Adapters* [3]					X	
- Manage Secure Execution Keys		O			O	
- Delete Secondary Secure Execution Key		X				

Table footnotes:

1. No specific authorization is required to open the **Configure Partition Links** task to the partition links overview.
2. During the initial storage setup for a DPM-enabled system, the storage administrator does not have access to the **Configure Storage** task until the system administrator configures storage cards for the system.
3. For machine type 3931 and later systems, OSM adapters are no longer required.
4. Starting with DPM R5.2, you cannot use these **Manage Adapters** tasks for HiperSockets adapters; instead, use the **Configure Partition Links** task to create, edit, and delete HiperSockets connections.

Appendix B. Sample System Cabling Plan

When you connect a system to storage by using the **Configure Storage** task, DPM creates an exportable file of an FCP and FICON adapter cabling plan that you can use to physically connect the system to SAN hardware. The file is in Comma Separated Values (CSV) format that you can view in a spreadsheet application.

The following sample shows the content of a CSV file. Note that the headings in the CSV file are all on a single line, instead of wrapping on two lines, as shown here. Also note that the card types in this sample do not necessarily apply to the latest system. For a list of the network adapters that are supported on a specific system, see the appropriate system technical guide on the IBM Redbooks web site at http://www.redbooks.ibm.com/.

```
System Name,Adapter ID,Adapter Port Location,Frame,Drawer,Domain,Slot,Port,Card Type,
Protocol,Optic Type,Switch ID
M01,0115,A15A-D113-J.00,A,A15A,1,D113,0,FICON Express 8s,FICON,short range,10
M01,0116,A15A-D113-J.00,A,A15A,1,D113,1,FICON Express 8s,FICON,short range,11
M01,0117,A15B-D114-J.00,A,A15A,1,D114,0,FICON Express 8s,FICON,long range,10
M01,0118,A15B-D114-J.00,A,A15A,1,D114,1,FICON Express 8s,FICON,long range,11
M01,0119,Z15B-LG13-J.00,Z,Z15B,2,LG13,0,FICON Express 16s,FCP,short range,-
M01,0120,Z15B-LG13-J.00,Z,Z15B,2,LG13,1,FICON Express 16s,FCP,short range,-
M01,0121,Z15B-LG14-J.00,Z,Z15B,2,LG13,0,FICON Express 16s,FCP,long range,-
M01,0122,Z15B-LG14-J.00,Z,Z15B,2,LG13,1,FICON Express 16s,FCP,long range,-
```

Appendix C. Sample NVMe adapter plan

If a DPM-enabled system has one or more IBM Adapter for NVMe1.1 features, you can view Non-Volatile Memory Express (NVMe) storage adapters through the **Configure Storage** task. You also can download an exportable file of the NVMe adapter plan, which lists details about the installed adapters. The file is in Comma Separated Values (CSV) format that you can view in a spreadsheet application.

Each NVMe adapter consists of two pieces of hardware: an IBM-supplied carrier card installed in a system I/O drawer, and the solid state drive (SSD) that customers purchase. The following sample shows the entries for an NVMe carrier card and an installed SSD in a CSV file.

```
System Name,Adapter ID,Adapter Location,Frame,Drawer,Domain,Slot,Card Type
P000T218,01B0,A31B-LG17,A,A31B,0,17,NVMe SSD
P000T218,01A0,A31B-LG14,A,A31B,1,14,NVMe carrier card
```

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