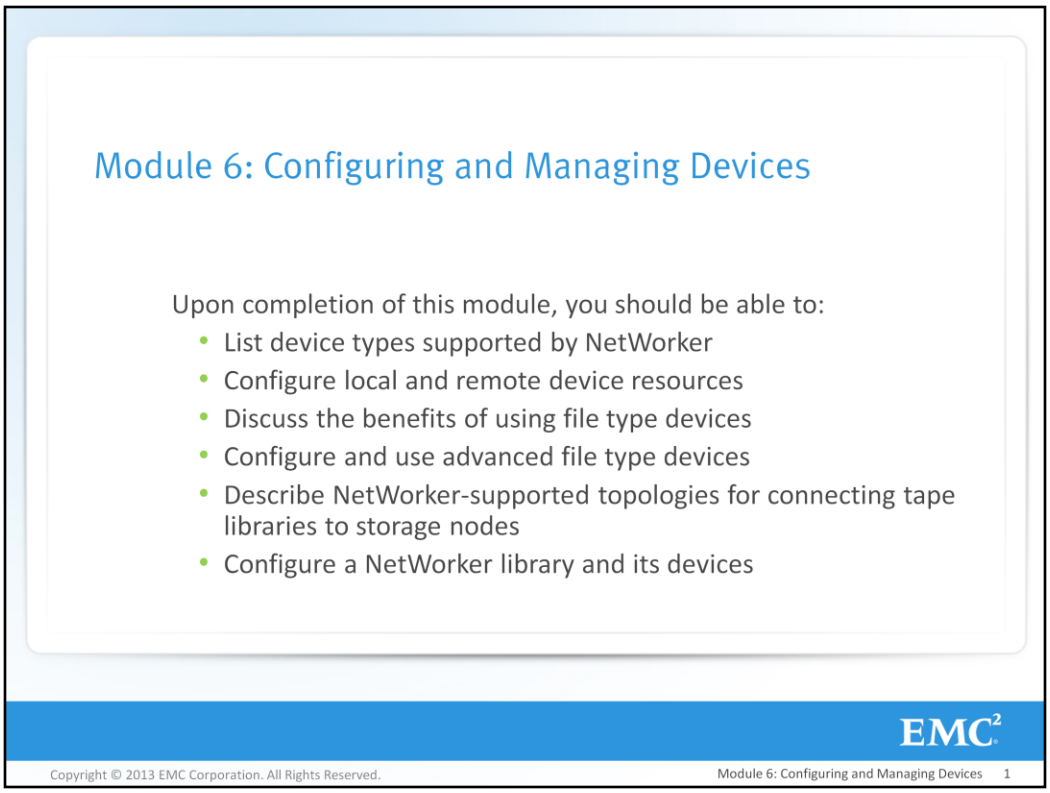
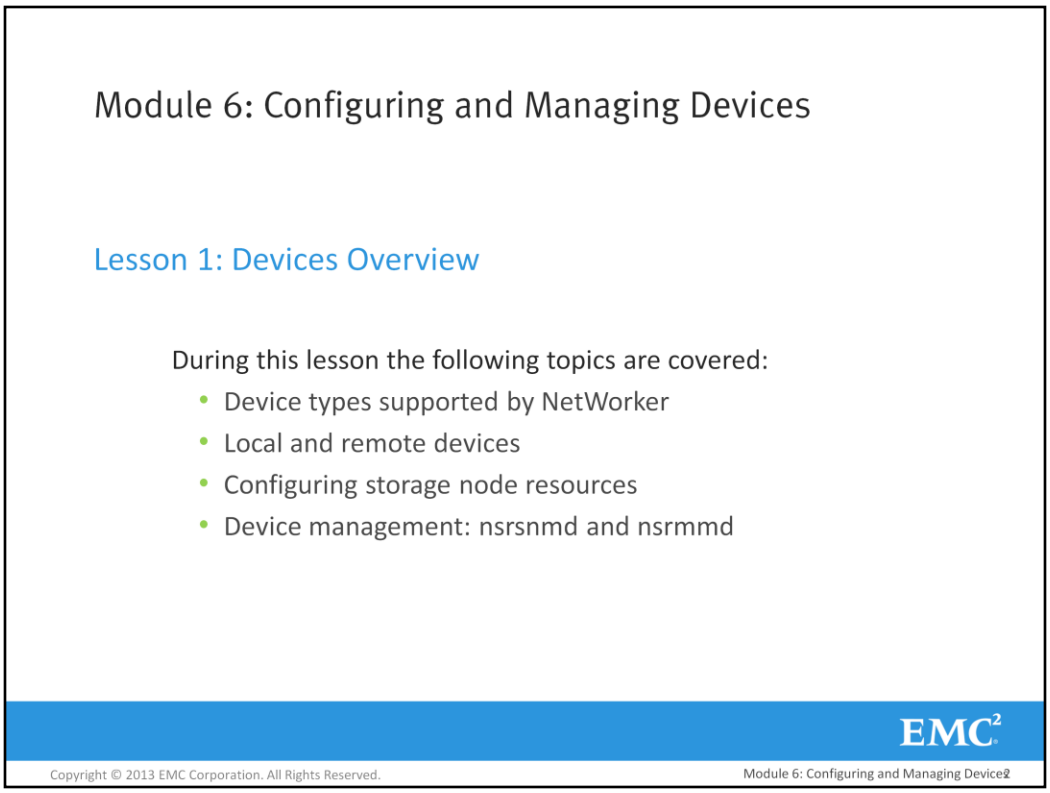
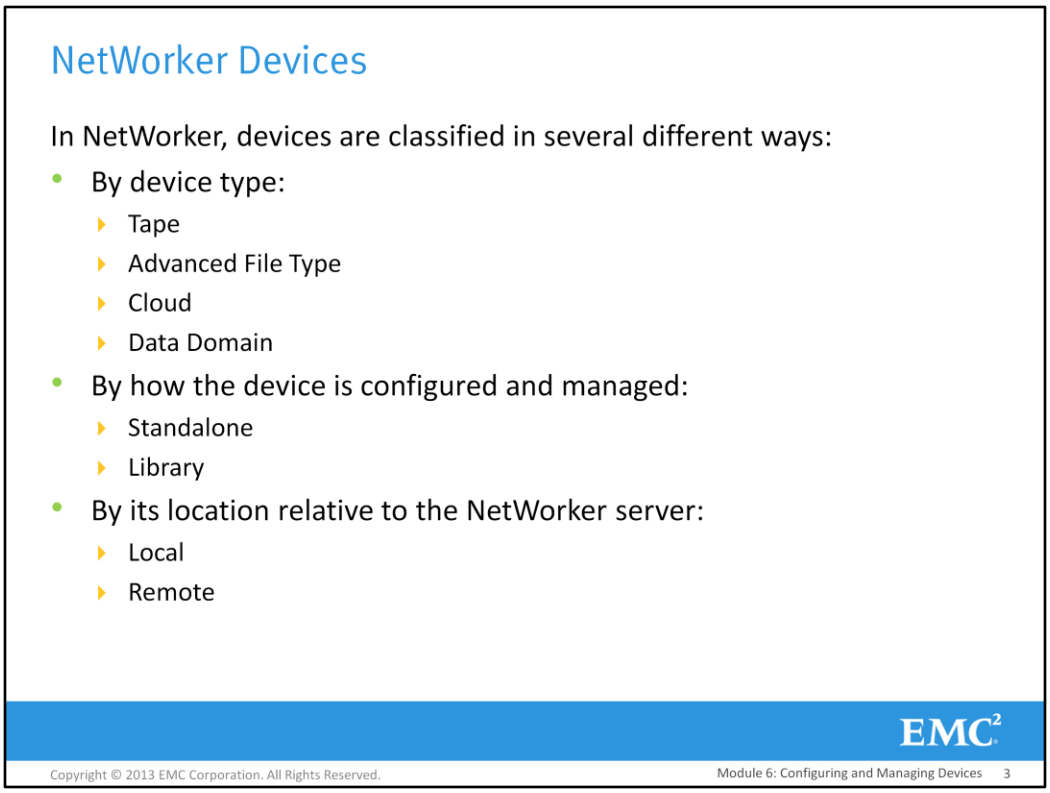


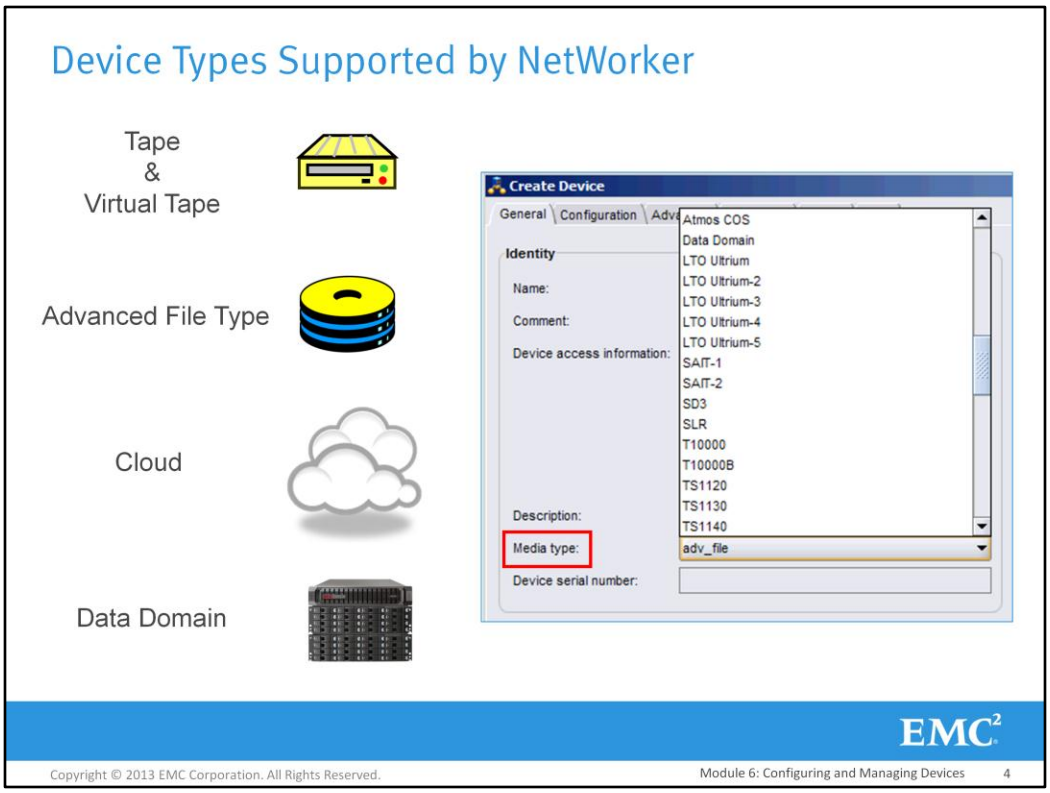
This module focuses on the various types of NetWorker backup storage devices, including a discussion of advanced file type devices, the different topologies for connecting tape libraries, and how to configure library and drive resources.



This lesson covers an introduction to the various device types supported by NetWorker, configuring a storage node resource, and device management with nsrsnmd and nsrmmd.



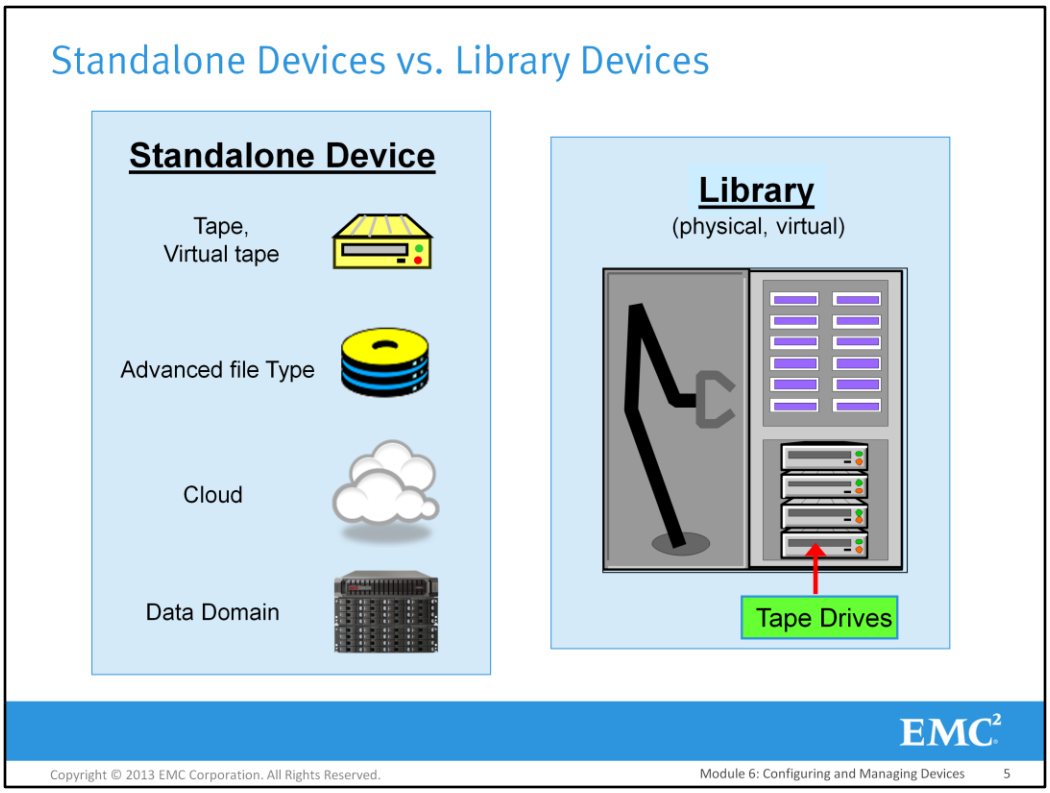
Each of the device classifications listed above is described in more detail on the following slides.



NetWorker supports many types of devices that can be used to store backup data. These device types include:

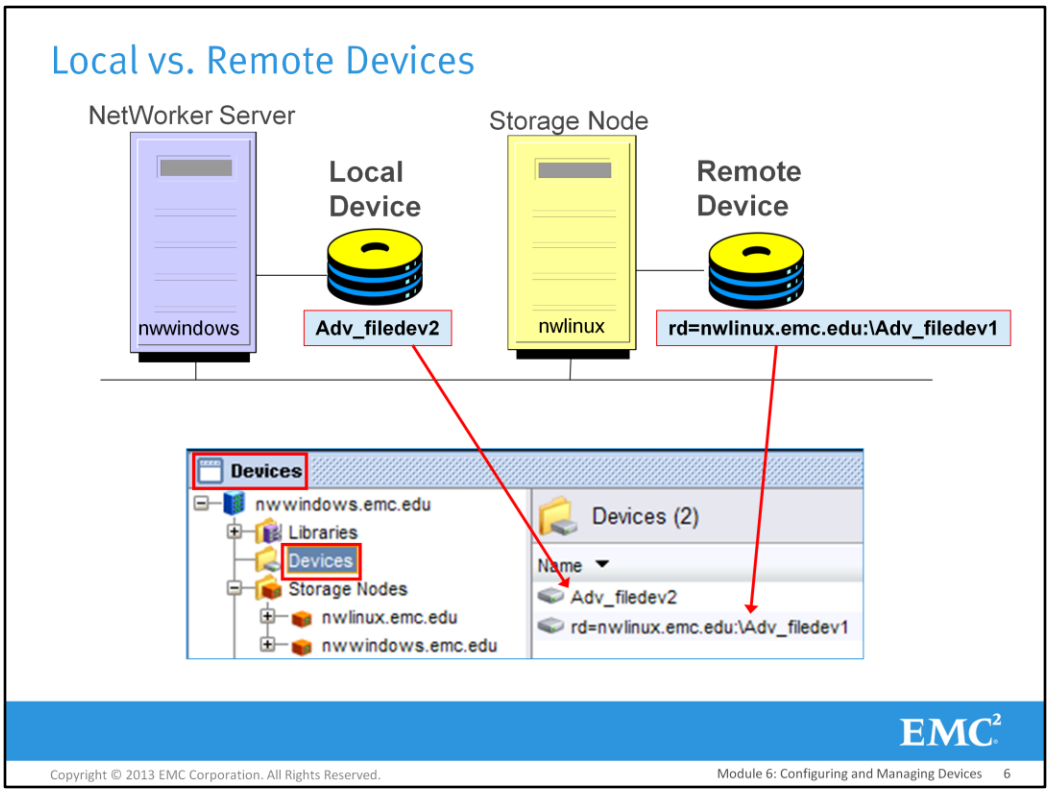
- **Tape:** includes tape drives and cartridges; may be physical or virtual. Examples include 4mm, 8mm, DLT8000, LTO Ultrium-5, SAIT-1, TS1140.
- **Advanced File Type:** refers to an existing file system directory configured in NetWorker as a backup to disk resource. The media type is adv_file. Once the device resource is configured, NetWorker uses the directory as a backup volume.
- **Cloud:** refers to EMC Atmos configured in NetWorker as a cloud storage device. The media type is Atmos COS. Backups to a cloud device occur over the TCP/IP network.
- **Data Domain:** refers to a NetWorker Data Domain DD Boost storage device. The media type is Data Domain.

Note: The libraries and devices available for configuration are listed in the ***Devices*** window of NetWorker Administration. Also, for an up-to-date list of supported NetWorker devices, refer to the *EMC NetWorker Hardware Compatibility Guide* at support.emc.com.



Devices managed by NetWorker are either standalone devices or library devices.

- A standalone device is any type of device that does not have a robotic arm for loading volumes. Thus, a volume must be manually loaded into the device (and mounted) before the device can be used for backup or recovery.
- A library (sometimes called an autochanger or a jukebox) is a multiple-volume device that uses a robotic arm to move media. A library will contain one or more drives. Drives within a library are configured and managed differently than standalone devices.

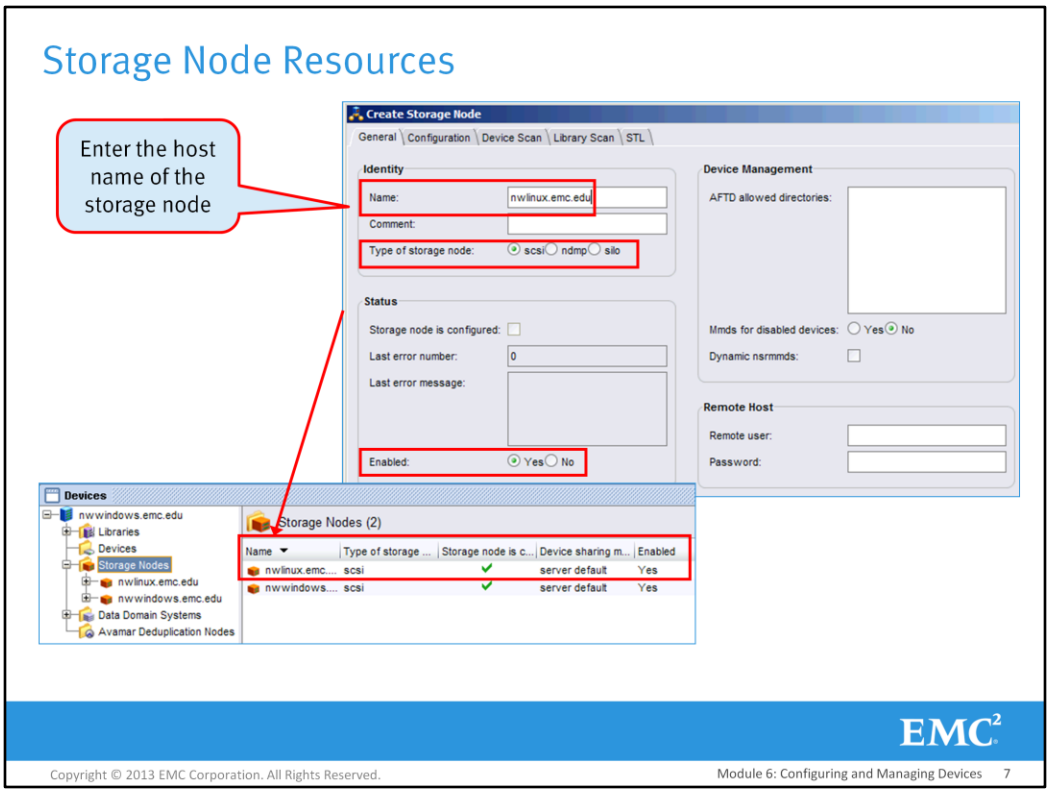


The NetWorker server manages the flow of save set data sent to a device. To accomplish this, the server needs to know whether the device is attached to the NetWorker server or to a remote storage node.

A NetWorker server can manage many storage nodes but a storage node can be managed by only one NetWorker server. In other words, a storage node cannot exist in two data zones at the same time.

Relationship to NW Server	Description
Local	A device that is attached to (either direct or SAN-attached) and controlled by the NetWorker server.
Remote	A device that is attached to (either direct or SAN-attached) and controlled by a NetWorker storage node that is not also the NetWorker server. All remote device names have an "rd=*sn_hostname*:" preceding the device path on the storage node. The slide shows an example of a remote device name.

Table 6-1: Device/Host Relationships



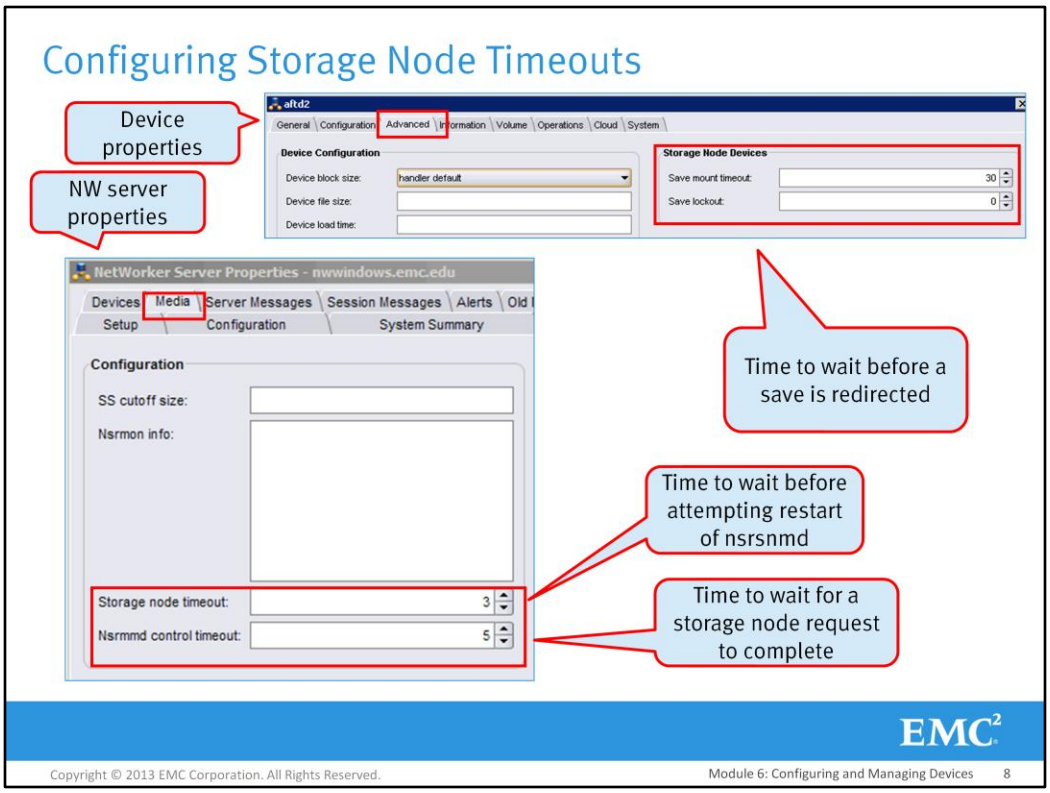
Storage nodes are the NetWorker components that physically control the backup devices. A storage node must have the NetWorker client and storage node software installed on them. Additionally, a storage node resource is configured for each storage node host.

To create a storage node resource, right-click **Storage Nodes** in the left pane of the ***Devices*** window and select **New**. In the resulting window specify the host name of the storage node. Select the type of storage node, SCSI, NDMP or SILO.

In the status attributes, a **Yes** for **Enabled** means that the storage node is available for use. Specifying **No** indicates a service or disabled state. New device operations cannot begin and existing device operations may be cancelled.

We'll review more of the most commonly used storage node attributes in the course by type of managed device.

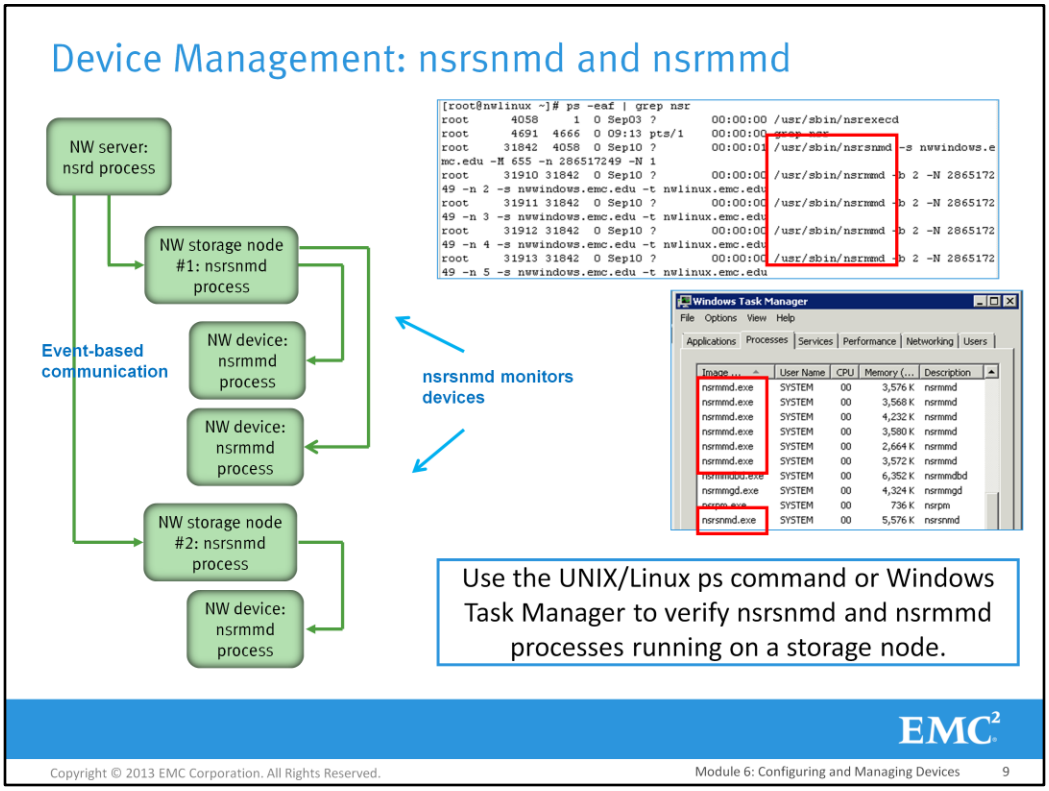
Note: A storage node resource for the NetWorker server is automatically created during installation of the NetWorker server.



There are several attributes in NetWorker that can be set to configure timeouts relating to storage node operations.

On the NetWorker server's resource ***Media*** tab, the **Storage node timeout** attribute specifies the number of minutes the NetWorker server waits before attempting to restart a `nsrsnmd` process that cannot be reached. The default value is 3 minutes. The **Nsrmmd control timeout** attribute configures the amount of time a NetWorker server waits for a storage node request to be completed. The default value is 5 minutes.

For remote devices, there are timeouts that specify how long to wait before the save is redirected to another storage node. If an initial save mount request is not satisfied within the time frame specified by the ***Save mount timeout*** attribute (default 30 minutes), the storage node is locked out from receiving saved data for the period of time specified by the ***Save lockout*** attribute. A value of 0 (default) means that the storage node will not be locked. These attributes are found on the ***Advanced*** tab of the device resource.



Recall that processes running on a NetWorker storage node include `nsrmmd` and `nsrsnmd`.

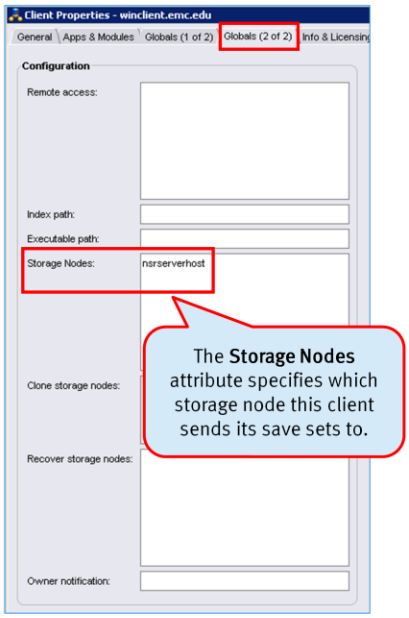
To support reading and writing of data, one `nsrmmd` process is started per configured device. Depending upon the configuration, AFTD and DD Boost devices use multiple concurrent nsrmmd processes per device and multiple concurrent save sessions per `nsrmmd` process.

There is one `nsrsnmd` process running on each storage node with configured and enabled devices. `nsrsnmd` manages all device operations that the nsrmmd processes handle on behalf of the NetWorker server's `nsrd` process. Communication between `nsrsnmd` and nsrd is event-based; `nsrsnmd` is automatically invoked by `nsrd`, as required.

To verify that the processes are running on a storage node, use the UNIX/Linux `ps` command or, on a Windows host, use the Windows Task Manager.

Configuring the Client's Storage Nodes Attribute

- The default value of the **Storage Nodes** attribute is **nsrserverhost**, a built-in alias for the NetWorker server.
- Prioritized list - if one storage node cannot receive the data, the next storage node on the list is contacted.
- The client resource of a storage node should list itself first.



The **Storage Nodes** attribute in the client resource is an ordered list of storage node hosts to which this client can send its backups. The default value is **nsrserverhost,** a built-in NetWorker alias referring to the NetWorker server. This means that by default, client's save sets are directed only to devices (`nsrmmd` processes) on the NetWorker server.

The **Storage Nodes** attribute becomes an ordered failover list if more than one storage node is listed. If the first storage node listed cannot support the backup within a configurable period of time (default is 30 minutes), the client is directed to the next storage node on the list.

The client resource of a remote storage node should list itself first. Doing so will cause the backup to be saved locally, minimizing network traffic.

To use a remote storage node, the **Storage Nodes** attribute of at least one NetWorker client must include the hostname of the remote storage node.

Lab Exercise 6-1: Configure a Storage Node Resource

In this lab, you will create a storage node resource for the NetWorker storage node host.

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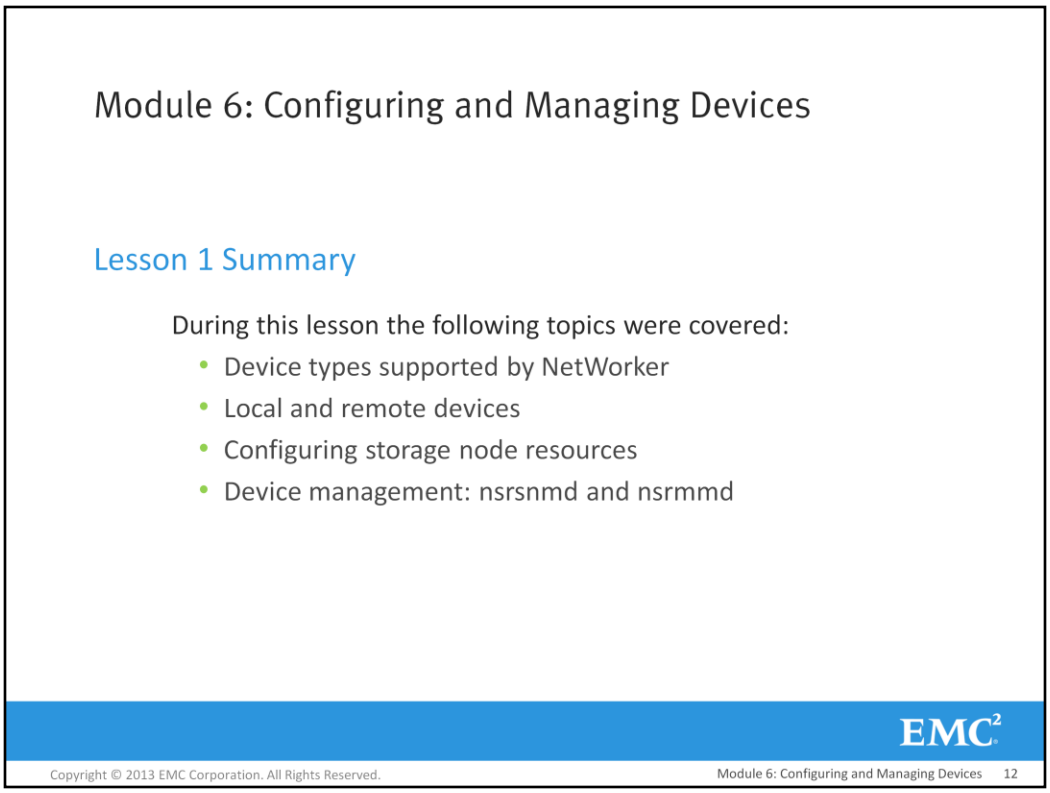
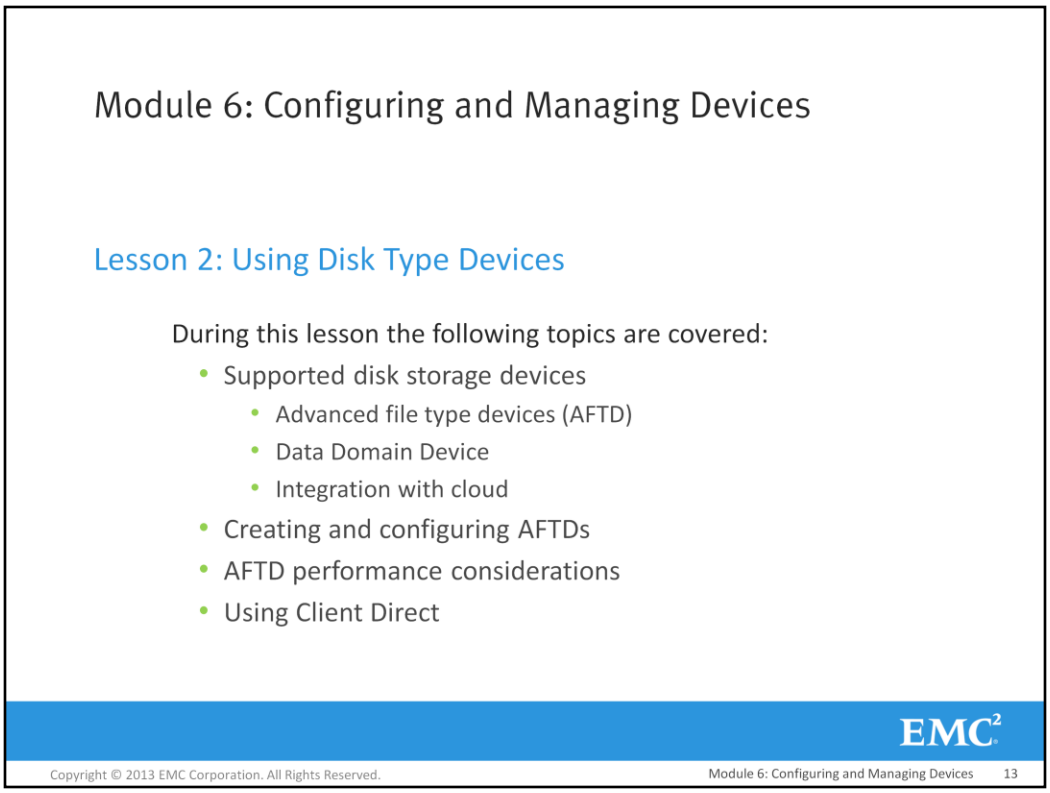
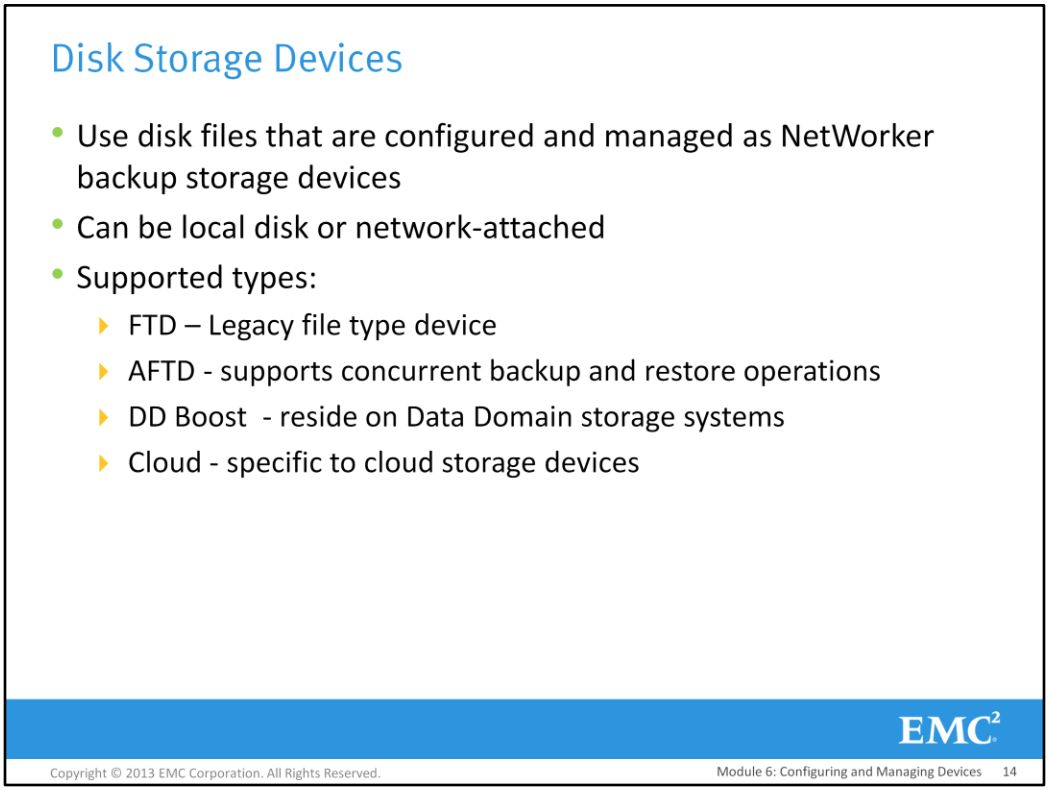
In this lab, you create a storage node resource for your NetWorker storage node host (either nwlinux or nwwindows).



This lesson covered an introduction to the various device types supported by NetWorker, configuring a storage node resource, and device management with nsrsnmd and nsrmmd.



This lesson covers using NetWorker disk storage devices with an emphasis on Data Domain, cloud, and advanced file type devices.



NetWorker backup to disk devices use disk files that are configured and managed by NetWorker. Disk devices can reside on a computer's local disk or they can be located on a network-attached disk.

The types of NetWorker backup to disk devices include:

File type device (FTD) - basic, legacy disk device type.

Advanced file type device (AFTD) - supports concurrent backup and restore operations. AFTDs can reside on a local disk on a NetWorker storage node or on network-attached disk devices that are either NFS or CIFS mounted to a NetWorker storage node.

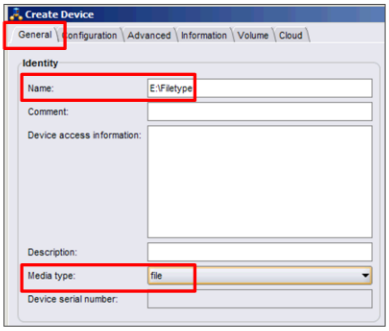
DD Boost device - reside on Data Domain systems with enabled DD Boost. Backup data is stored in a DD Boost device in deduplicated format.

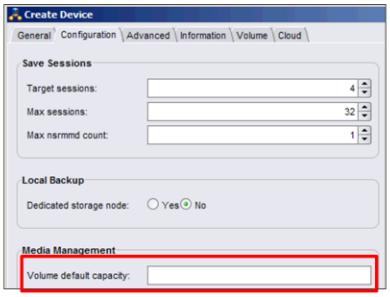
Cloud devices - specific to cloud storage devices, such as EMC Atmos.

Note: DD Boost and Cloud devices are beyond the scope of this course. The *EMC NetWorker Data Domain Deduplication Devices Integration Guide* provides details on DD Boost devices. Please see the EMC Education Services web site for other courses in the EMC Backup and Recovery curriculum offerings.

File Type Devices (FTD)

- Media type: file.
- Device name is the same as the directory path.
- Must be local to the storage node or NFS only.
- Concurrent operations are not available.
- Use **Volume default capacity** to restrict the size of the device's volume.
- Recommended to use AFTD or DD Boost devices instead of file type devices.



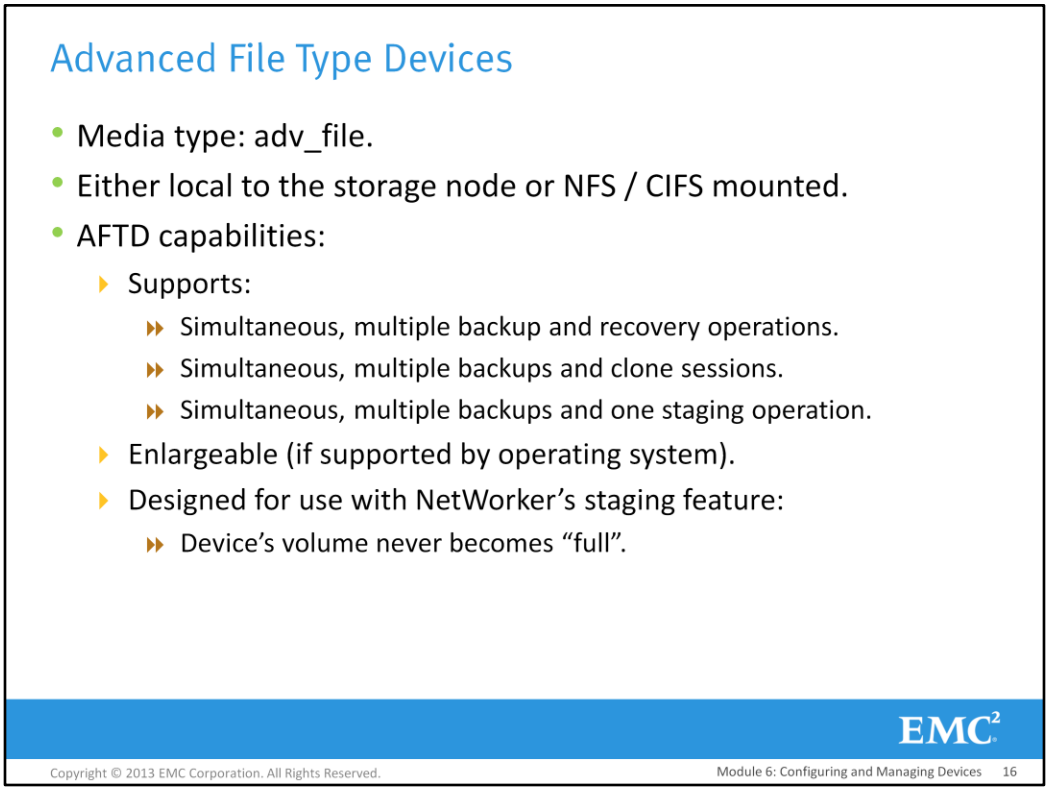


A file type device (FTD) uses an existing directory within a file system as its volume. File devices can be local to Windows/UNIX/Linux storage nodes or NFS-mounted to UNIX/Linux storage nodes. Each save set directed to the device is written to a separate file within the directory.

When creating a NetWorker device resource for a file device, the name of the device is the full pathname of the directory, for example **`E:\`**, **`D:\Filedev1`**, or **`/filedevice2`**. It is strongly suggested that you create separate file systems for each file type device. If multiple file devices share the same file system, they will each contend for the available disk space. If a file device resides in a file system containing operating system or user files, there will also be contention for available space. If a file type device cannot be assigned its own dedicated file system, the device's **Volume default capacity** attribute should be used to limit the amount of space that can be used by the device. If this attribute has a value (it is null by default), the volume becomes full upon the specified amount of data (**750 MB**, **12 GB**, **1 TB**, etc.) being written to it.

After the device resource is created, a file type device's volume is labeled and mounted.

File type devices are legacy devices and their use is limited. It is recommended to use AFTD or DD Boost devices instead of file type device.



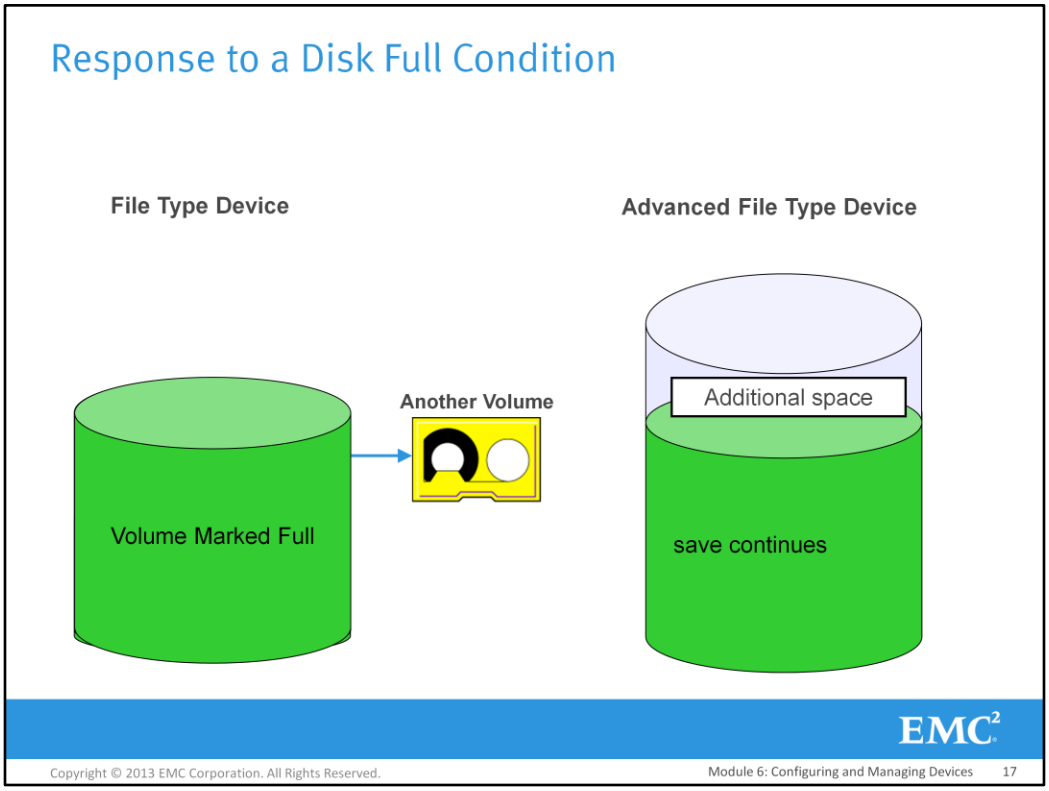
Advanced file type devices overcome the main restrictions of traditional file type devices. Advanced file type devices support multiple backups and read operations, simultaneously. This allows you to recover, clone, or stage data from an AFTD while backups are in progress. To support this capability, multiple concurrent `nsrmmd` processes are used per device and each `nsrmmd` can support multiple concurrent save sessions.

The following operations can be performed concurrently on a single storage node:

- Multiple backups and multiple recover operations
- Multiple backups and multiple clone operations
- Multiple backups and one staging operations
- When recovering from an AFTD, save sets are recovered concurrently. Multiple save sets can be simultaneously recovered to multiple clients. AFTD save sets can be cloned to two different volumes simultaneously. Concurrent recoveries is limited to file type recoveries and are performed using the recover command.

Many file systems can be dynamically enlarged, allowing the size of an AFTD volume to be increased without relabeling the volume.

Unlike a file type device, advanced file type devices are supported for both NFS and CIFS.



An advanced file type device responds differently than a file type device to a “disk full” condition. A file type device behaves much like a tape device. When there is no more room on the volume, NetWorker marks the volume full and continues backing up the save set to another volume. This volume may be either a disk or tape volume.

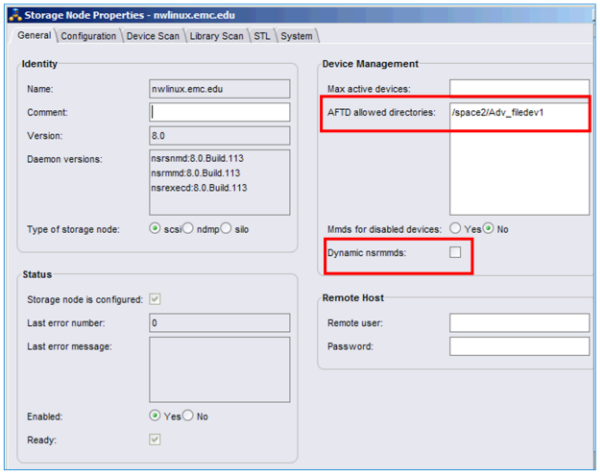
An AFTD volume is never marked as full. A save set being written to an advanced file type device will never continue (span) onto another volume. Instead, if the file system containing the volume becomes full, NetWorker suspends all saves being directed to that device until more space is made available on the volume. A message is displayed stating that the file system requires more space. The `nsrim` process is invoked to reclaim space on the volume. A notification is sent by email to the NetWorker administrator.

You can make more space available in a number of ways:

- Manually delete unneeded save sets.
- Move save sets from the full volume to another volume (staging).
- Dynamically add space to the volume (file system), if it is supported by the operating system and file system.

Configuring Storage Nodes for AFTDs

- Create one directory for each disk that will be used for an AFTD that the storage node will manage.
- Dynamic nsrmmds enabled means that 1 nsrmmd process is started per device and more are only added on demand.

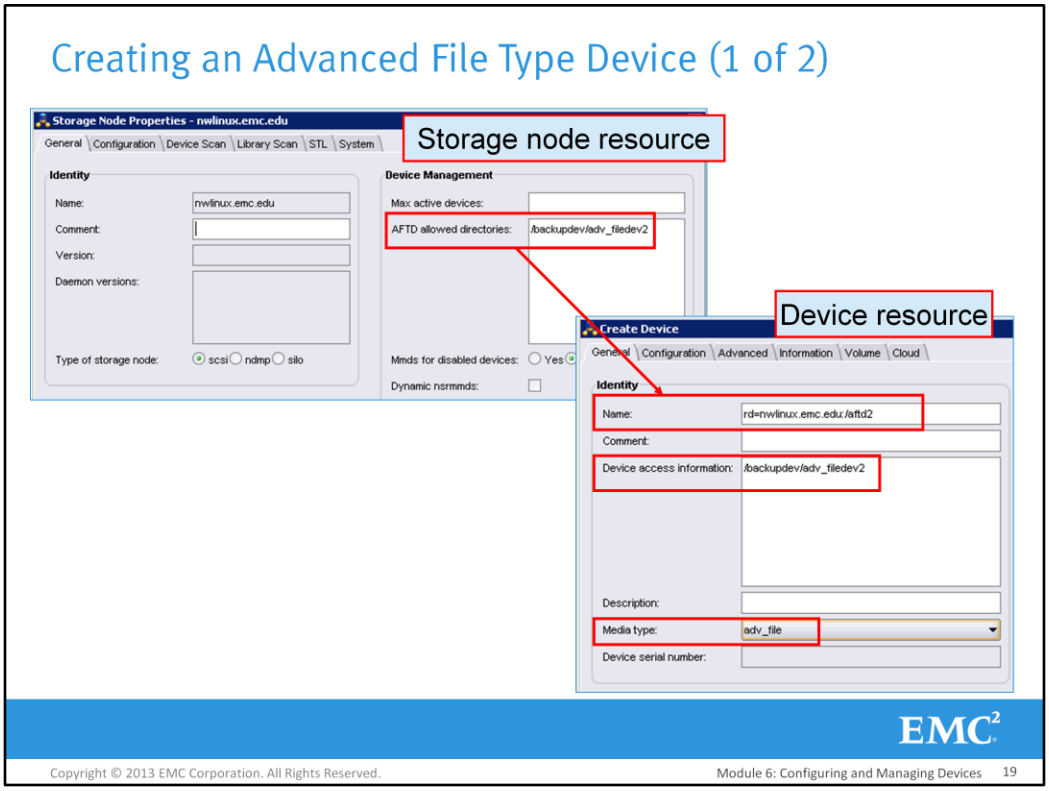


Each AFTD device is identified with a single NetWorker storage volume. Before creating an AFTD resource, create one directory for each disk to be used for the AFTD.

As a security feature to restrict where AFTDs can be created, in the applicable storage node resource, you can enter the path or paths of the storage directory that will contain AFTDs into the **AFTD allowed directories** attribute.

Do not use a temporary directory. It is strongly suggested that you create separate file systems for each AFTD. If multiple AFTDs share the same file system, they will each contend for the available disk space. If an AFTD resides in a file system containing operating system or user files, there will also be contention for available space.

For **Dynamic nsrmmds**, select whether `nsrmmd` processes on the storage node devices will be started dynamically. When not selected, which is the default setting, NetWorker runs all available `nsrmmd` processes. If selected, NetWorker starts one `nsrmmd` process per device and adds more only on demand, as needed.

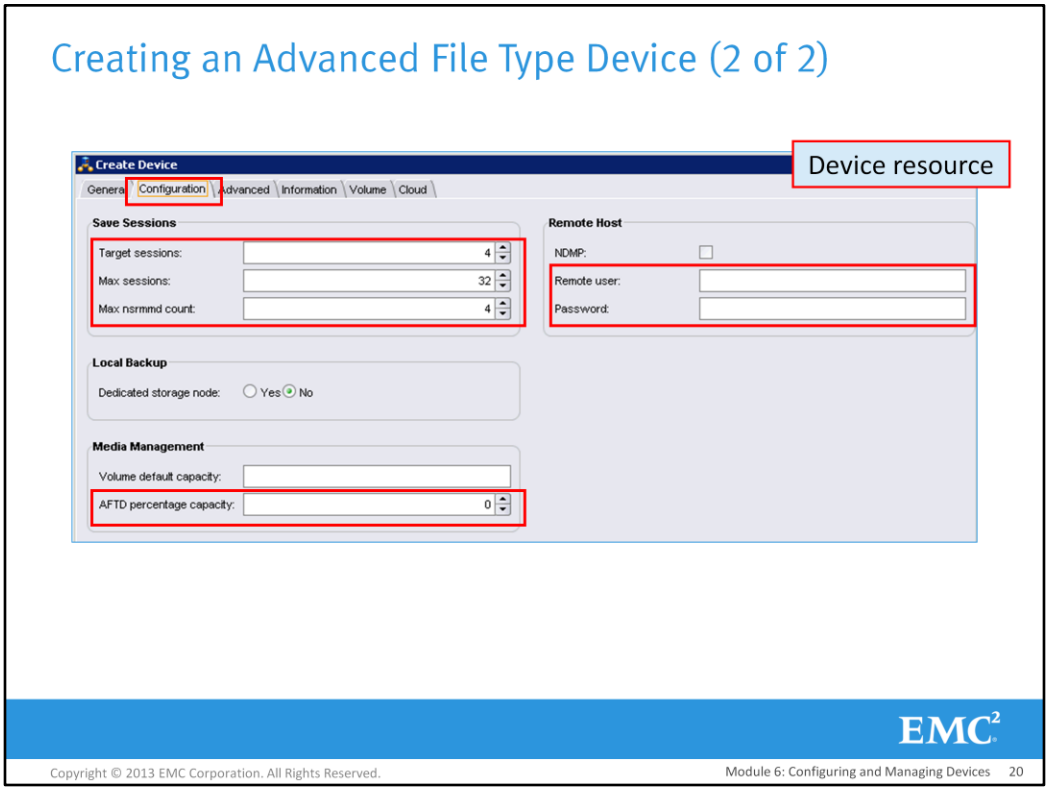


Each AFTD device is defined by a single path, although the access path may be specified in different ways for different client hosts.

NetWorker AFTD devices can be created from the ***Devices*** window using either the ***Device Wizard*** or the ***Properties*** window.

The attributes from the ***Properties*** window are shown here; however, with either method, similar information is provided:

- For **Name**, enter the name you would like to use for the device. This can be the path to the device, or it can be a meaningful name of your choosing. If the storage node is not also the NetWorker server, this AFTD will be a remote device. The remote device name must use this format: **rd=*storagenodename*:*devicename***.
- In the **Device access information** attribute, enter the complete path to the device directory. Multiple entries may be made. The first path enables the storage node to access the device via its defined mount point. You can also provide alternate paths for Client Direct clients.
- Select **adv_file** as the **Media type** for advanced file type devices.

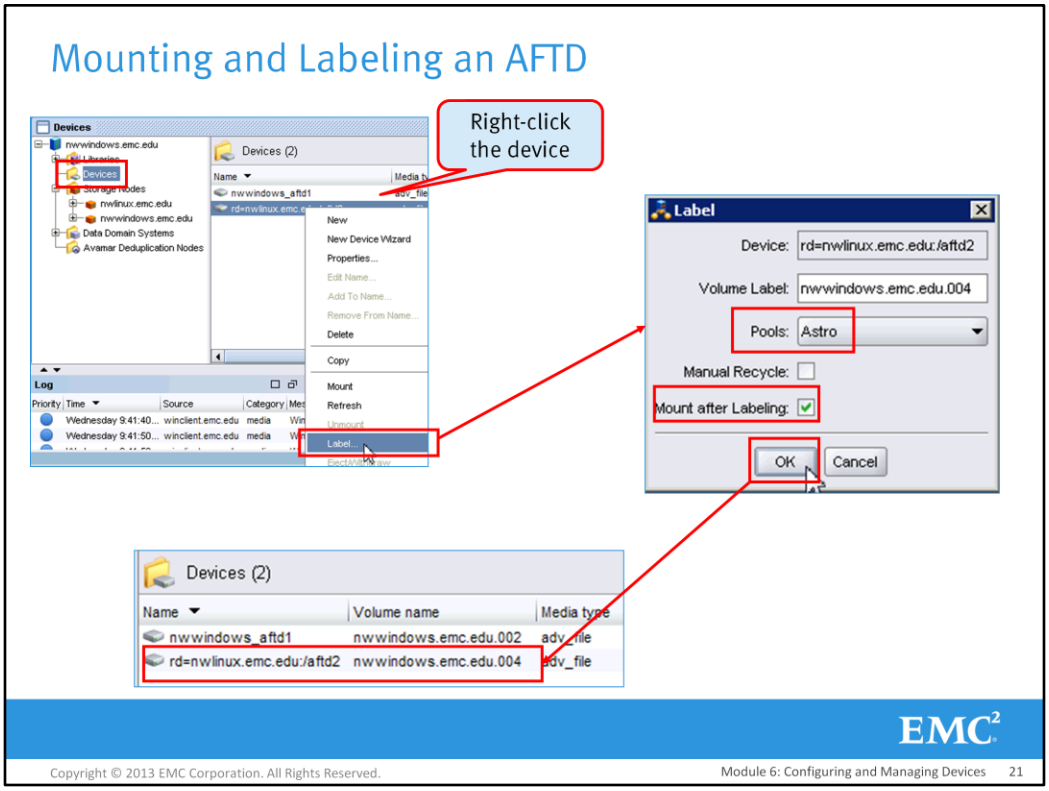


On the ***Configuration*** tab, set the number of concurrent sessions and the number of `nsrmmd` processes the device may handle.

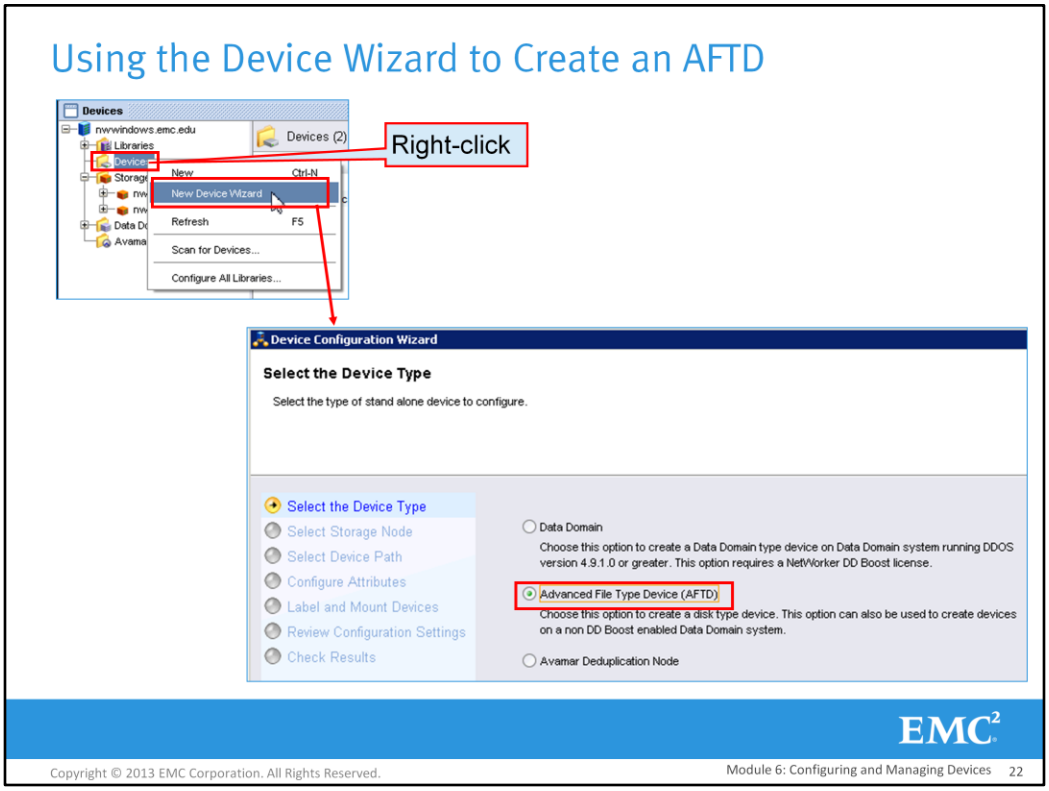
- **Target sessions** is the number of sessions that a `nsrmmd` process will handle before another device on the host will take additional sessions. This setting is used to balance the sessions among `nsrmmd` processes. If another device is not available, then another `nsrmmd` process on the same device will take the additional sessions. Typically, this field is set to a lower value. The default value for AFTDs is 4.
- **Max sessions** is the maximum number of sessions that the device may handle. If no additional devices are available on the host, then another available storage host will be used, or retries are attempted until sessions are available. The default value is 32 for AFTDs. This typically provides the best performance.
- **Max nsrmmd count** limits the number of nsrmmd processes that can run on this device. This setting is used to balance the nsrmmd load among devices. The default value is 4.

Additional fields to configure include:

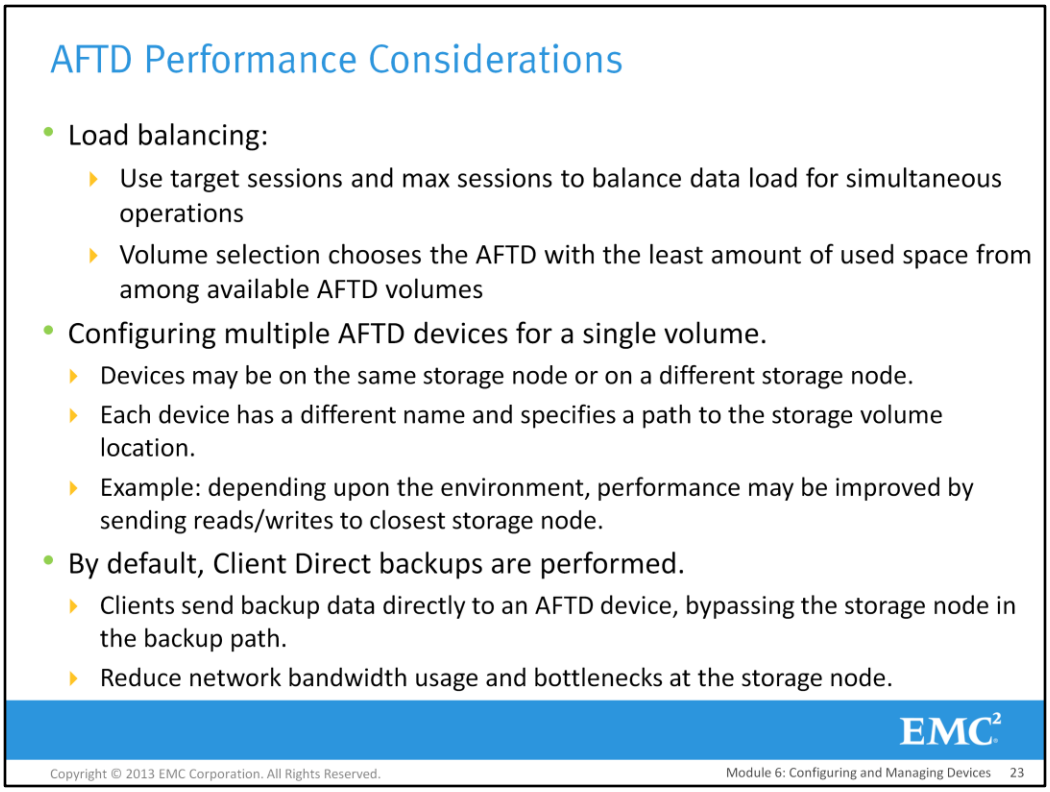
- Provide a remote user name and password if an NFS or CIFS path is specified in the **Device access information** field.
- The **AFTD percentage capacity** attribute is used to determine at what capacity NetWorker should stop writing to the AFTD. A value of 0 or leaving the attribute empty, is equivalent to a setting of 100%. High and low watermarks for the volume are calculated based on a percentage of the restricted capacity. When changing this field, the volume must be remounted for the change to take effect.



After the AFTD device resource is created, label a volume in the device into a media pool and then mount the volume.



You can also use the ***Device Configuration*** wizard to create an AFTD. From the ***Devices*** window, right-click **Devices** and select **New Device Wizard**. Select **AFTD** for device type. Complete the information in the wizard as required. Verify the device settings and select **Finish**.



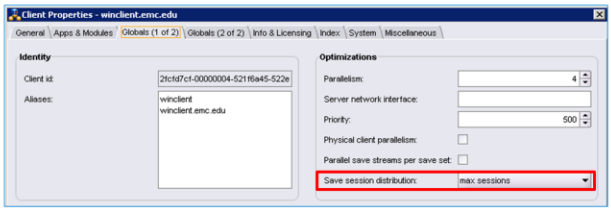
The data load for simultaneous operations can be balanced across available devices by using the target and max sessions per device. Also, when there are multiple AFTD volumes belonging to a pool, NetWorker will choose the AFTD with the least amount of used space. By using the total used capacity for AFTD volume selection, the first labeled device is not excessively used. Together these capabilities provide for effective load balancing across disk volumes.

It is possible to configure multiple AFTD devices that share a single storage volume. The devices can be on the same storage node or on a different storage node. Each device must have a different name and must specify a path to the storage location. This enables storage devices and volumes to be better utilized by allowing different devices to mount and access volumes at the same time. A new session can be distributed to any other `nsrmmd` seeing the same volume.

Clients with network access to AFTD or DD Boost storage devices can send their backup data directly to the storage devices, thus bypassing the storage node in the backup path. The storage node continues to manage the devices for the NetWorker clients but does not handle the data. Using Client Direct has the potential for reducing bandwidth usage as the backup data travels directly from the client to the storage device. Also, any bottlenecks at the storage node are avoided.

Save Session Distribution (SN Load Balancing)

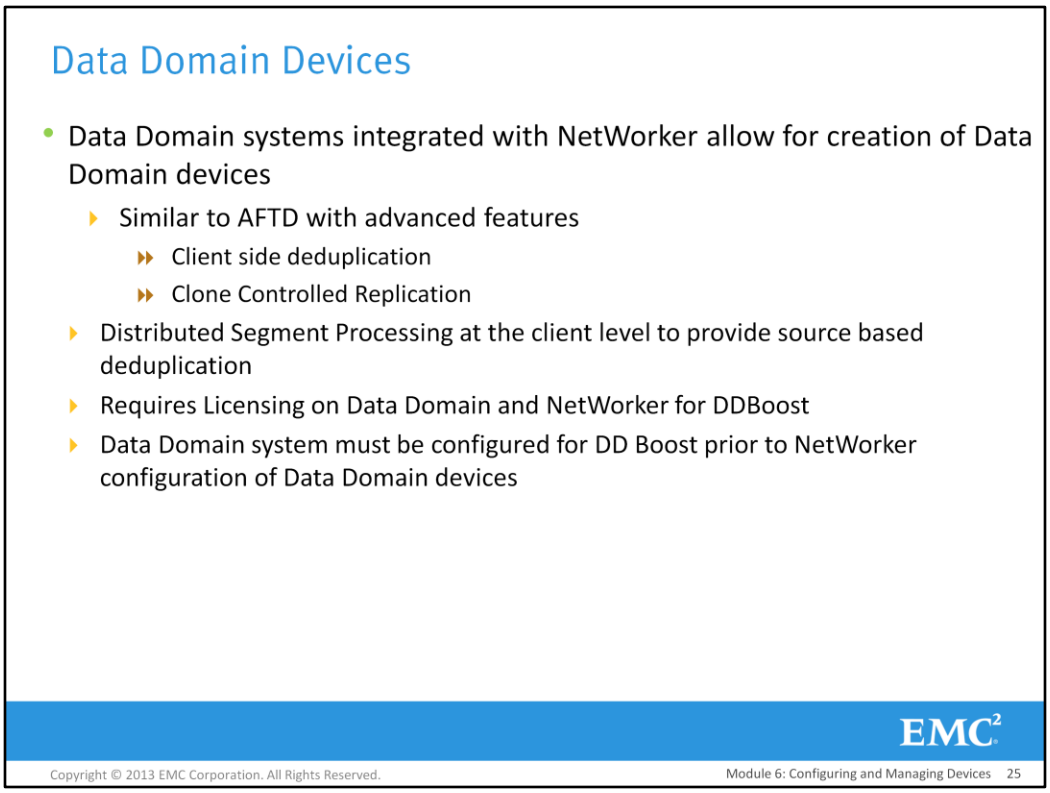
- Requires NetWorker 8.1 and higher
- Ability to configure and control load balancing across storage nodes
  - Globally across all clients or on selected clients
- Save session distribution option on clients
  - Max Sessions
    - Save sessions are distributed based on each SN device's max session attribute (default)
    - More likely to concentrate load on fewer SNs
  - Target sessions
    - Save sessions are distributed based on each SN device's target session attribute
    - More likely to spread backup across multiple storage nodes



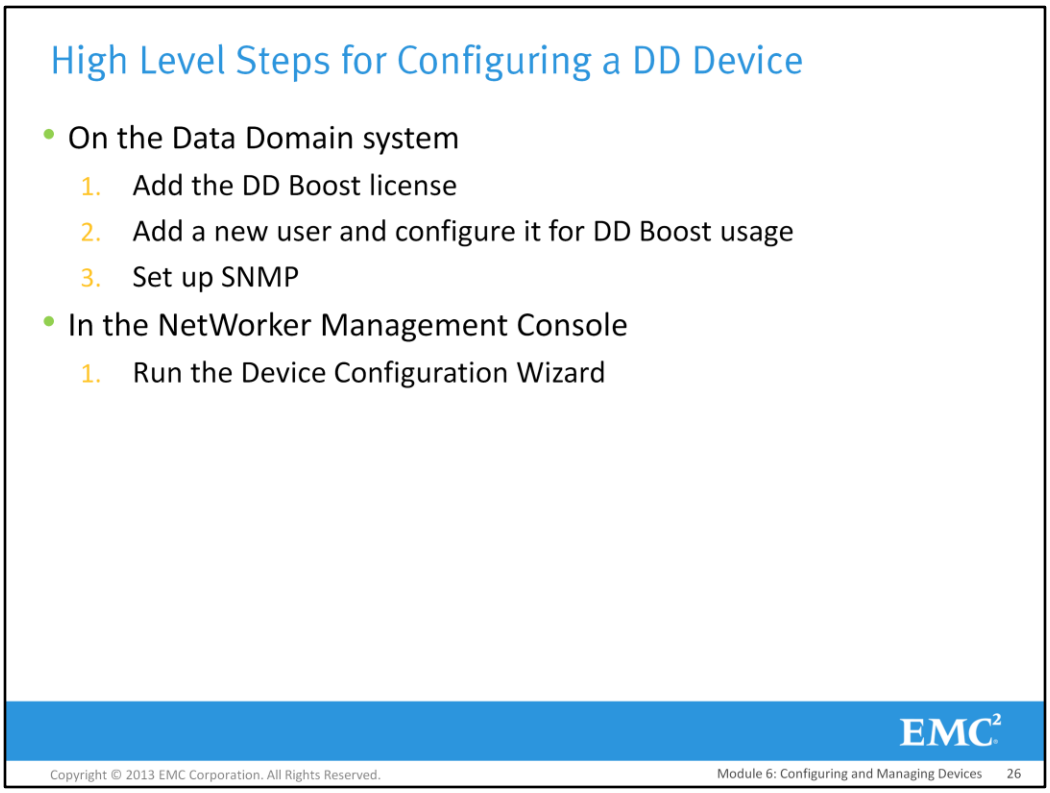
In NetWorker 8.1 load balancing across storage nodes is now configurable globally across all clients, or on an client by client basis. Save sessions are distributed based on the selection in the **Save session distribution** box on the client properties.

Options include:

- **Max Sessions** – This option distributes save sessions based on the max sessions attribute of all devices configured on the storage node.
- **Target Session** – This option distributes save sessions based on the targets sessions attribute of all devices configured on the storage node.



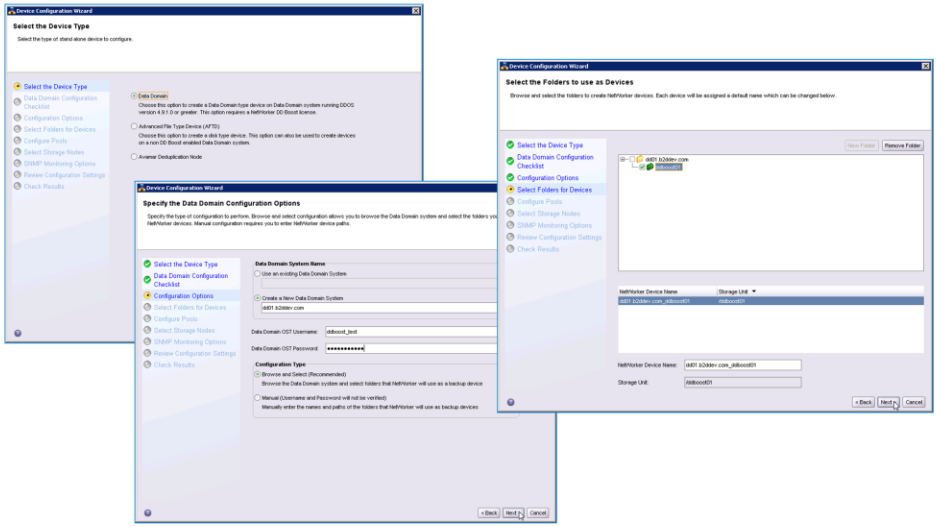
When NetWorker is integrated to Data Domain with DD Boost, part of the deduplication process takes place on Storage Node. The distributed segment processing (DSP) component, reviews the data that is already stored on the Data Domain system and sends only unique data for storage.



This slide summarizes the high level configuration steps that must be performed on both the Data Domain system and within the NetWorker Management Console to configure Data Domain devices. It's important to note that it is a two step process in which the Data Domain system must first be configured before the NetWorker steps can be performed. The Data Domain system only needs to be set up the first time a device is created. After that only the NetWorker Management Console configuration needs to be performed to add additional devices.

Configure Data Domain Devices in NetWorker

- New Device Configuration Wizard used to configure



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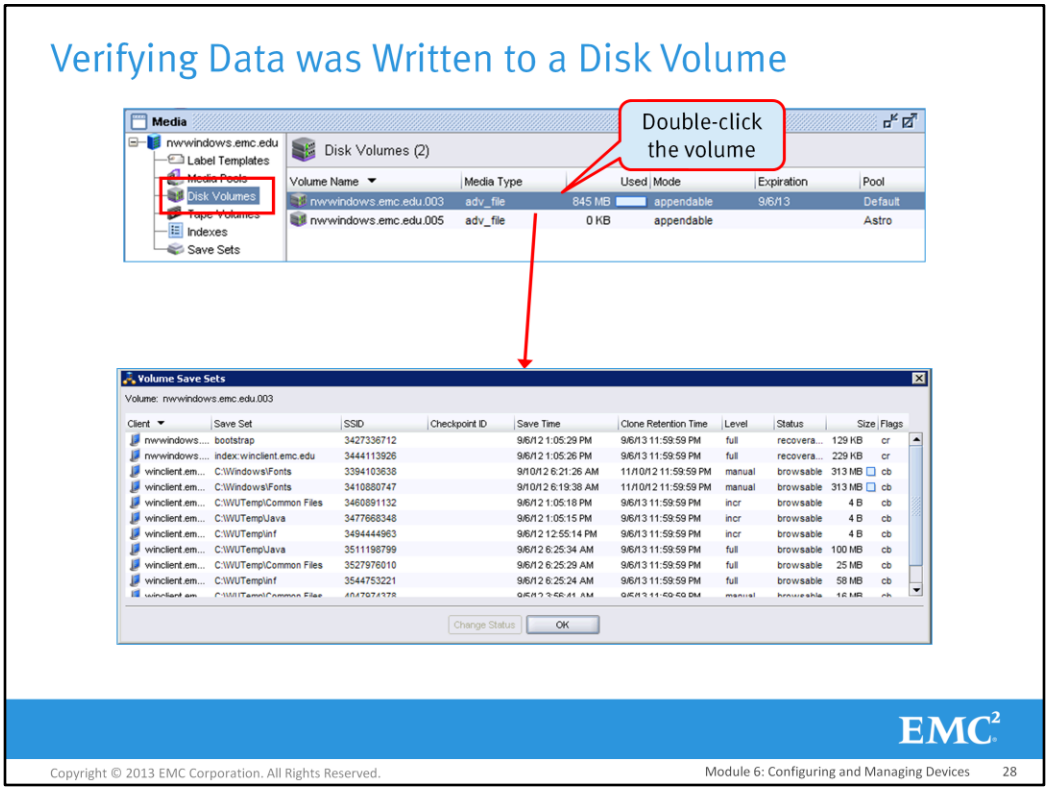
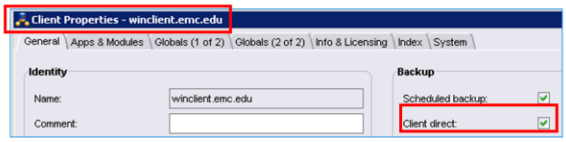
Configuring Data Domain devices is done using the New Device Wizard in the NetWorker Management Console. The wizard is launched as if you were creating and AFTD, however the Data Domain device type is selected instead. Next you follow the wizard screen by screen through the selection of the Data Domain system to be used, followed by the creation and selection of the device folder, finally pool and storage node selection is performed.

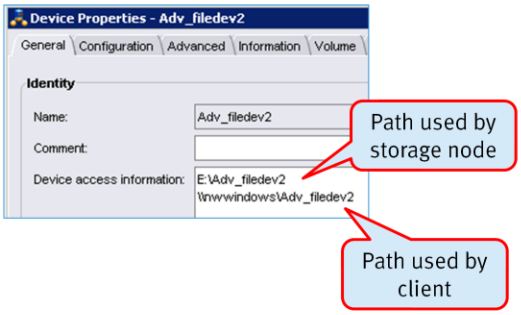


You can check the save sets on an AFTD volume using the **Disk Volumes** node from the Administration ***Media*** window. Information displayed includes the client and save set name, save set id, save and clone retention time, backup level, save set status and flags. This information is discussed in detail in the *NetWorker Database Management* module later in this course.

Using Client Direct with AFTD and DD Devices

- Client Direct is enabled, by default.
  - If Client Direct cannot be used, a traditional storage node backup is performed
  - Feature can also be disabled.
- Requirements:
  - Clients require a network connection and a remote connection to reach the device.
  - The devices **Device access information** attribute specifies the access information.



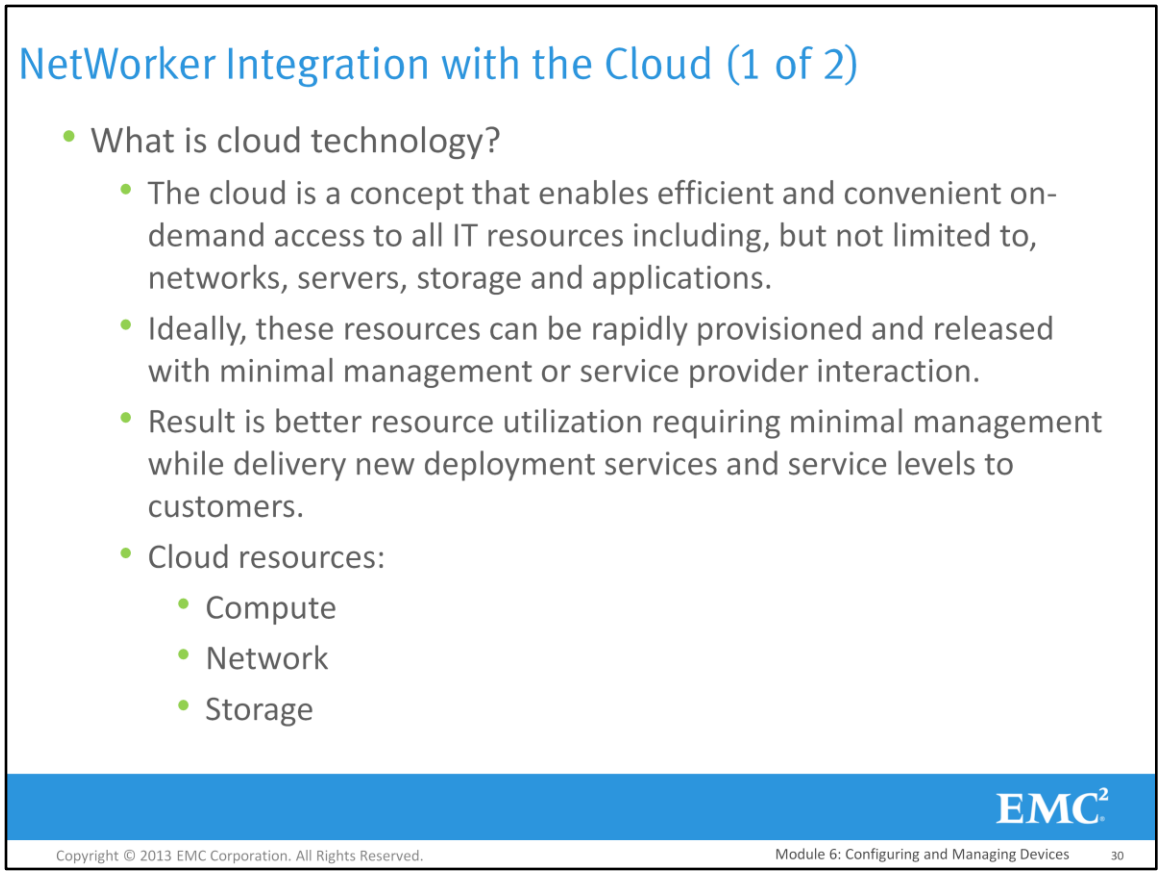


The Client Direct feature is enabled for a client by default. If a Client Direct backup cannot be performed (e.g. a network connection to the storage is not supplied), a traditional backup via the storage node is performed. Client Direct clients require a network connection and remote access to the storage device, such as a CIFS or NFS path.

The path(s) to the AFTD device are specified in the device's **Device access information** attribute. If the storage device is directly connected to the storage node, a different access path is specified for the client than that for the storage node. A configuration using a CIFS share is shown on the slide.

If the storage device is not directly connected to the storage node, as with NAS, the device access information is the same for the storage node and clients.

For Client Direct backups to AFTDs using checkpoint restart, checkpoint restart points are not made less than 15 seconds apart. Checkpoints are always made after larger files requiring more than 15 seconds to backup.

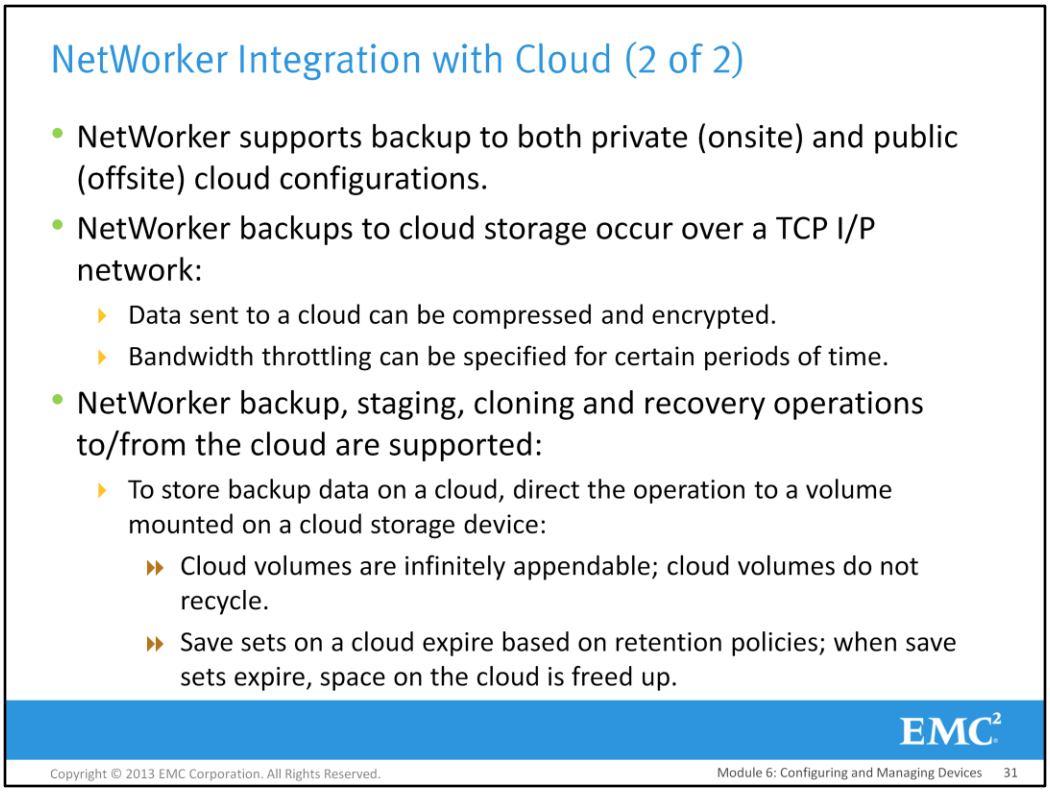


Cloud computing or cloud technology is still an evolving model, hence there are many definitions and points of view. For this lesson, we define cloud as a concept that enables efficient and convenient on-demand access to all IT resources. These resources include networks, servers, storage, and applications.

The “as a service” model represents a new way of resource delivery in IT. Just as virtualization ushered in faster and more robust services, it is now having a similar effect when applied to servers and storage. Server and storage environments can be easily provisioned, expanded, contracted, decommissioned, and repurposed yielding extreme flexibility and elasticity.

Benefits of cloud computing include:

- Increased capabilities
- Improved performance
- Lower cost and reduced risk
- Flexible scaling
- Less infrastructure management complexity



NetWorker provides expanded backup and recovery capabilities through integration with Cloud Optimized Storage. The NetWorker Cloud Backup Option provides support for backing up to both private (onsite) and public (offsite) cloud configurations.

Backup operations to cloud storage occur over a TCP I/P network. Data sent to a NetWorker cloud device can be encrypted and/or compressed. There is also a bandwidth throttling mechanism for cloud backup devices that allows you to limit the amount of bandwidth that NetWorker can consume for cloud operations during specified periods of time.

All traditional NetWorker workflows are supported with cloud storage in NetWorker, including backup, recovery, staging and cloning operations. To send backup data to a cloud, you direct the backup operation (backup, clone, etc.) to a volume mounted on a cloud storage device. Save sets on a cloud expire based on retention policies. When save sets expire, space on the cloud is freed up. Cloud volumes are infinitely appendable. Cloud volumes are not recycled. Cloud volumes can be manually deleted from the NetWorker Administration **Media** view.

Lab Exercises 6-2 and 6-3: Advanced File Type Devices

In these labs, you will create an AFTD and then configure and run a client direct backup.

- Lab Exercise 6-2: Configure an Advanced File Type Device
- Lab Exercise 6-3: Configure and Run a Client Direct Backup

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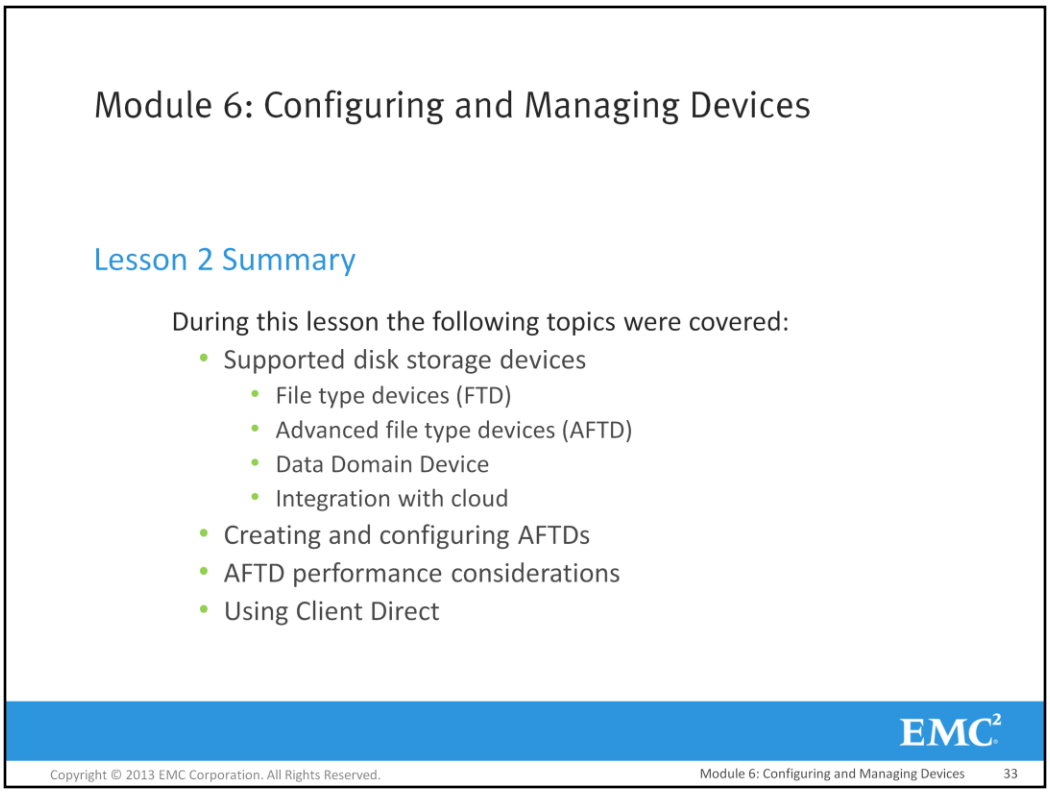
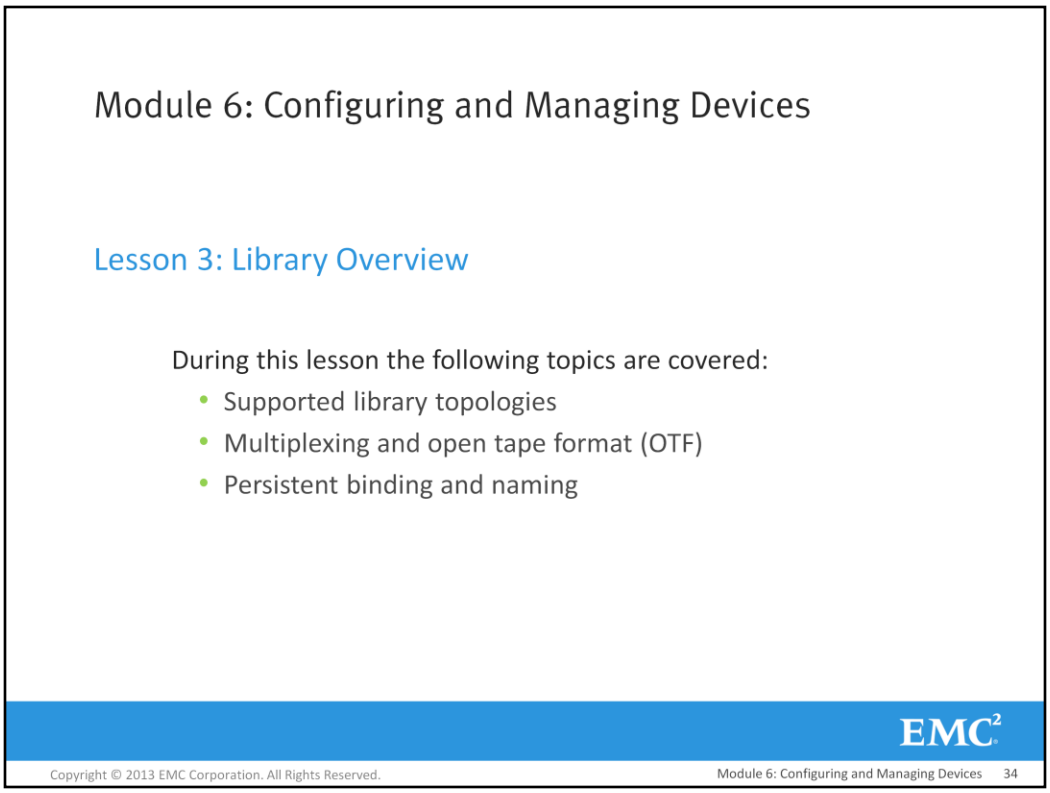
In this lab, you will:

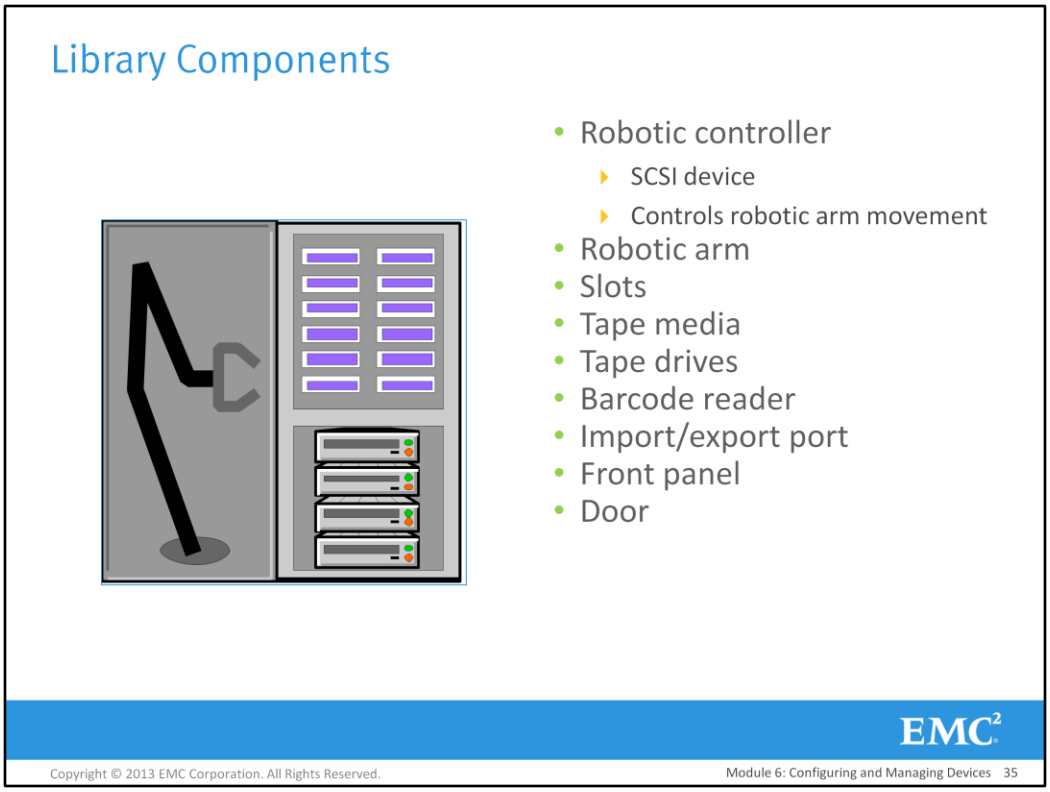
- Create an AFTD.
- Perform a backup to the new device.
- Configure a NetWorker device to be used for Client Direct.
- Run a Client Direct backup.



This lesson covered using NetWorker disk storage devices with an emphasis Data Domain and advanced file type devices.



This lesson covers an overview of using libraries with NetWorker including supported library topologies, multiplexing and OTF, and persistent binding and naming.

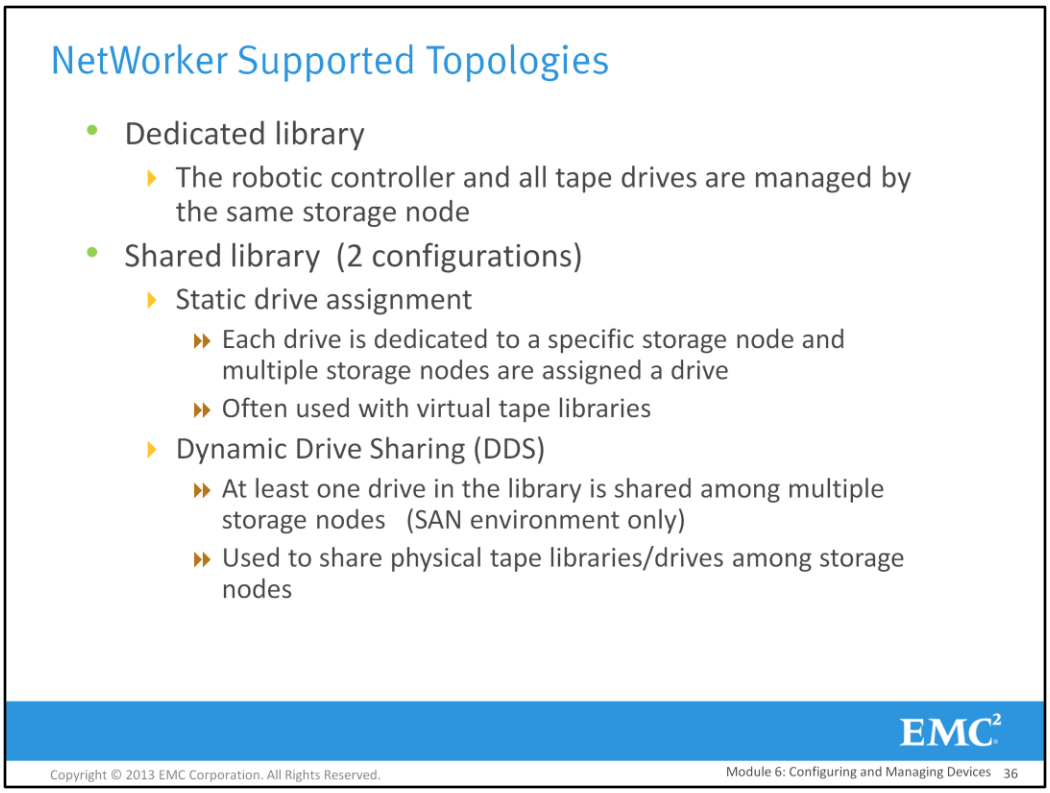


Libraries supported by NetWorker have the following components:

- **Robotic controller** - This is a SCSI-connected device that allows a host to send requests to and obtain information from the library. For example, a host sends a request to the robotic controller to move a tape from a slot into a drive.
- **Robotic arm** - This is the mechanism that moves tapes. It is commonly an arm with a gripper.
- **Slots** - This is where volumes are stored when not loaded in a tape drive. Each slot has a unique element address.
- **Media** - These are the volumes, which are also known as cartridges or tapes.
- **Drives** - Each tape/optical drive also has a unique element address.

In addition to the above components, many libraries also have the following:

- **Bar code reader** - This is an optical device that reads a bar code affixed to a tape. Using a bar code reader improves the speed of creating or refreshing the library's inventory of tape media.
- **Import/export port** - This is a special port used to move tapes into and out of the library without opening the door. It is also known as the Cartridge Access Port (CAP).
- **Front panel** - This is used to set up and control the library.
- **Door** - This allows access to the slots, media, and drives. Many libraries have a sensor that detects when the door has been opened, which may initiate an inventory.

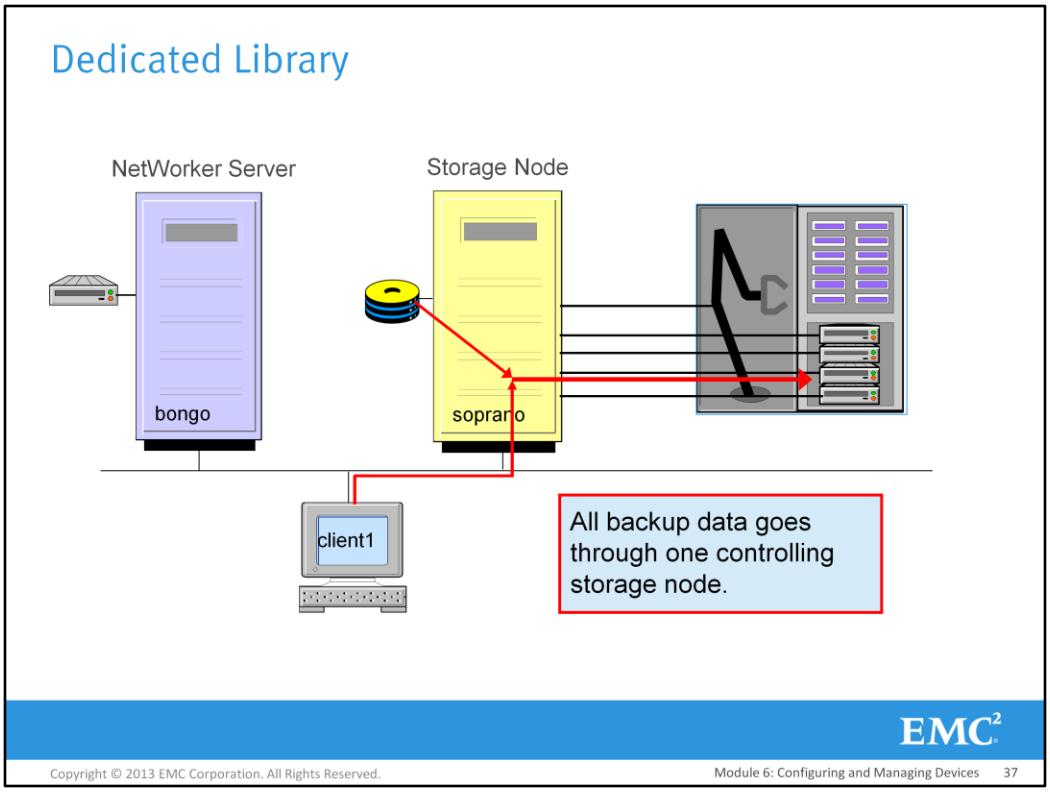


NetWorker supports various library connection topologies.

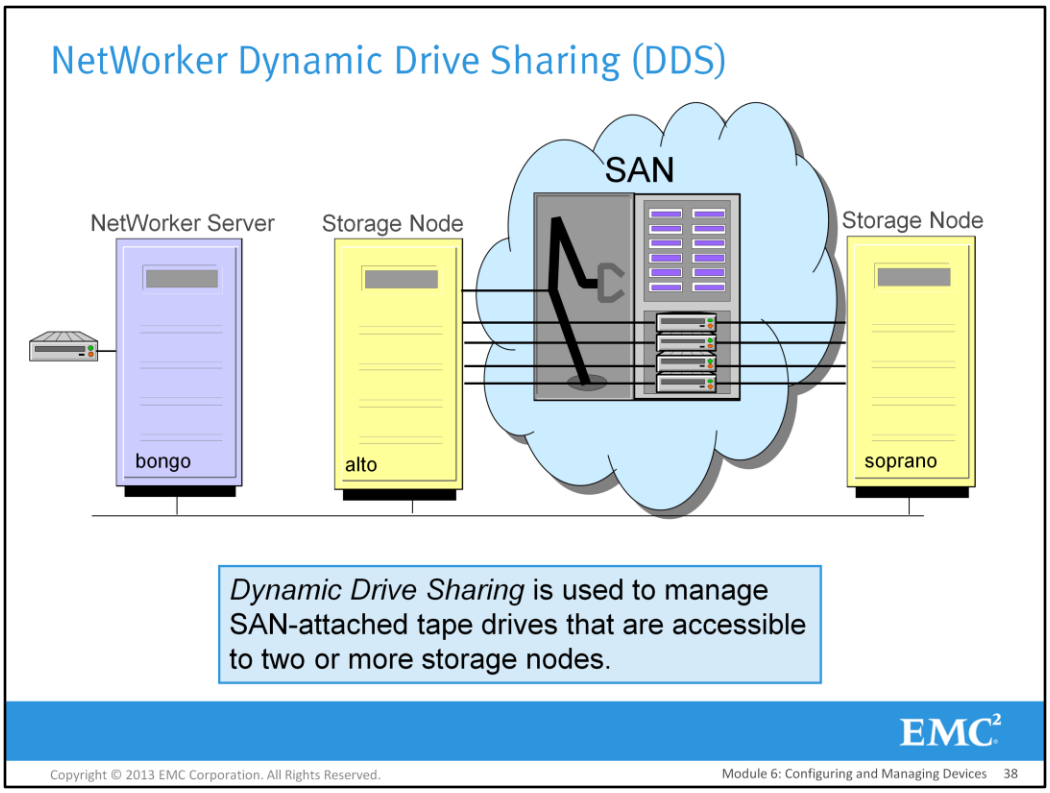
A **dedicated library** is controlled by a single storage node.

A **shared library** is cabled in such a manner that two or more storage nodes control some portion of the library. However, all drives are statically bound to a specific storage node. A shared library is supported in SAN (Storage Area Network) and non-SAN environments.

Dynamic sharing of a drive in a library is supported only in a SAN environment. Utilizing Dynamic Drive Sharing (DDS), individual drives in the library are controlled by more than one storage node. However, only one storage node can use a drive at any given time.



As shown in the slide, all drives in a *dedicated library* are controlled by a single storage node. Backup data from clients other than **soprano** must be sent to the storage node **soprano** using the TCP/IP network.



Using **Dynamic Drive Sharing (DDS),** a tape drive is accessed and used by two or more storage nodes within a single data zone. However, only one storage node can control a drive at any given time.

Although it is more common to dynamically share drives residing in a library, standalone drives may also be dynamically shared.

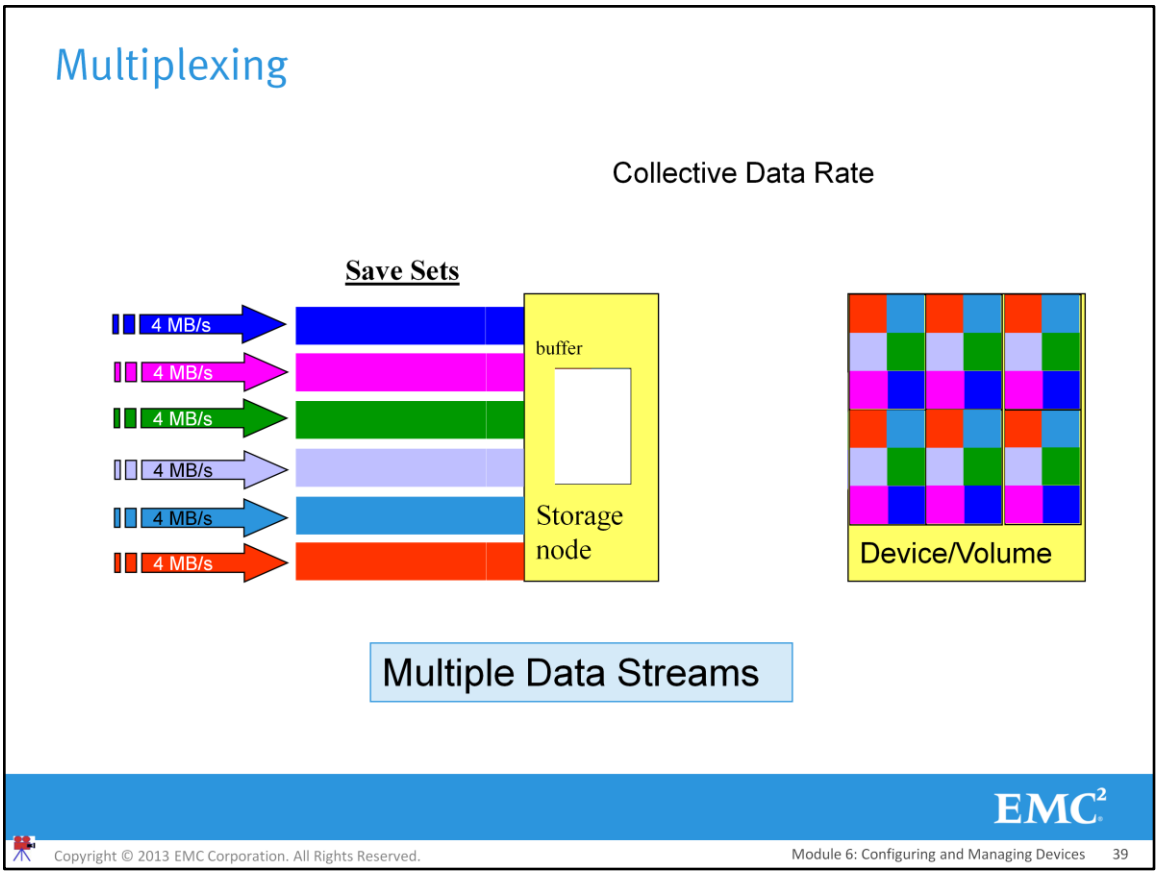
It should also be noted that not all drives in a library must be dynamically shared. For example, in the environment depicted in the slide, it would be possible to allow **alto** access to all four tape drives but allow **soprano** access to only the top drive. Thus, only the top drive would be dynamically shared.

DDS reduces hardware demands by allowing multiple storage nodes to use the same drive, but at different times. Once configured, the administration (labeling, mounting, etc.) of a shared drive is the same as for a non-shared drive.

For more information about NetWorker DDS configurations, refer to the *EMC NetWorker Administration Guide*.

Important: DDS is only supported in a storage area network (SAN) environment. DDS is only supported within a single data zone. EMC Alphastor software allows you to share a device across data zones.

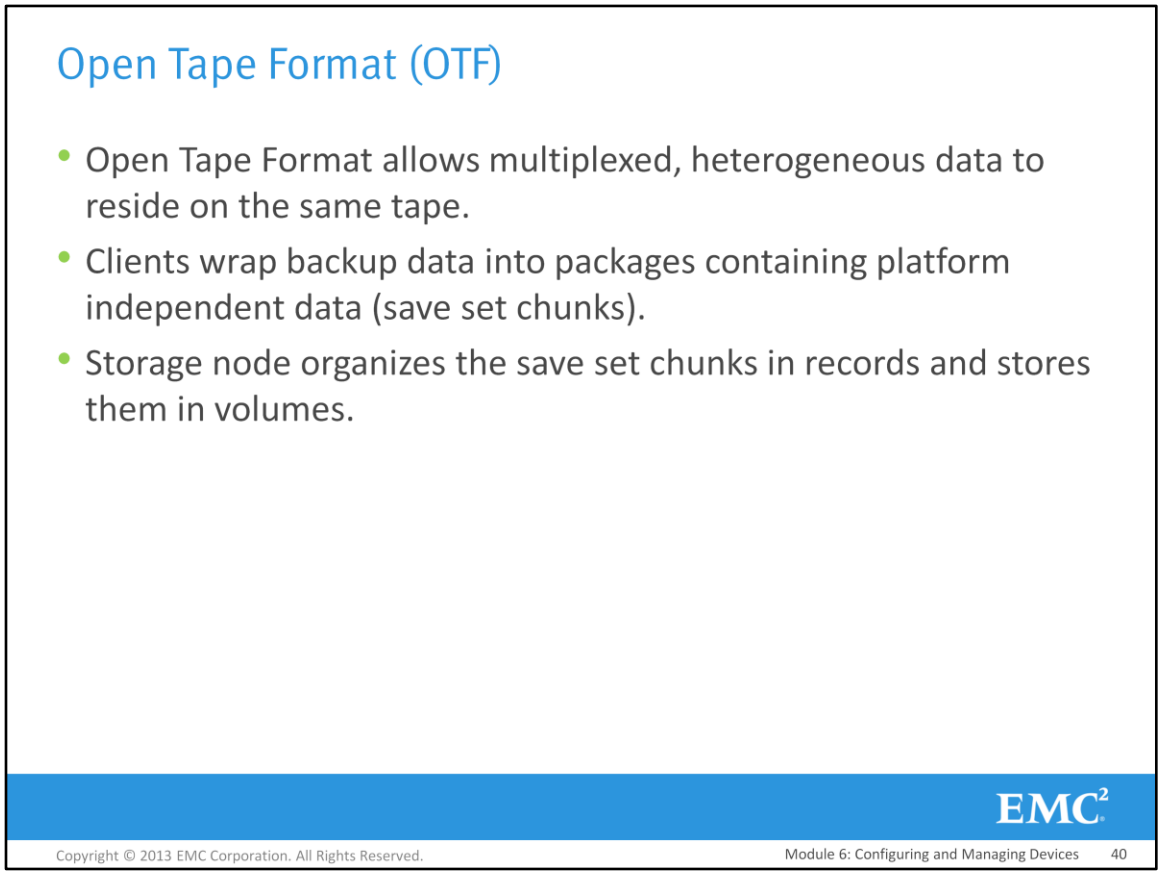
Note: Using DDS with a virtual tape library is not recommended.



In an environment *without* multiplexing, only one stream of data is written to the device at any given time. This situation is not ideal because as more clients perform simultaneous backups, the tape drive's throughput is not optimized.

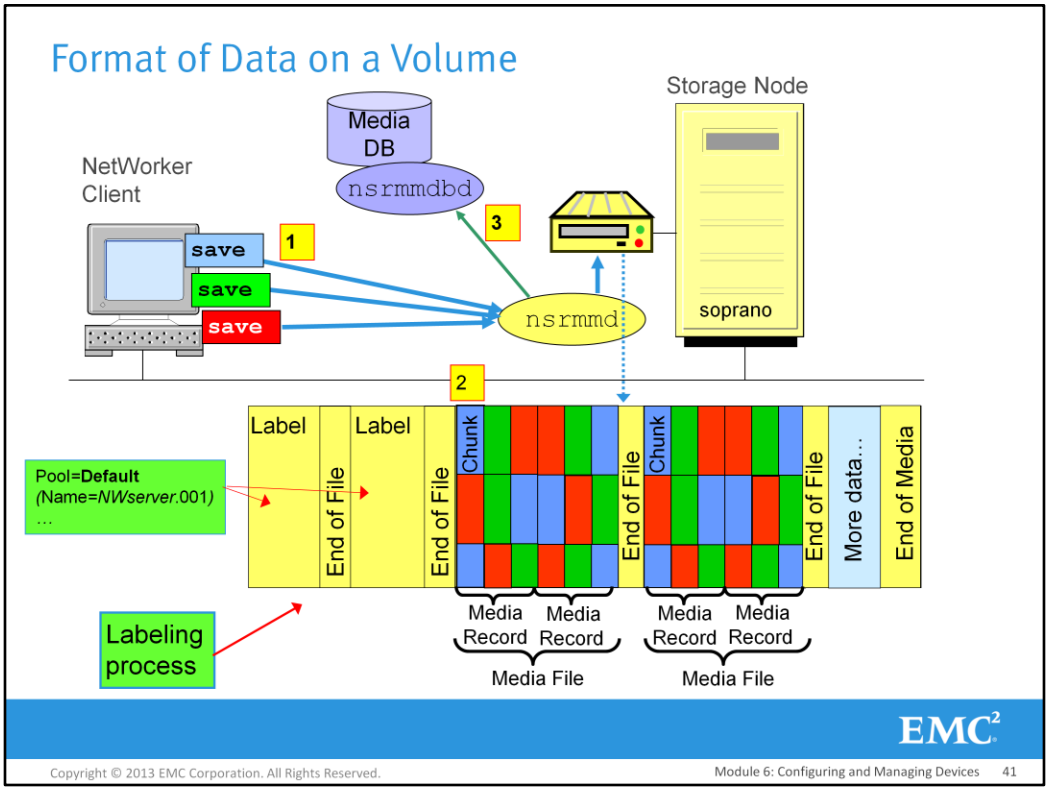
Multiplexing enables more than one save stream to write to the same device at the same time. This allows the device to write to the volume at the collective data rate of the save streams, up to the maximum data rate of the device.

The amount of multiplexing allowed (the number of save sets that can back up simultaneously) is primarily controlled by two NetWorker settings, *server parallelism* and device *target sessions*. These settings will be discussed in detail in a later module.



Open Tape Format (OTF) is a data format that allows multiplexed, heterogeneous (UNIX, Windows, NetWare, etc.) data to reside on the same tape. NetWorker clients send data in save set chunks to a storage node. The storage node arranges them in m*edia records* and *media files* which are stored in *volumes*. The way the storage node organizes the records and files is also platform-independent (Open Tape Format), allowing any NetWorker storage node to read the data. Because of Open Tape Format, a NetWorker storage node can be migrated to a host running a different operating system.

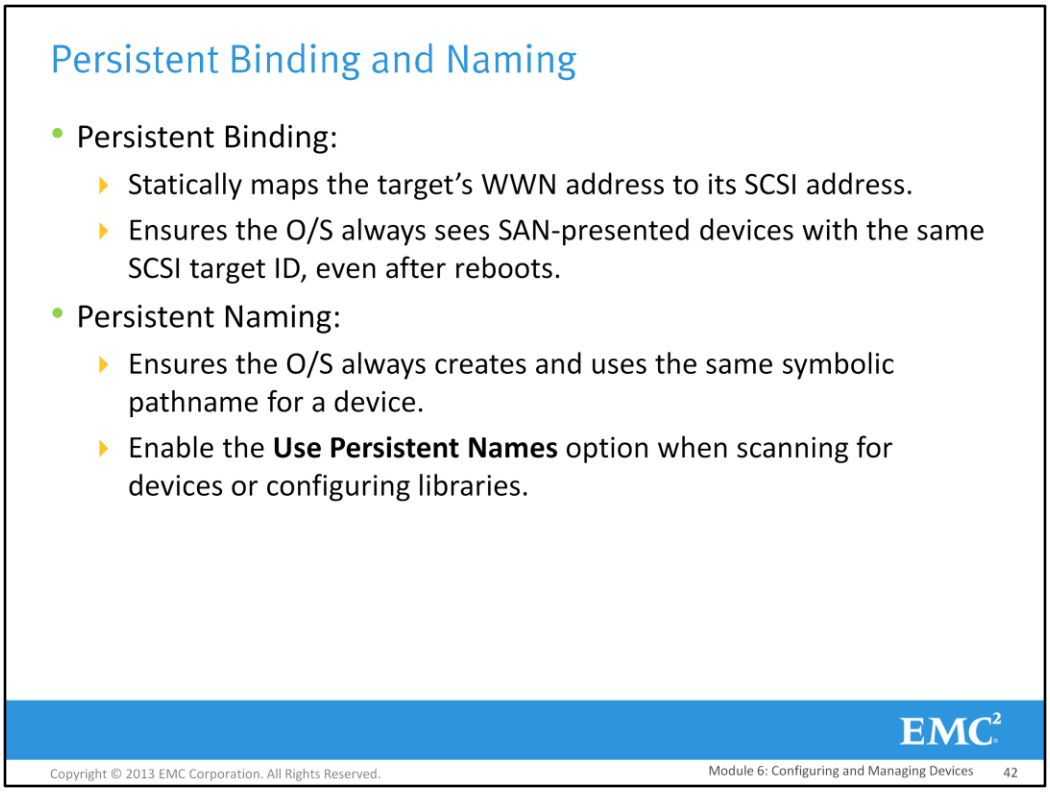
Note: For more information on OTF, refer to the `mm_data topic in the` *`EMC NetWorker Command Reference Guide`*`.`



After a device resource is created and a volume with a NetWorker label is mounted, `nsrmmd` writes save set data to the volume using the process illustrated in the slide:

1. When a save is initiated, `nsrmmd` interfaces with the device to write the data to the volume.
2. The `nsrmmd` daemon performs the following tasks to support multiplexing of backup data, using Open Tape Format:
   - Breaks each save set into chunks.
   - Combines chunks from various save sets into records.
   - Sends the records to the device which writes them to the volume.
   - Periodically, `nsrmmd` writes end-of-file marks to the volume, creating media files. These file marks are used for faster positioning during reading of the volume.
3. As each record is written to the volume, `nsrmmd` sends tracking information to the media database on the NetWorker server. This information is inserted into volume and save set records in the database, and tracks the location of each media file, media record, and save set chunk.

Note: For more information on Open Tape Format, see the `mm_data` topic in the *EMC NetWorker Command Reference Guide* or the UNIX/Linux man pages.



Persistent binding statically maps a target's WWN address to the desired SCSI address, ensuring the operating system always sees SAN-presented devices with the same SCSI target ID across reboots. This feature is enabled by default on some operating systems, while on others it has to be set manually.

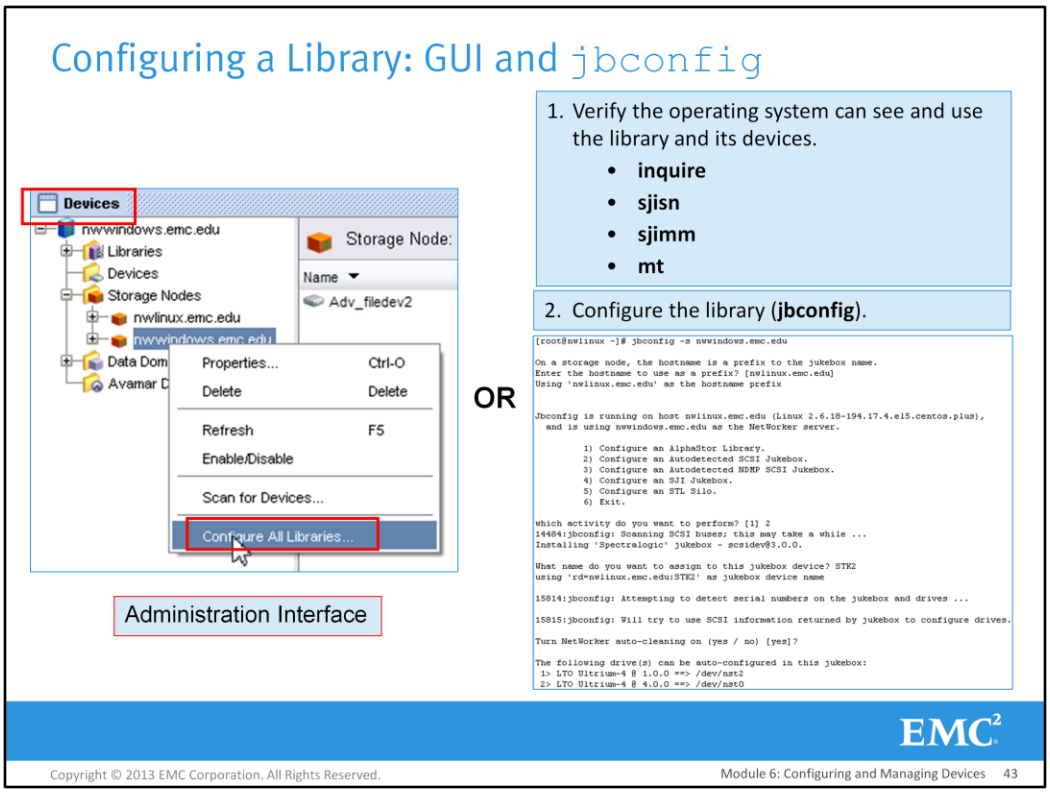
Persistent binding is required for consistent library operations as NetWorker communicates with the library controller over a SCSI address that is chosen during initial library configuration.

If the SCSI address changes, the library becomes unavailable. In such situations, it is required to disable the library and change the "control port" address to reflect the new SCSI address of the library controller.

Persistent naming is used to ensure that the operating system (O/S) or device driver of a server always creates and uses the same symbolic path for a device (sometimes referred to as device file).

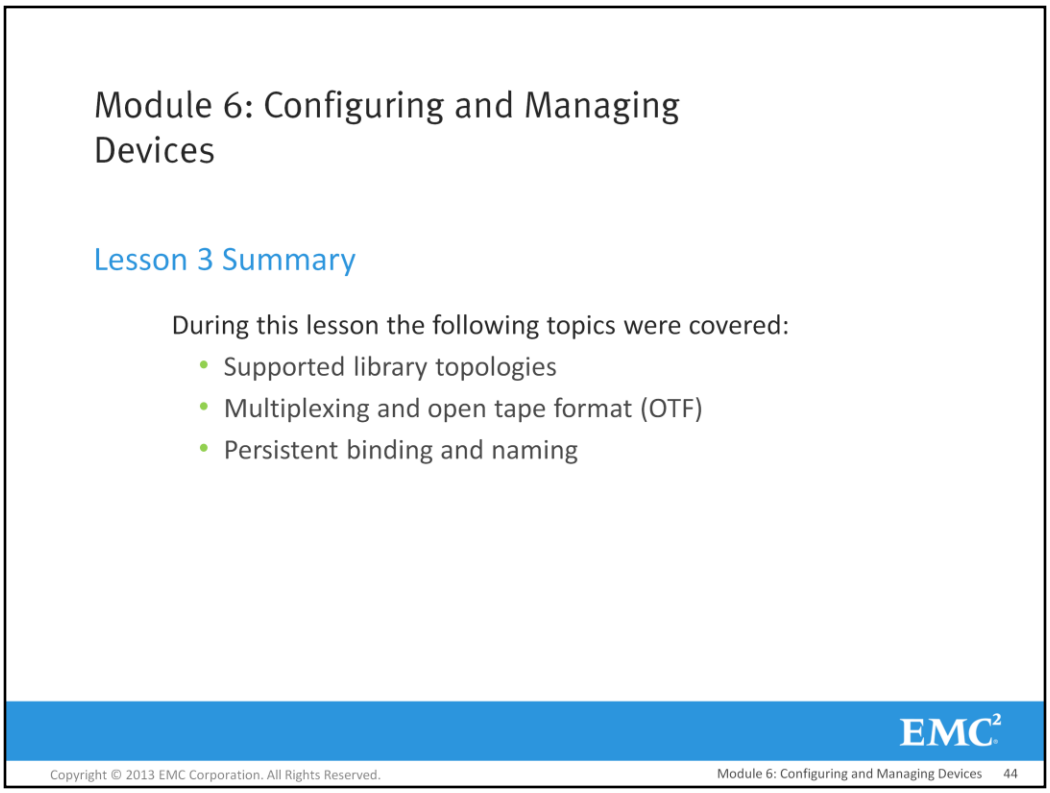
As a best practice, EMC recommends enabling persistent binding and naming for tape libraries and tape devices. This avoids device reordering on reboots or plug and play events. If a device reordering occurs, the NetWorker software is not able to use any affected drives until the configuration is manually corrected.

For details on how to configure persistent naming from the operating system or device driver, refer to your operating system and/or device driver documentation.

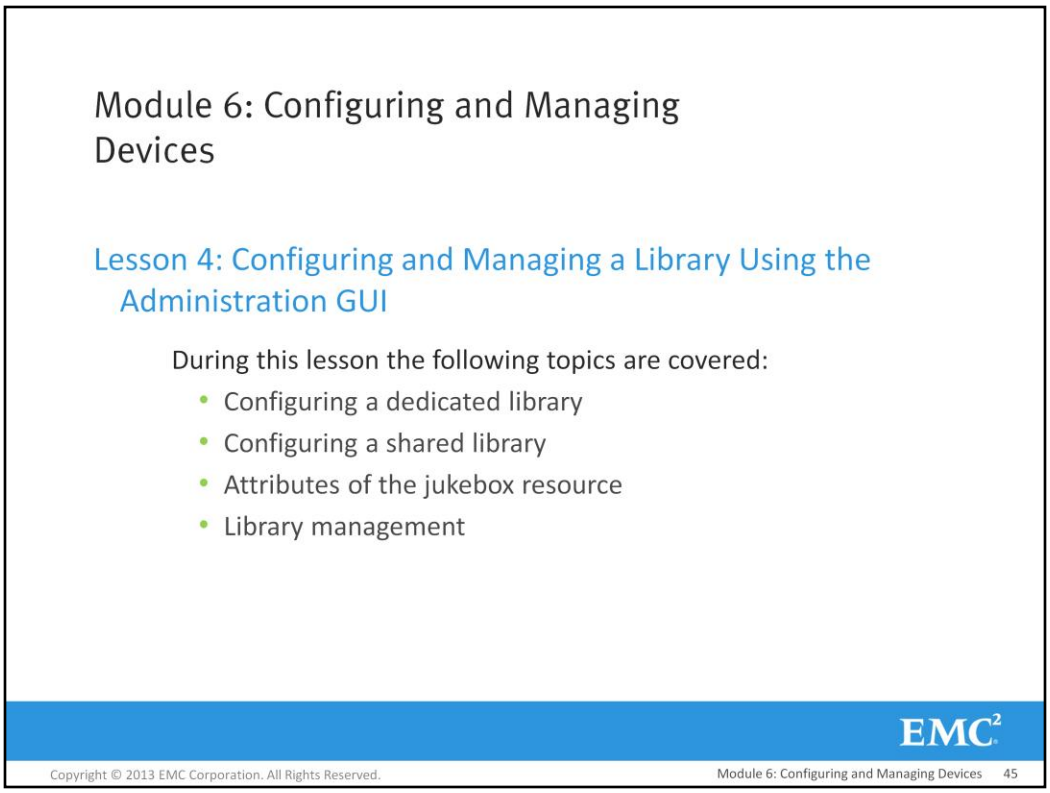


For NetWorker to use a library, a jukebox resource (NSR jukebox) must be created. This is done using either NetWorker Administration or the command-line utility, `jbconfig`.

For a library to be configured using NetWorker Administration, the library must be able to provide hardware information, such as device serial numbers, to NetWorker. If this information cannot be automatically provided to NetWorker by the firmware, `jbconfig` is used to configure the library.



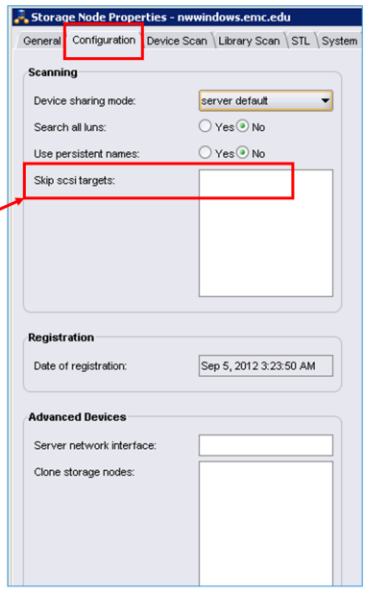
This lesson covered an overview of using libraries with NetWorker including supported library topologies, multiplexing and OTF, and persistent binding and naming.



This lesson covers how to configure and manage a library and its devices and volumes using the NetWorker Administration interface.

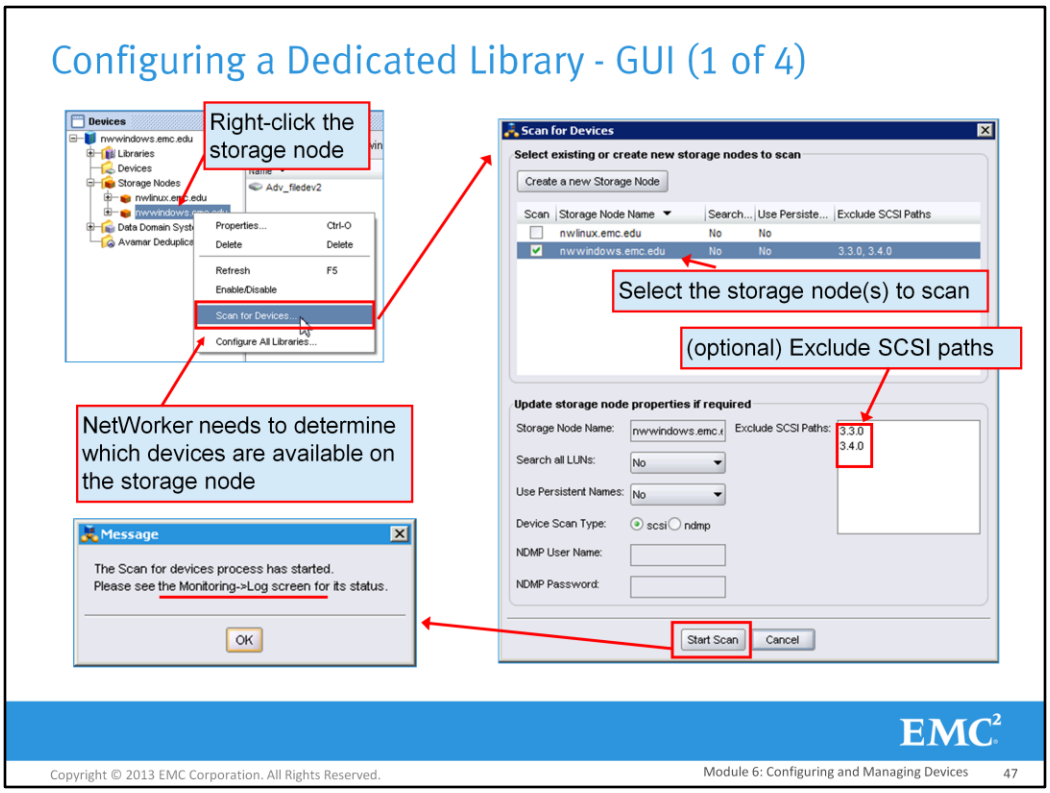
Configuring Storage Nodes for Libraries

- A storage node resource is required before the storage node can be scanned for devices.
- Specify any SCSI addresses to skip during the scan in **Skip scsi targets.**



To use NetWorker Administration to configure a library or drive on a storage node, a storage node resource must exist. The resource is used to scan the host for configurable tape drives and libraries. Note that a storage node resource is automatically created for the NetWorker server during installation.

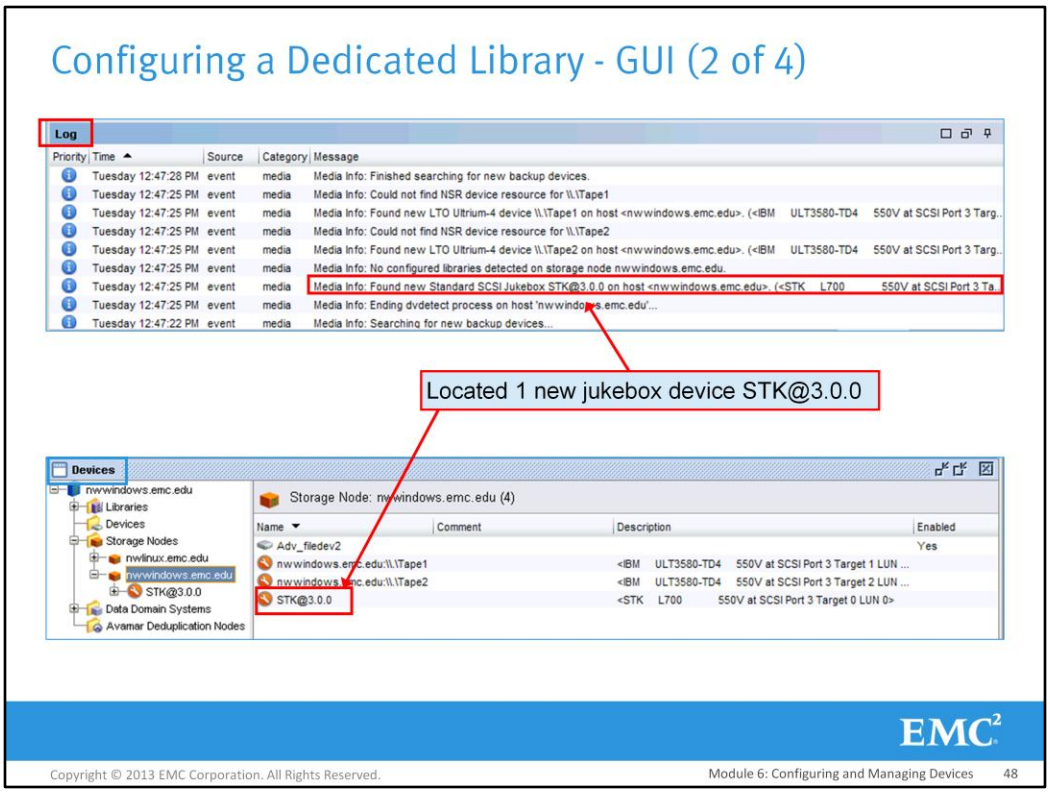
The **Skip scsi targets** field is used to specify SCSI addresses to skip (in *bus.target.lun format)* when performing a scan operation. This is useful if the storage node has tape drives or libraries that you do not want NetWorker to use. Placing a list of SCSI addresses to be skipped in the storage node resource results in those addresses being skipped during all scan operations.



A tape library can be configured using the Administration GUI.

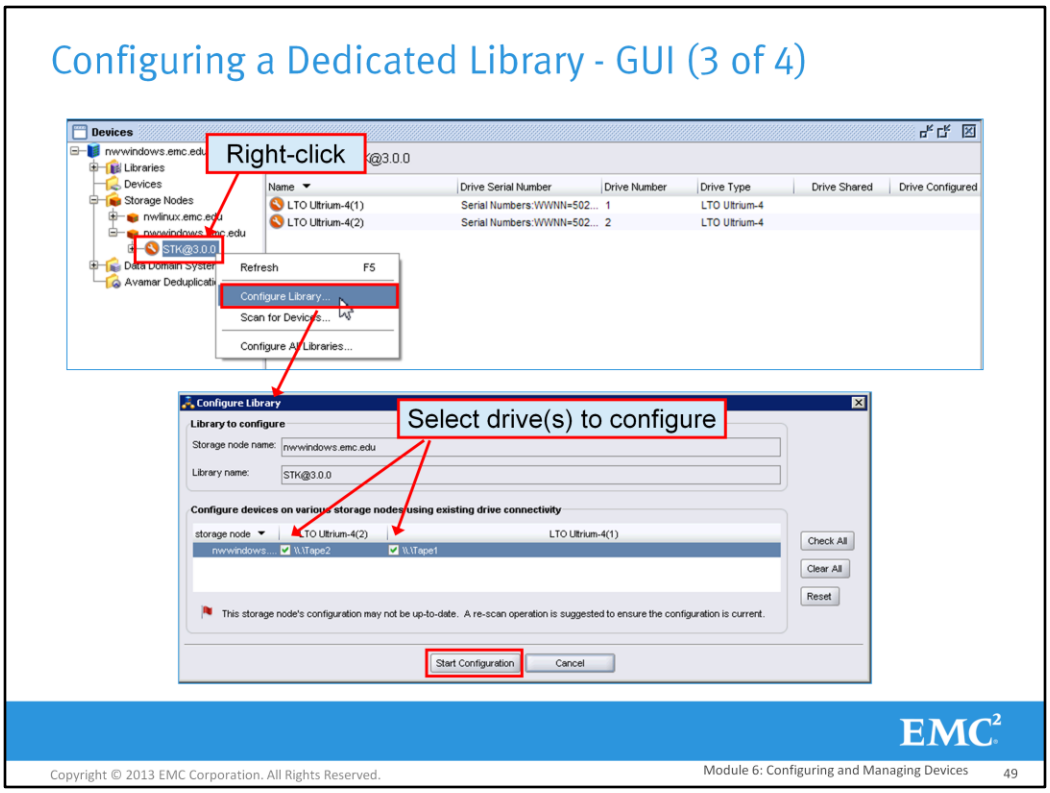
The first step in configuring a library is to scan the controlling storage node for libraries and devices that are not yet known to the NetWorker server, either direct attached or SAN attached. This is done by right-clicking the storage node in the left pane of the ***Devices*** window and selecting **Scan for devices** from the context menu. A window will open in which you can specify the storage node to scan. Although the storage node selected in the left-pane is automatically chosen, you can choose to scan any or all storage nodes for which a storage node resource is configured.

If there are unconfigured tape drives or libraries on the storage node(s) that you do not wish to be affected by a scan operation, specify each SCSI ID in the **Exclude SCSI Paths** field. This field can be used to prevent NetWorker from configuring a device and from unnecessarily scanning attached SAN disks or non-tape library/drive SCSI IDs. Any addresses in the **Skip scsi targets** attribute of the storage node resource are automatically included in the **Exclude SCSI Paths** for the storage node.



You can monitor the progress of the scan operation by viewing the ***Log*** screen.

After the scan operation is finished, unconfigured devices are displayed in the left pane of the ***Devices*** window. The icon used to represent an unconfigured drive or library looks like an orange circle containing a wrench.

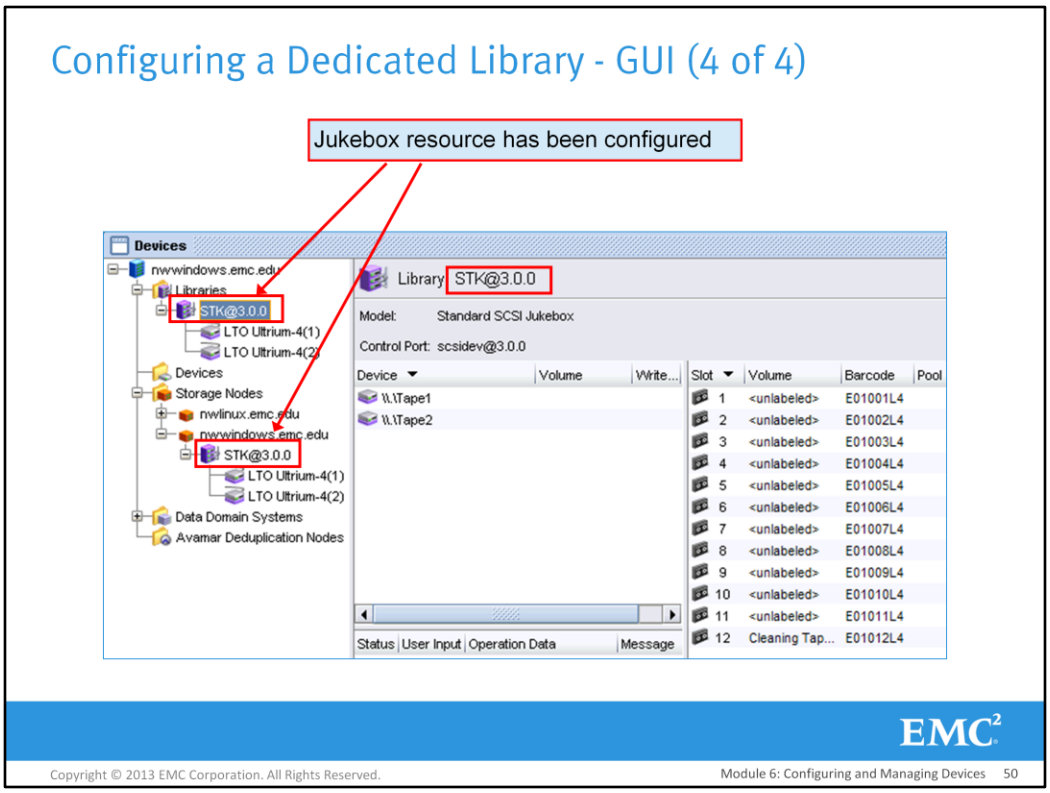


Next, configure the library (jukebox resource) and its devices. Right-click an unconfigured tape library in the left pane of the ***Devices*** window and select **Configure Library** from the drop-down menu. To create jukebox resources for all unconfigured libraries on a storage node, use the **Configure All Libraries** selection.

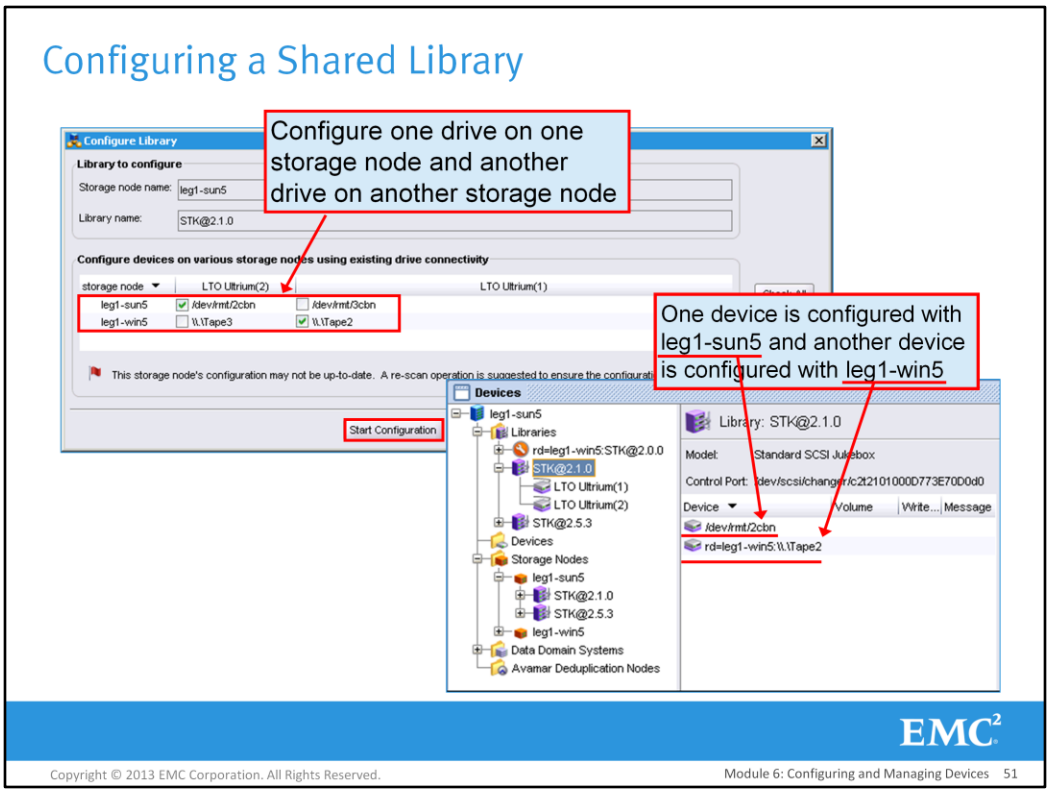
In the resulting ***Configure Library*** window, assign the drives in the library to the storage node that will control the robot. In the slide, there is only one storage node shown, nwwindows. However, in a SAN environment, it is possible that additional storage nodes are able to access the library. If these storage nodes have been scanned by NetWorker, they are also displayed in the window.

Click **Start Configuration** to create the jukebox resource and device resources for the drives within the library.

Important: An unconfigured library is listed in the left pane under each storage node that has access to it. Always configure a library under the storage node that you want to control the robot.



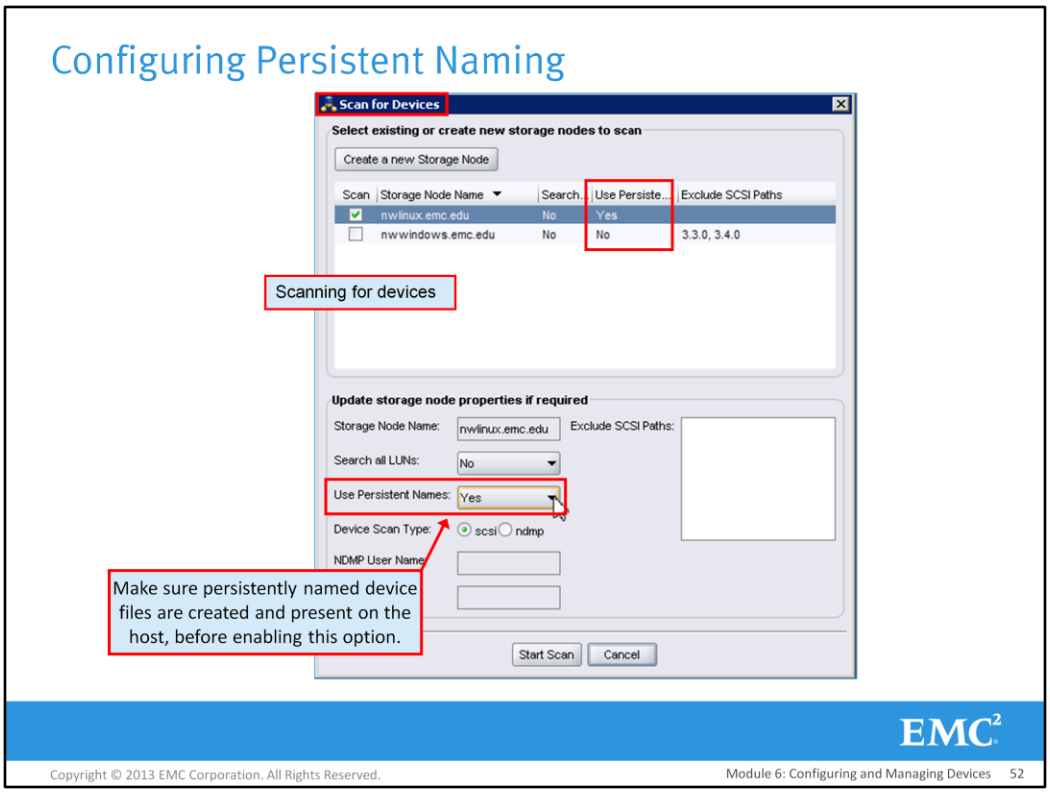
After a jukebox resource has been created, the icon for the tape library in the ***Devices*** window changes to reflect the fact that the library is now configured. Devices have been created for the tape drives. The slide shows a configured library with two tape drives. The display also shows that there are 12 slots in the library with 11 unlabeled tapes and 1 cleaning tape.



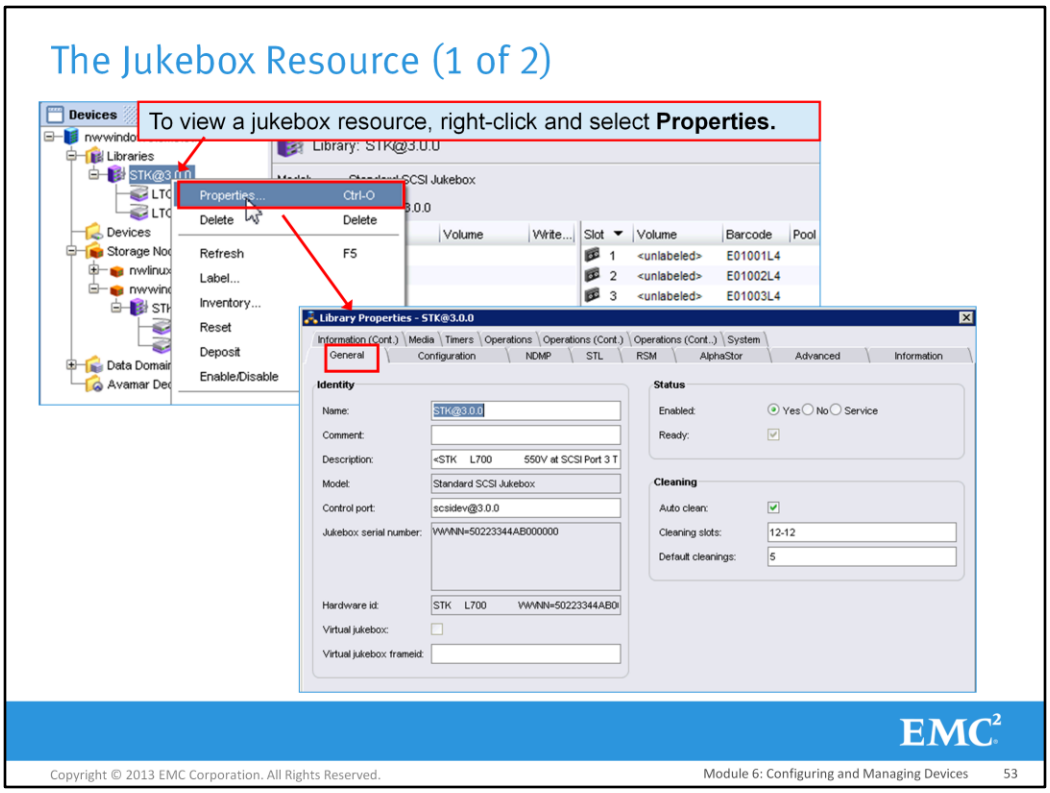
With library sharing, two or more storage nodes are each assigned one or more drives in the library to manage. Only one storage node manages each drive. When configuring a shared library, NetWorker uses the device serial numbers read during the scan operation to determine which storage nodes are able to access each drive in the library.

In the slide, `\\.\Tape3` on leg1-win5 and `/dev/rmt/2cbn` on leg1-sun5 have the same serial number. NetWorker also recognizes that `\\.\Tape2` on leg1-win5 and `/dev/rmt/3cbn` on leg1-sun5 have the same serial number and therefore point to the same physical drive. During library configuration, one drive is assigned to leg1-win5 and the second drive is assigned to leg1-sun5. After the library has been configured, the information in the ***Devices*** window reflects the fact that there are now two device resources associated with the tape library. The tape library is controlled by leg1-sun5. One of the drives is configured with leg1-sun5 and the other with leg1-win5.

Important: Always configure a library using the storage node that you want to control the robot.



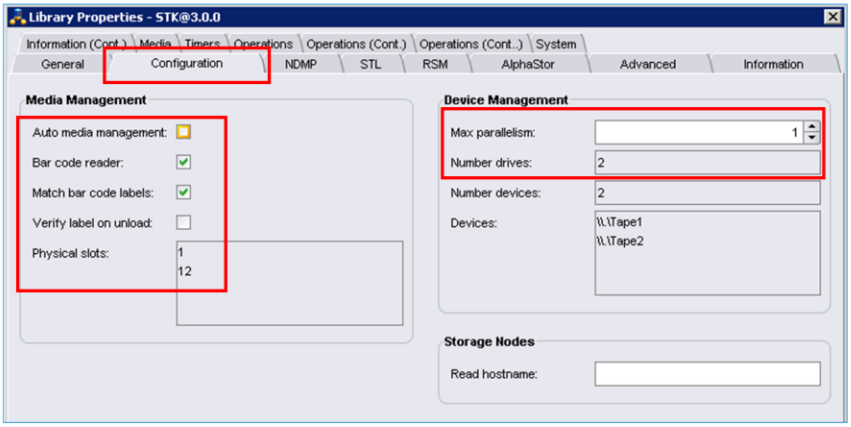
Device file names, created as a result of persistent naming, depend on the O/S and device drivers used to enable and configure tape devices. Where persistent binding has been enabled on the host, enable the **Use Persistent Names** option when scanning for tape devices, as shown on the slide.



Clicking a configured library displays information about the library's devices and current volume inventory.

To view a jukebox resource, right-click the library and select **Properties** from the drop-down menu. The ***General*** tab shows basic information about the library.

The Jukebox Resource (2 of 2)



Attributes found on the ***Configuration*** tab include:

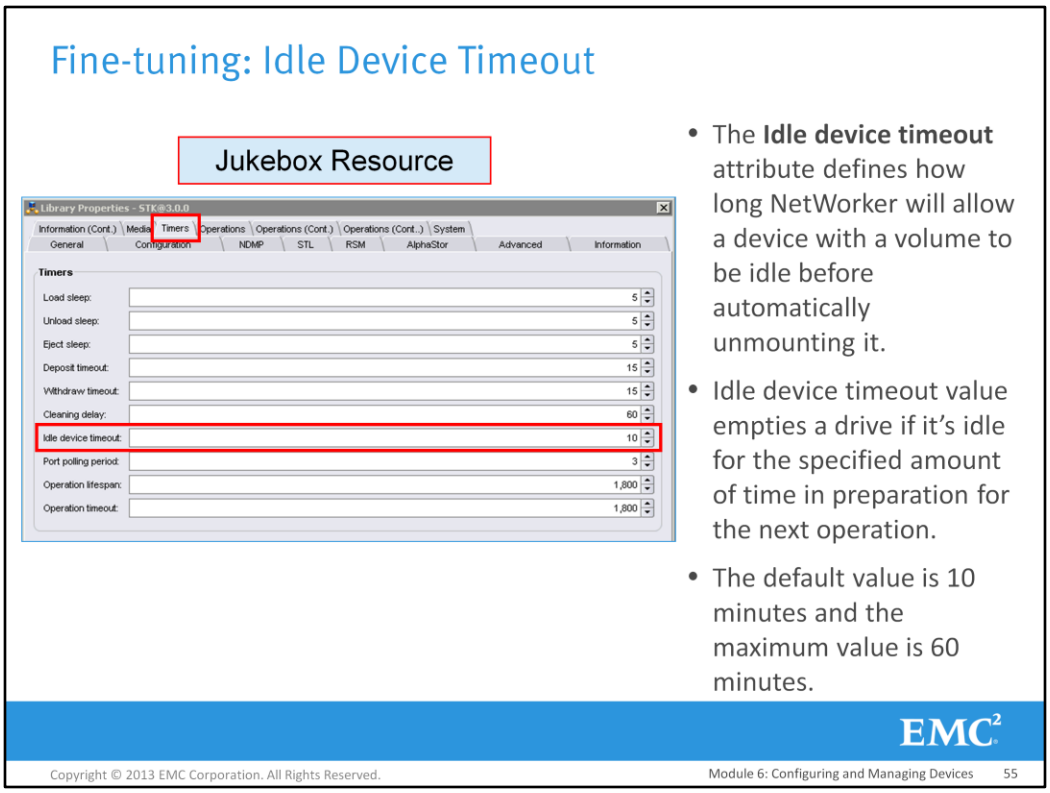
Auto media management: Indicates whether NetWorker should automatically label and write to non-NetWorker tapes as needed. It is disabled by default.

Bar code reader: Indicates whether NetWorker should list the bar code on the tape in the jukebox's inventory and in the media database. It is enabled by default.

Match bar code labels: Indicates whether NetWorker should use the value on the bar code as the NetWorker volume name for the tape. It is enabled by default.

Physical slots: these are the first and last slots containing writable media. All slots in this range can contain writable media.

Max parallelism: The maximum number of drives to use concurrently for a label or inventory operation. The default value is one less than the number of drives in the jukebox (**Number drives** attribute).



Idle device timeout is an attribute in the jukebox resource that defines how long a NetWorker storage node waits to unmount an idle volume from a drive in the library. Until the timeout period has elapsed, the NetWorker storage node has control of the drive.

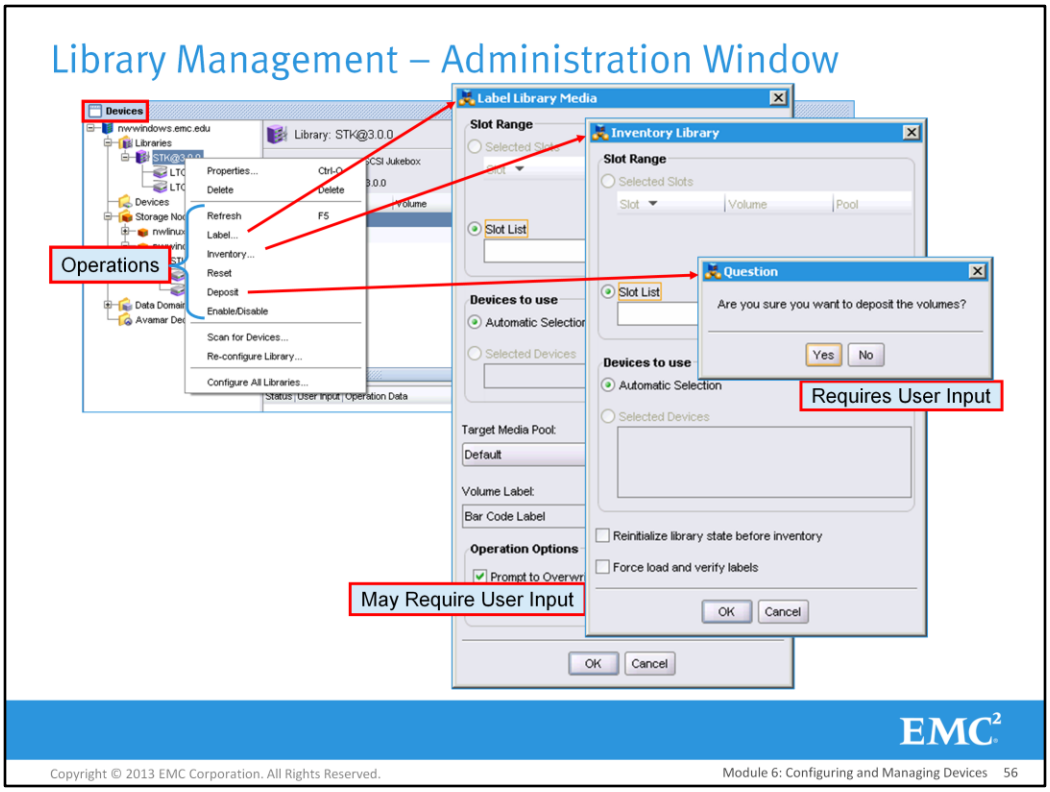
Lowering the **Idle device timeout** value ensures the drive is emptied quickly, within the specified timeout value. The drive and the volume are then available for a next operation.

The default setting is 10 minutes and the maximum setting is 60 minutes. If the value is 0, the tape remains in the drive until it is manually unmounted.

Notes:

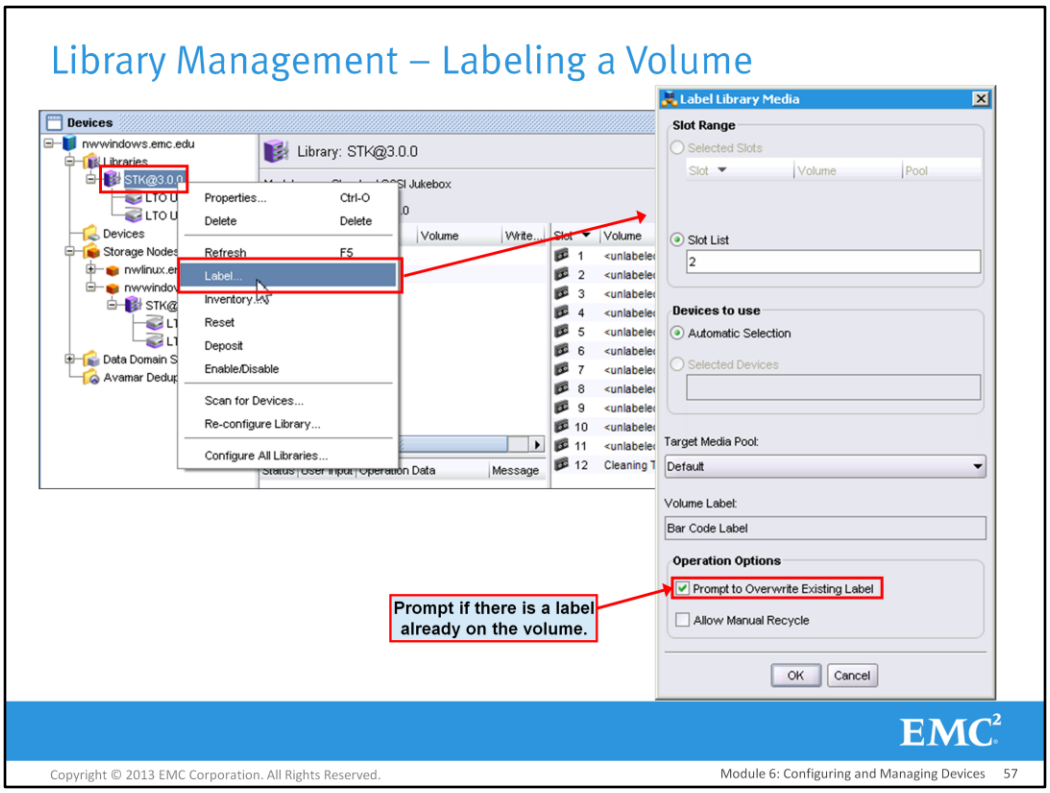
Idle device timeout can be configured for a device in the library from the ***Advanced*** tab of the device resource.

For a virtual tape library, NetWorker automatically sets the **Load sleep**, **Unload sleep**, and **Eject sleep** timers to 0 seconds.



NetWorker libraries are managed using either the NetWorker Administration ***Devices*** window or the `nsrjb` command-line utility.

Using the ***Devices*** window, mount, unmount, label, and inventory operations are performed by right-clicking a tape library and choosing the appropriate selection from the drop-down menu. From the menu, you can also perform a hardware reset of the library and have volumes moved from the import slots to empty volume slots.



After configuring a library, a volume must be labeled before the library and its devices can be used for backups. To label volumes in a library, right-click the library name in the left pane of the ***Devices*** window and select **Label** from the drop-down menu.

In **Slot List**, specify the slots containing the volumes to be labeled.

In **Target Media Pool**, select the pool to which this volume will belong.

With **Prompt to Overwrite Existing Label** checked (default), NetWorker prompts the user if there is an existing label on the volume.

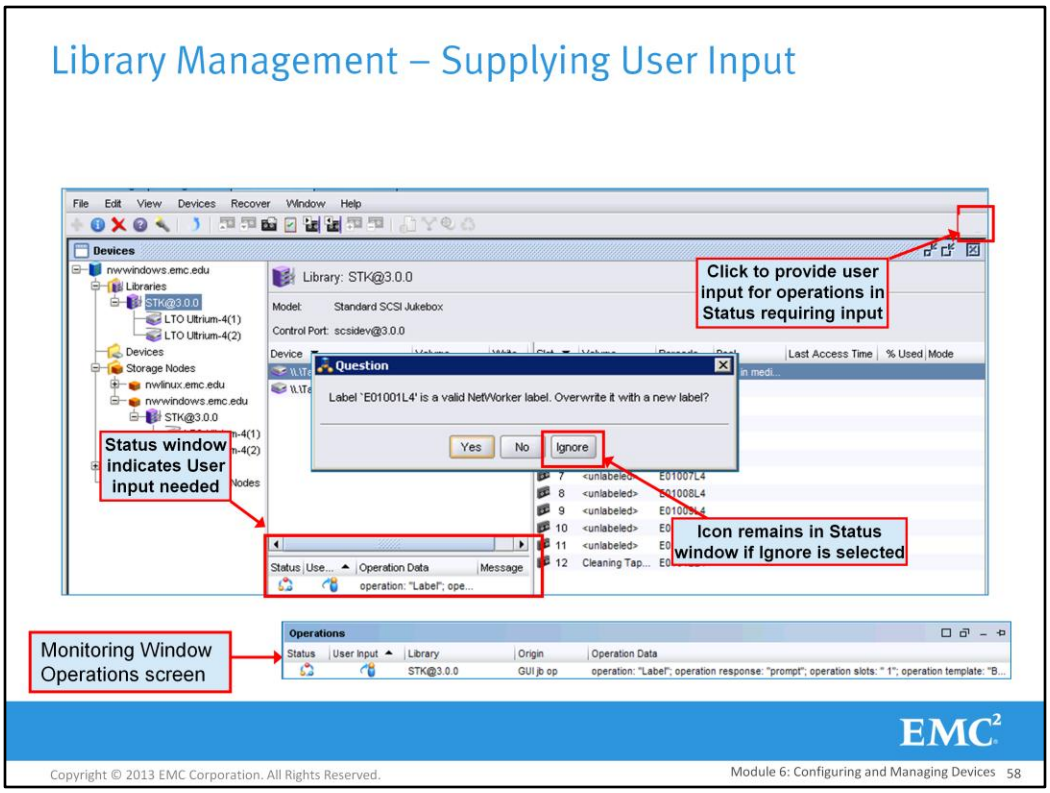
If the volume should not be recycled automatically, select **Allow Manual Recycle**.

After a volume is labeled, it must be mounted before NetWorker can use it. This is done automatically within a library.

Notes:

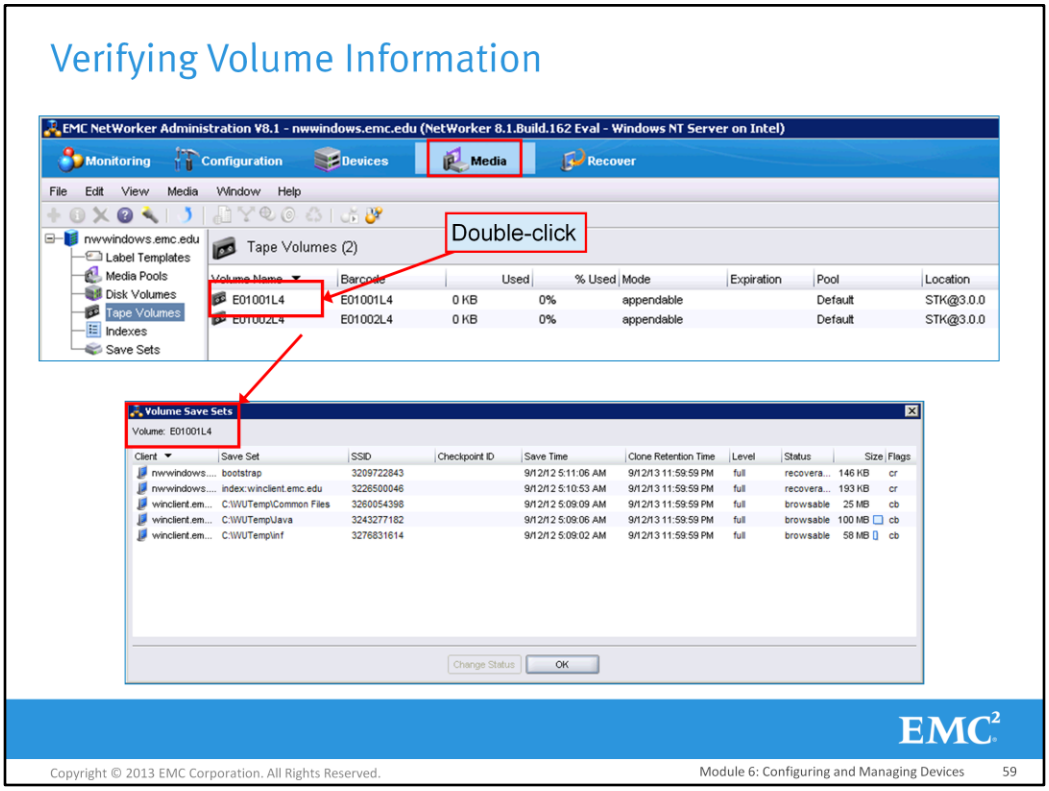
When **Auto Media Management** is enabled, NetWorker automatically mounts a volume in a device when needed and labels the volume if it is unlabeled.

If an existing volume is labeled in NetWorker, existing data on the volume will be completely lost. You will not be able to recover any data that existed on the tape before the label operation.



The **Status** table in the ***Devices*** window shows operations in progress. When there is an operation that requires user input, such as labeling a tape which already contains a label or depositing volumes into a library, NetWorker pops up a dialog box automatically and a **User Input** icon is displayed in the **Status** table.

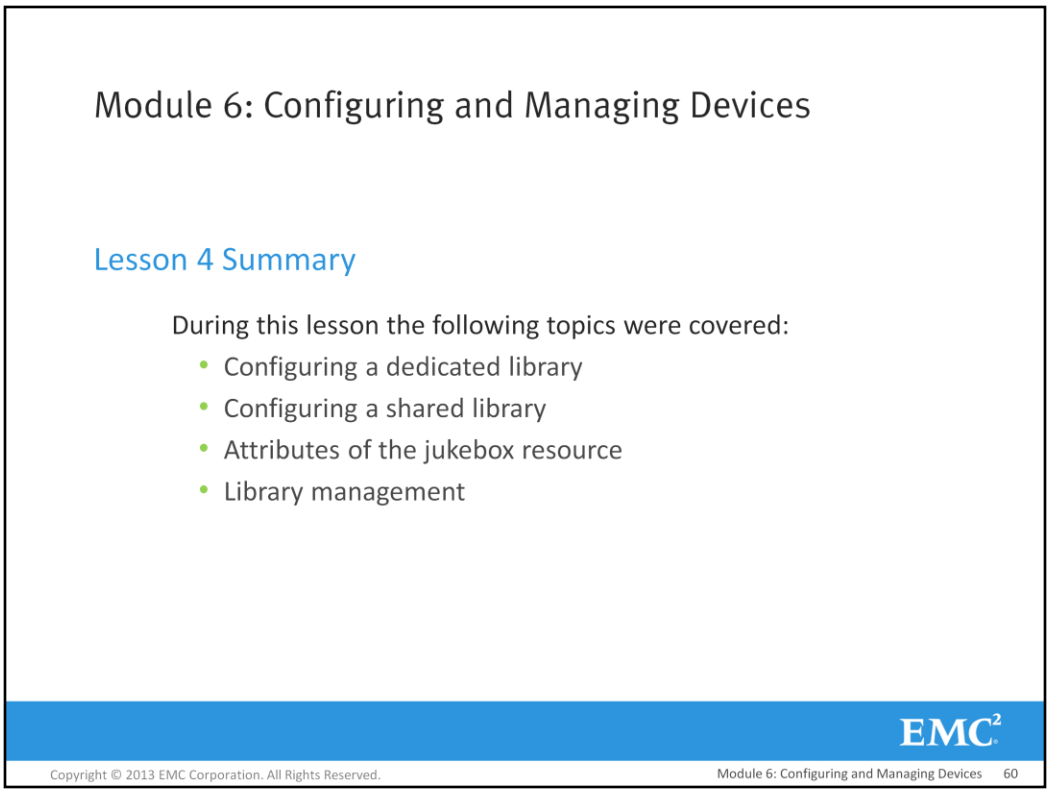
If you choose **Ignore** from the dialog box, the icon remains in the **User Input** field as a reminder that input must be provided before the operation will continue. To later supply input, click the **User Input** icon on the shortcut bar. Note that this icon is available from any NetWorker Administration window. Alternately, input can be supplied by selecting **Supply Input** from the ***Operations*** screen of the ***Monitoring*** window.



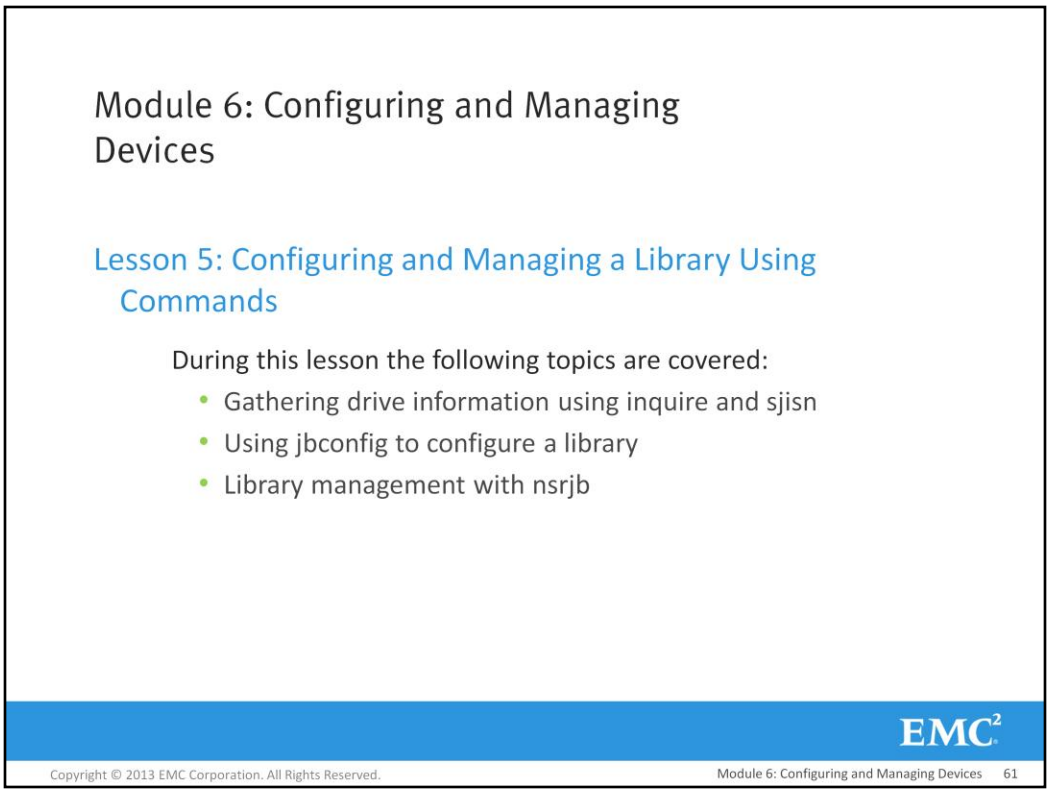
To see status information for labeled tape volumes , select **Tape Volumes** in the left pane of the ***Media*** window. Attributes displayed for the volumes include:

- **Barcode:** the volume's bar code, if configured.
- **Used:** the amount of data written to the volume.
- **% Used:** the percentage used based on the Volume default capacity value in the device resource.
- **Mode:** the volume mode, possible values are appendable, manual recycle, read-only and recyclable.
- **Expiration:** the date on which the volume will become recyclable.
- **Pool:** the pool to which the volume belongs. You can check the save sets on a volume using the **Tape Volumes** node from the Administration ***Media*** window.

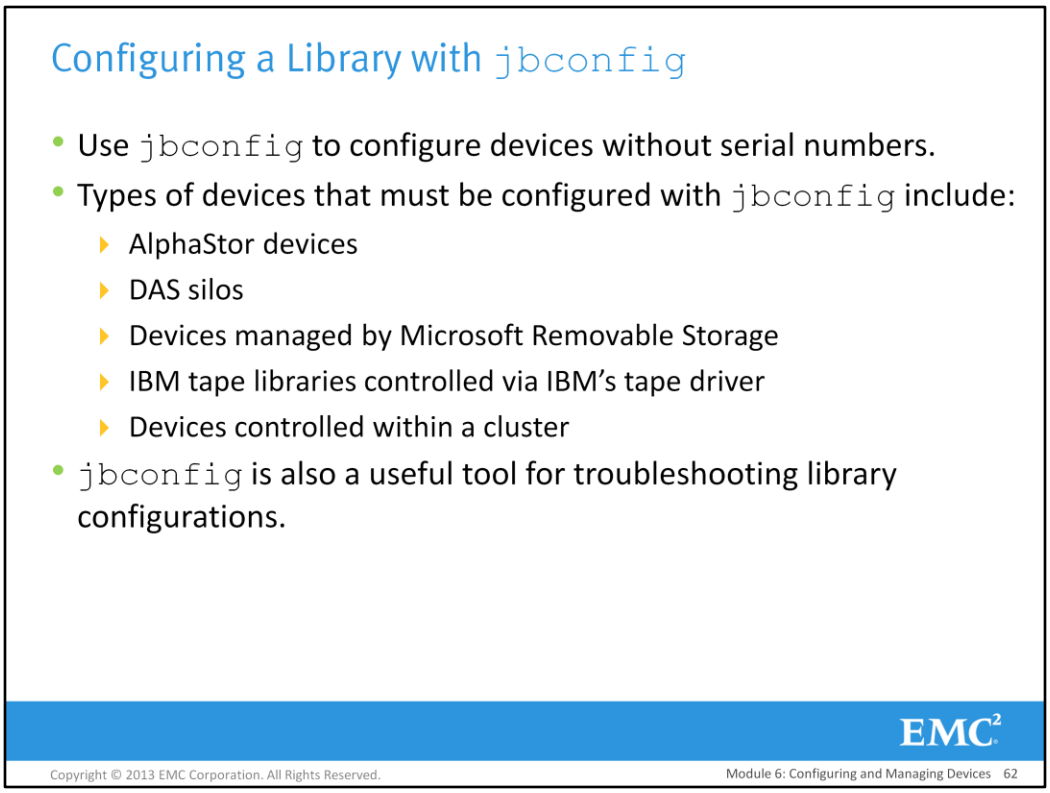
By double-clicking a volume in the right pane, you can display a list of save sets that have been written to the selected volume. This is a good way to verify that a first backup to a tape device is happening as expected.



This lesson covered how to configure and manage a library and its devices and volumes using the NetWorker Administration interface.



This lesson covers how to configure and manage a library and its devices and volumes using NetWorker commands.

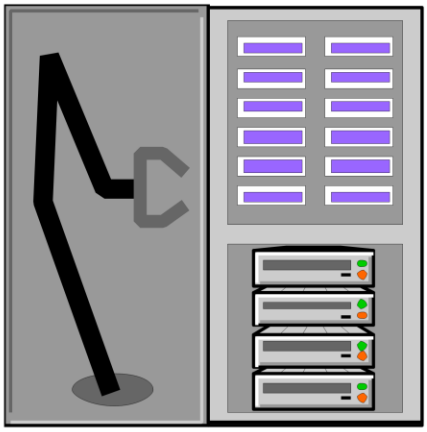


Libraries that have serial numbers can be configured using either NetWorker Administration or the NetWorker **jbconfig** command. However, devices that do not provide serial numbers must be configured using jbconfig. Also, jbconfig is used in situations where NetWorker Administration doesn't recognize or configure the library, and when troubleshooting library configuration problems.

Situations where jbconfig must be used to configure a library include the following:

- AlphaStor devices
- DAS silos
- Devices managed by Microsoft Removable Storage
- IBM tape libraries controlled via IBM's tape driver
- Robotics controlled within a cluster
- Any library that does not return serial numbers

Understanding Drive Order and Pathname Mapping



- Drives have several identifiers: SCSI address, element address, pathname.
- Drive with lowest element address is the first drive in the library.
- Use persistent binding and naming to avoid device reordering issues.

SCSI Addr	Element Addr	OS Pathname
1.1.2	63003	\\.\Tape0
1.1.3	63002	\\.\Tape1
1.1.4	63001	\\.\Tape2
1.1.5	63000	\\.\Tape3

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Tape drives in a library have several identifiers, including:

SCSI address - Each tape drive has a unique bus, target, and logical unit number (LUN). Many people mistakenly believe that the lowest SCSI address is the first tape drive in the library. This is not always the case.

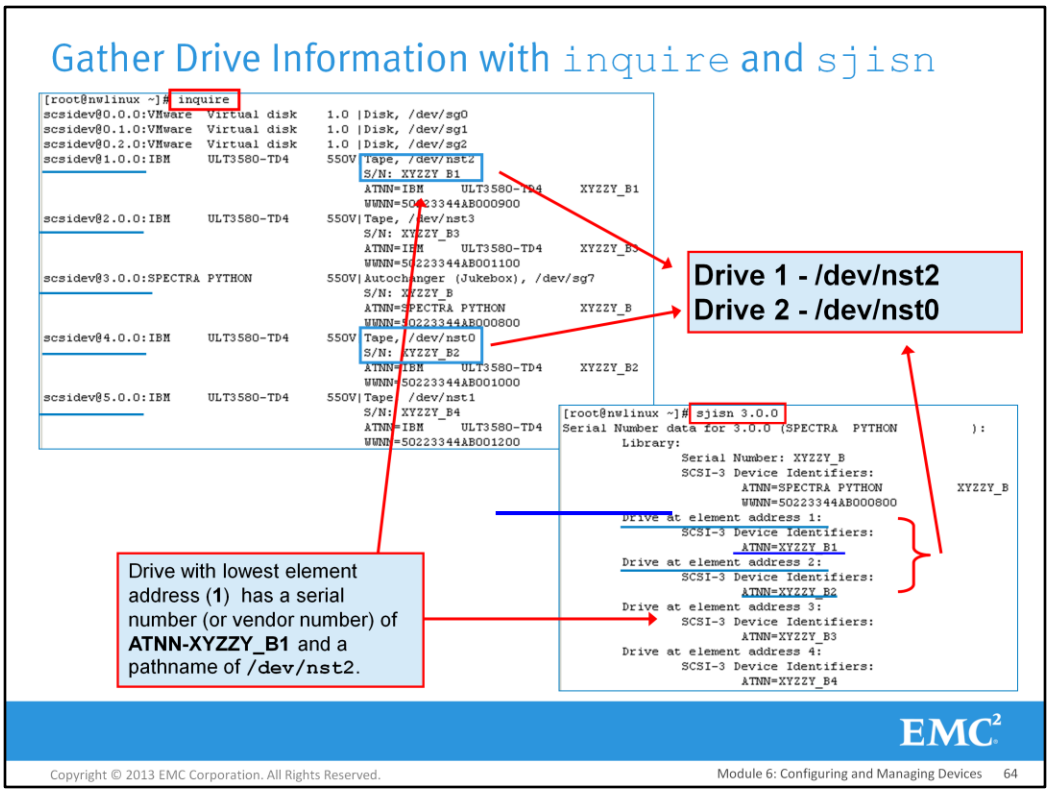
Library element address - Each slot and tape drive is assigned a unique element address by the robotic controller. The tape drive with the lowest element address is the first drive; the next highest element address is the second drive, and so on.

Operating system pathname – A tape drive is accessed through its operating system device pathname.

When using `jbconfig` to configure a tape library, you are prompted to enter the operating system pathname of each drive, beginning with the drive having the lowest element address. Understanding the order of the drives is necessary to properly configure the library.

When using `jbconfig` to configure the library shown in the slide, you are prompted four times for the pathname of a tape drive in the library. What is the correct sequence of pathnames to enter? Since you are first prompted for the drive having the lowest element address, the correct sequence is `\\.\Tape3`, `\\.\Tape2`, `\\.\Tape1`, and `\\.\Tape0`. This order corresponds with the ordering of the element addresses.

Persistent binding and persistent naming can be used to resolve issues regarding device ordering.



Before running `jbconfig`, make sure that the operating system can see and use the library and its devices.

The NetWorker `inquire` command lists all SCSI devices detected by the operating system on the storage node. This command is part of the storage node software.

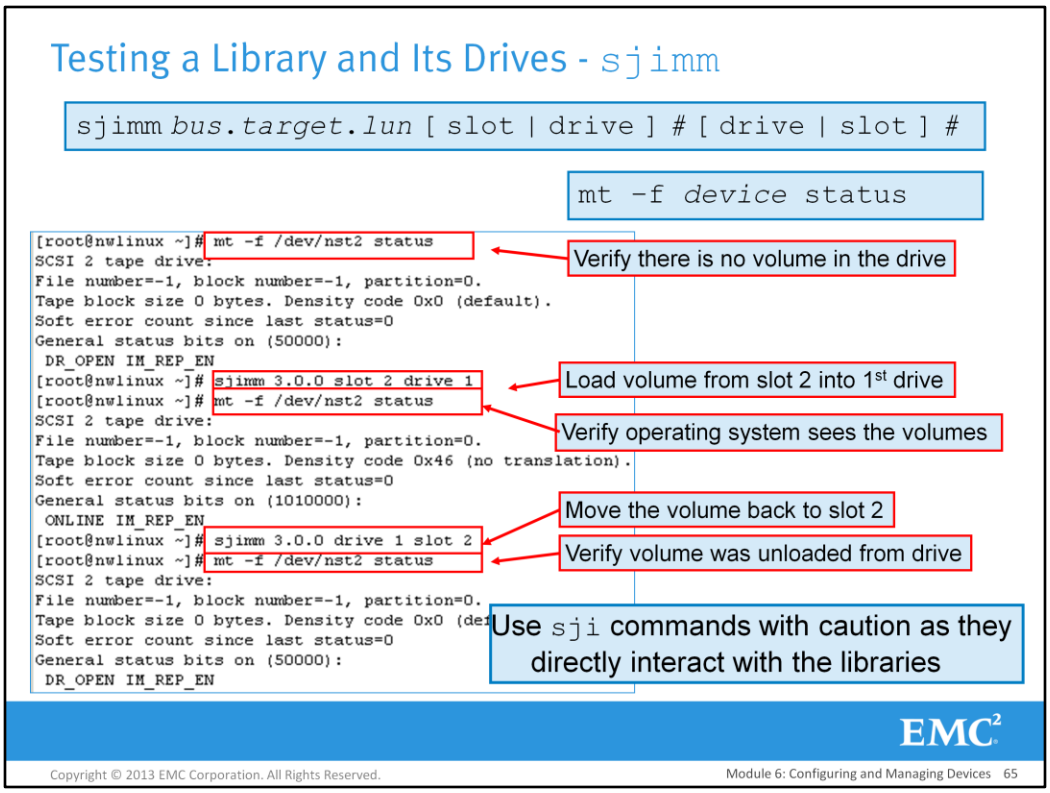
The `sjisn` command is used to display information about a specific library. Not all libraries support the `sjisn` command.

The syntax of `sjisn` is: `sjisn` *bus.target.lun*

By comparing the output from `inquire` and `sjisn` you can determine the tape drive ordering and the operating system pathname assigned to each drive.

In the slide, the `sjisn` output shows the serial number of the drive at element address 1 is XYZZY_B1. The output of the `inquire` command shows the operating system has assigned the drive with that serial number a device pathname of **/dev/nst2**. Since 1 is the lowest numbered element address, when prompted by `jbconfig` to provide the path name of the first drive in the library, you should enter **/dev/nst2**.

Note: For more information, see the `inquire`, `changers`, and `sjisn` topics in the *EMC NetWorker Command Reference Guide* and the UNIX/Linux man pages.



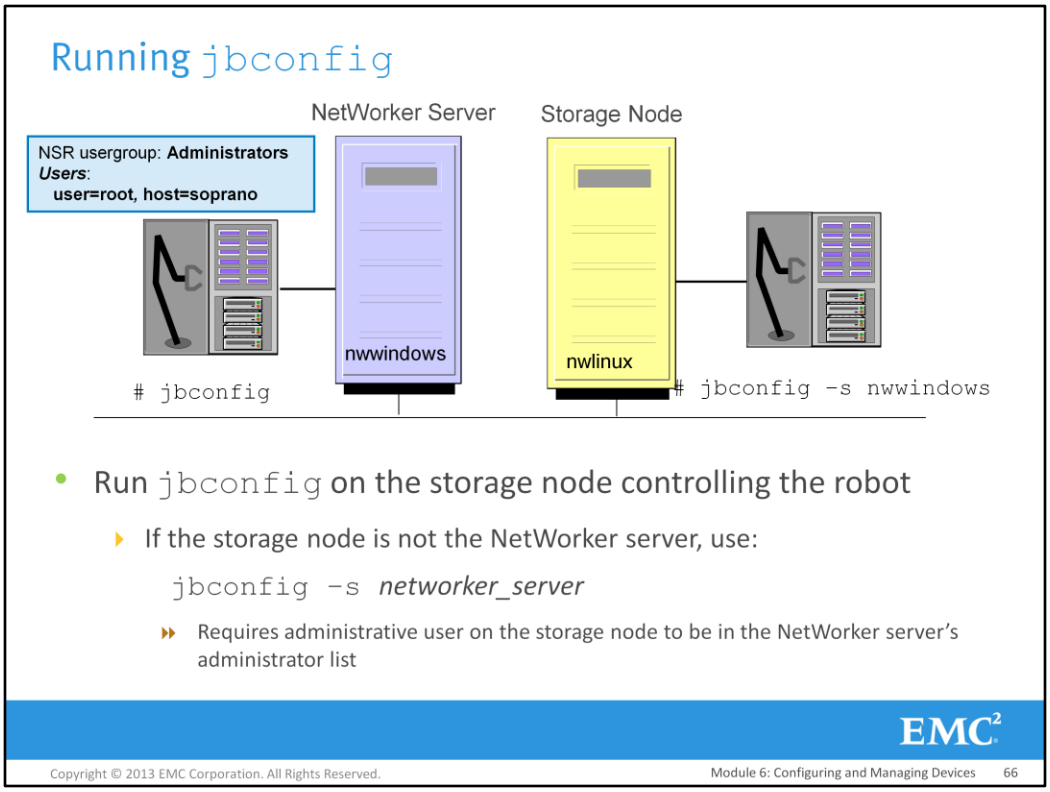
To test the functionality of a library, the NetWorker `sjimm` command can be used. It allows you to move media between slots and drives in a library. You may also be able to move media using the library's interface, such as its front panel.

To test a device, load a volume into a drive and then verify the operating system can see the volume in the drive. This can be done using the `mt` command, which is native to UNIX hosts and is provided as part of the NetWorker software on Windows hosts. When mt is used with the status option, it will either return data on the device in the drive, or state no device in drive.

You can also use the `sjirdtag` and `sjirelem` commands to display the changes being made by the `sjimm` command. These commands read the media presence and data from a jukebox. The `sjirelem` command can also print where the last place of a piece of media had been prior to its current location, when the jukebox provides that information.

See the `sjimm`, `mt`, `sjirdtag`, and `sjirelem` topics in the *EMC NetWorker Command Reference Guide* and the UNIX/Linux man pages for more information and a description of additional features.

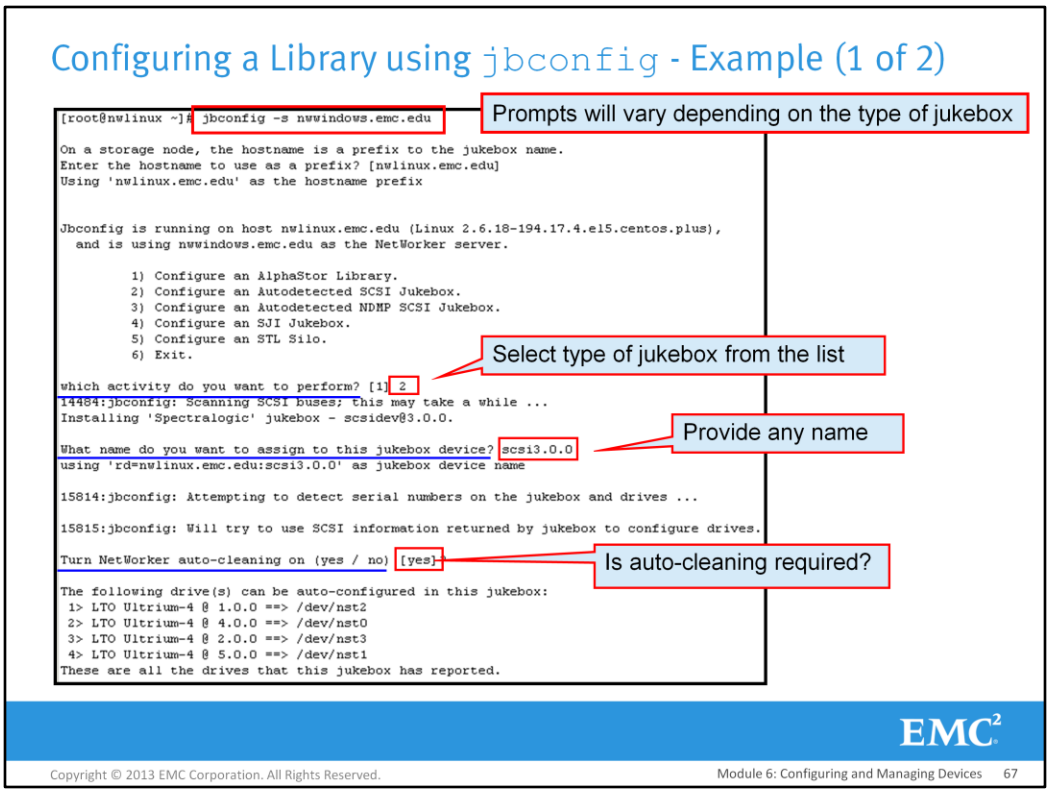
Caution: A series of commands exists that allow direct interaction with libraries (`sji` commands) and tape drives (`cdi` commands). These commands should only be used by expert users, as the consequences of using them can be unknown. These commands may directly interact with the libraries and drives without the knowledge of NetWorker.



The **jbconfig** command is executed from the storage node managing the library control port (robotic arm). If it is a remote storage node, you should use the `-s` option followed by the name of the NetWorker server. If the **-s** option is not used and **nsrd** is not running on the local host, you are prompted for the name of the NetWorker server on which the jukebox resource will be configured.

Since **jbconfig** creates a jukebox resource on the NetWorker server, if it is executed from a storage node, the administrative user running the command must belong to the NetWorker server's **Administrators** user group. After **jbconfig** creates the resource, the user can be removed from the user group.

After the jukebox resource is created, it is managed using either of the standard administrative interfaces: NetWorker Administration or **nsradmin**.



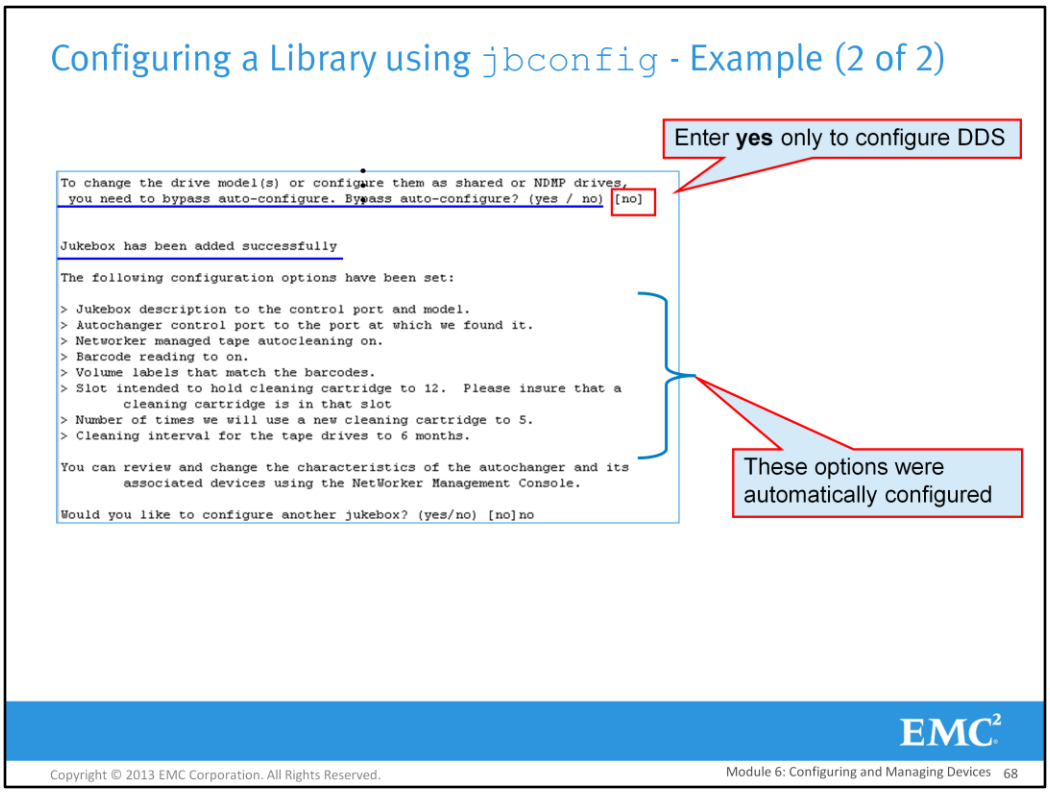
`jbconfig` prompts vary from library to library, but commonly include:

Type of Jukebox - This course covers auto-detected SCSI libraries.

Which Jukebox - Select the library to configure from the list of auto-detected libraries. Only SCSI libraries that have not already been configured are listed. If there is only one configurable library, you are not prompted.

Jukebox Name - The name you want to assign to the library.

Auto Clean - Indicate whether to use NetWorker to manage device cleaning.



Is any drive intended for NDMP use? - Network Data Management Protocol (NDMP) is a protocol used by Network Attached Storage (NAS) devices to control backups and backup devices. Answer **yes** if any of the drives will be used to receive NDMP data.

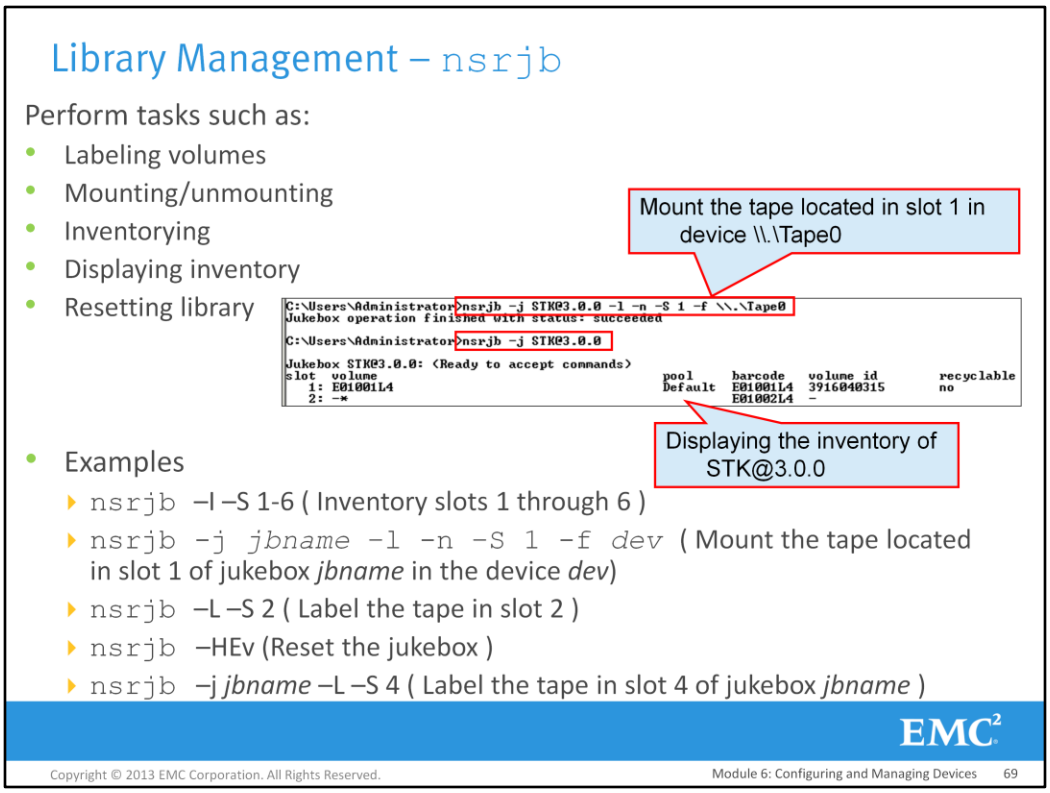
Additional **`jbconfig`** prompts include:

Is any drive going to have more than one path defined - Answer **yes** if dynamic drive sharing is being configured for any of the drives in the library.

The pathname of each tape device – This is the operating system pathname.

Device type - such as LTO2 or DLT7000.

After receiving all your input, **`jbconfig`** lists the options that have been set.

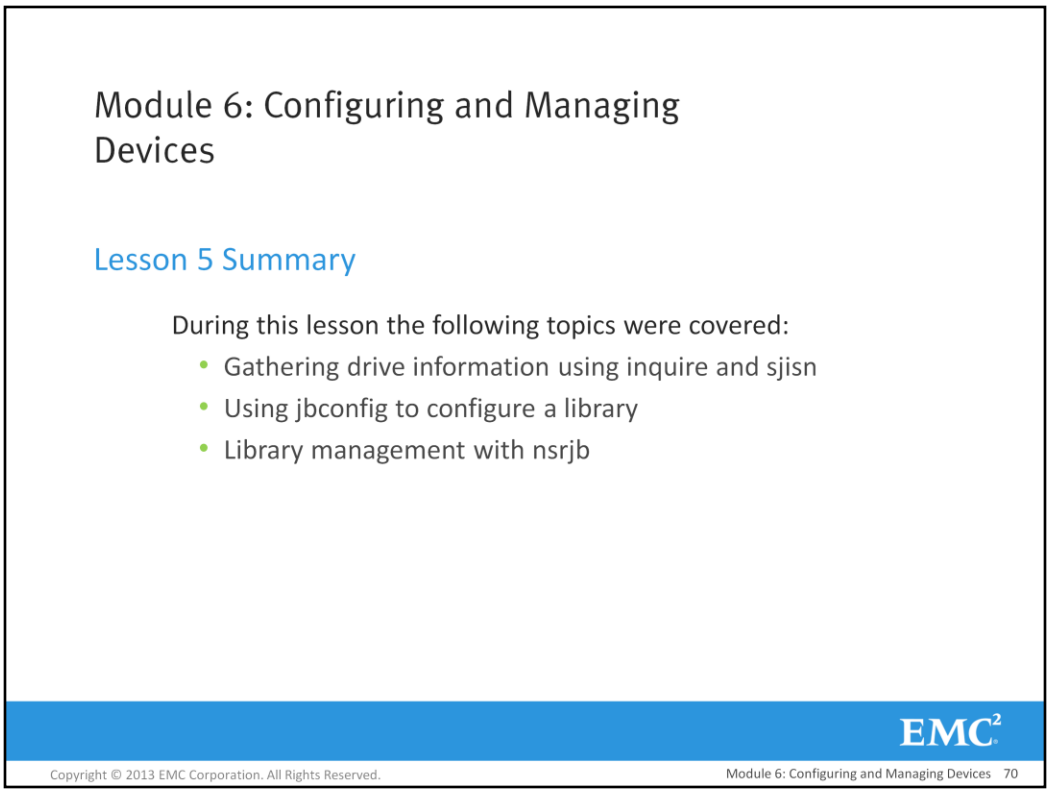


nsrjb is a NetWorker command line utility used to manage NetWorker library (jukebox) operations. `nsrjb` can be used to perform tasks such as labeling volumes, mounting and unmounting volumes, and inventorying and resetting a library. The slide shows several examples of using the command.

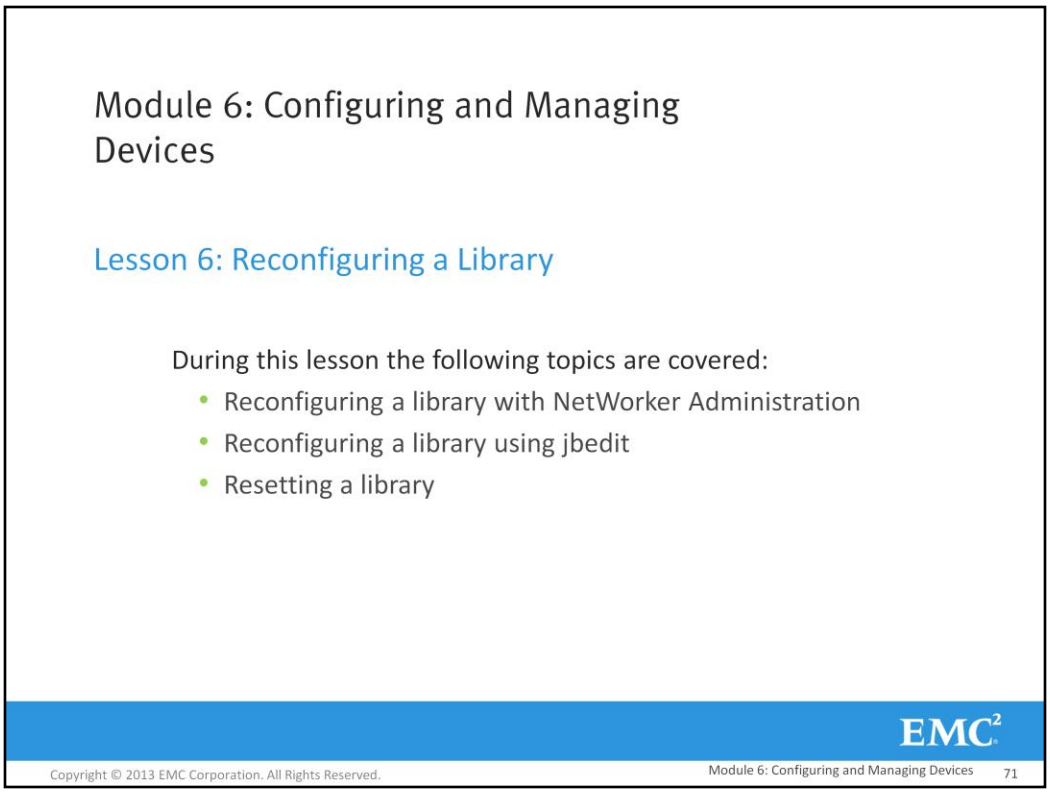
Command options include:

- `-C` - List the jukebox contents. (This is the default option.)
- `-H` - Reset the jukebox to a known state: drives emptied, etc.
- `-E` - Reset the jukebox element status.
- `-I` - Inventory the volumes in the jukebox.
- `-S` *slots* - The slot(s) to use for operations such as labeling, inventorying, withdrawing, etc.
- `-j` *jbname* - Specify the jukebox on which to perform the operation.
- `-u` - Unmount the volume, drive, or slot specified.
- `-l` - Mount (load) the volume, drive, or slot specified.
- `-f` *device* - The device to use for the operation.
- `-L` - Label the volume, drive, or slot specified.
- `-v` - Produce verbose output.
- `-p` - Verify and print the volume label.

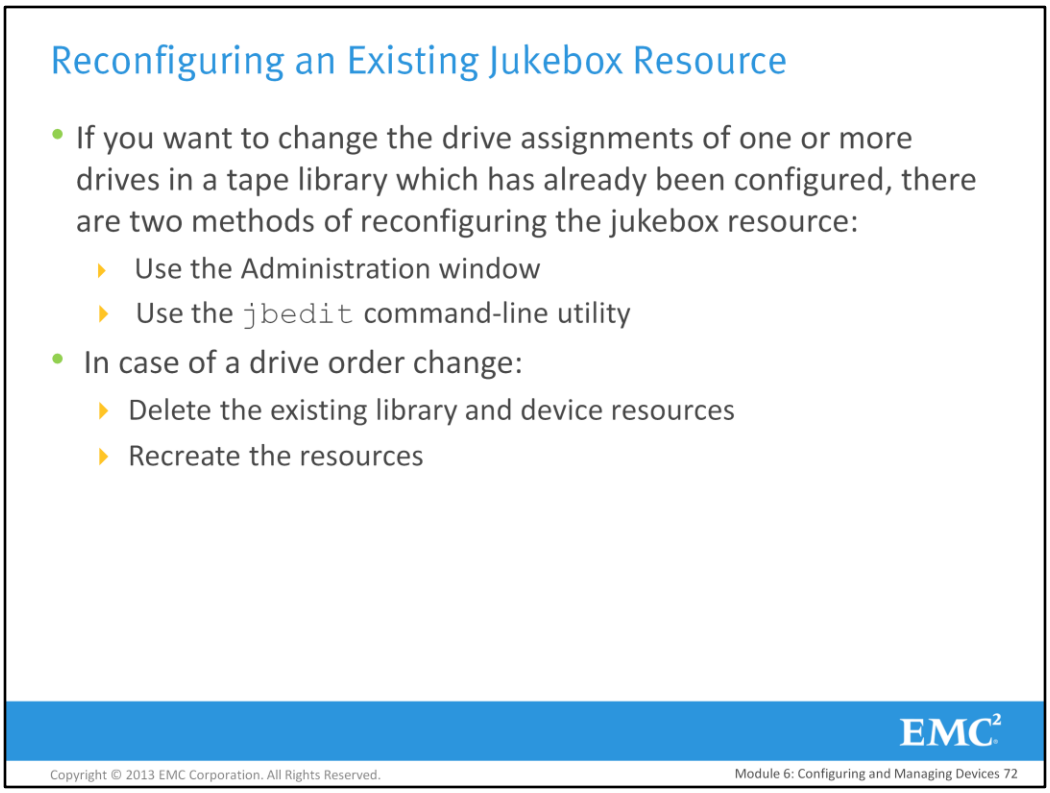
Note: `nsrjb` has many additional options. See the `nsrjb` topic in the *EMC NetWorker Command Reference Guide* and the UNIX/Linux man pages for more information.



This lesson covered how to configure and manage a library and its devices and volumes using NetWorker commands.



This lesson covers how to reconfigure and reset a library using various NetWorker interfaces.



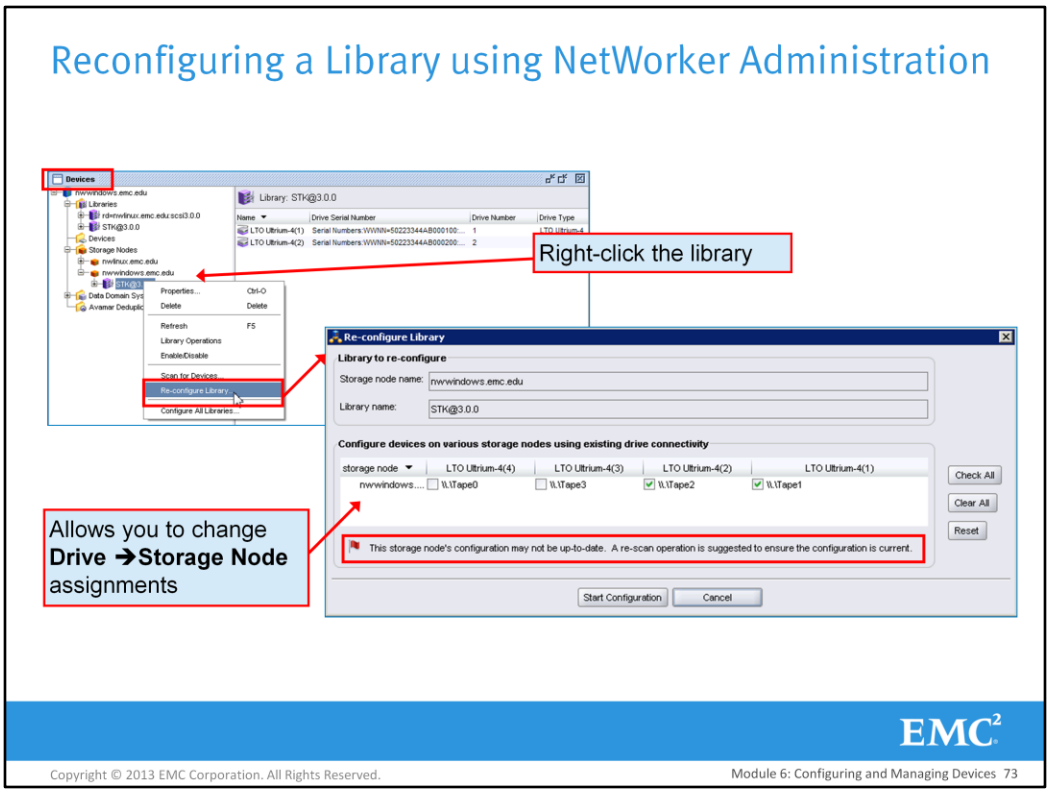
There may be occasions when it is necessary to reconfigure an existing library (jukebox) resource. Examples of when a library reconfiguration is needed include:

- You have a dedicated library that you would now like to share.
- You want to configure drives in the library that were previously excluded from the configuration.
- There is a shared library in which you have one or more devices you would like to dedicate to a specific storage node.

You can perform reconfiguration using either NetWorker Administration or the `jbedit` command. Another way to reconfigure a library is to completely remove the existing jukebox resource and its associated device resources and then configure the library again.

If a drive ordering change has taken place and the NetWorker software is no longer correctly communicating with devices, correct the problem within the NetWorker configuration by using either NetWorker Administration or `jbedit`. To resolve the issue, first delete the existing library and device resources and then recreate the resources.

If devices have already been configured in NetWorker prior to enabling persistent binding on the host, delete the existing devices, perform a re-scan with **Use Persistent Naming** enabled, and then add the devices back again.

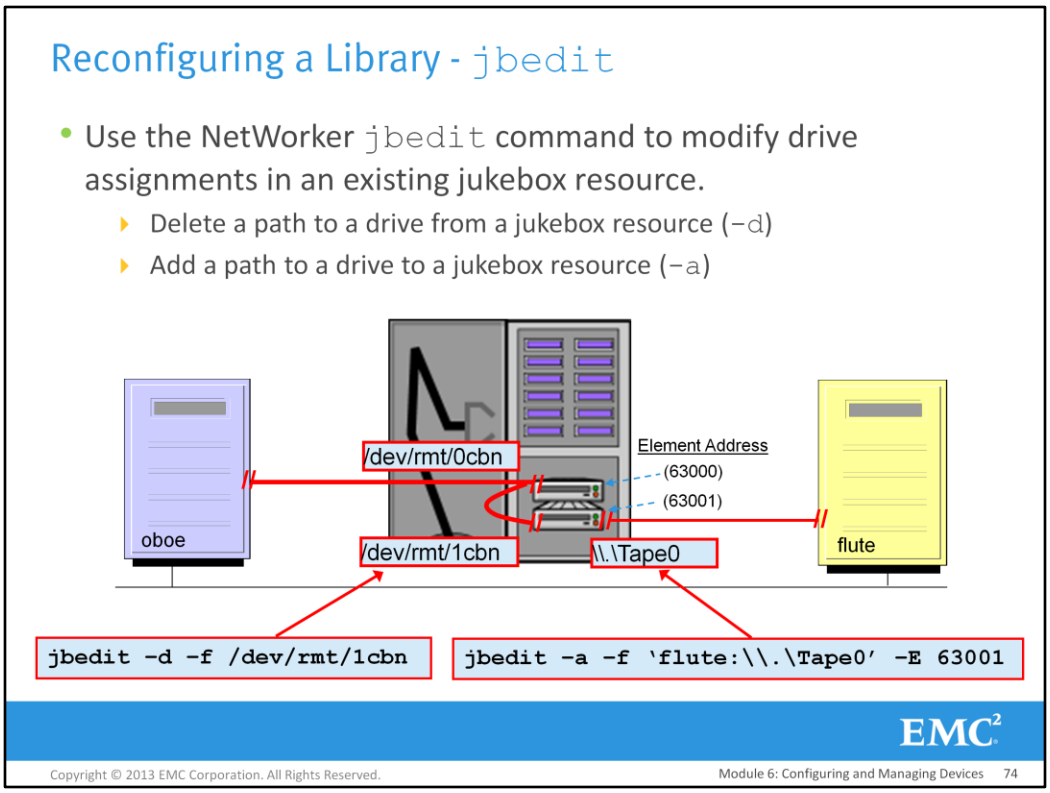


To reconfigure a library that is already configured, you can use the NetWorker Administration ***Devices*** window. Right-click the library in the left pane, and select **Re-configure Library** from the context menu to open a window in which you can change the storage node drive assignments. Running a scan operation first to ensure that the configuration is up-to-date is suggested.

When sharing a previously dedicated library, to prepare the hardware for library reconfiguration:

1. Shut down and power off all storage nodes involved in the sharing. (Direct-attached only)
2. Power-off the tape library. (Direct-attached only)
3. Cable the hardware for your planned configuration. (Direct-attached only)
4. Make sure that the operating system of each storage node can see and use the drives it will be controlling. This may require some sort of reboot, or rezoning in a SAN environment.

Important: Before changing drive assignments, you should unload all volumes from all drives in the library. This is done either by selecting the library in the left pane, right-clicking in the middle pane and selecting **Reset** from the drop-down menu, or by executing **`nsrjb -u`**.



To reconfigure an existing jukebox resource, **`jbedit`** with the **`-d`** option is used to delete devices from the library configuration and then with the **`-a`** option to add the devices again.

`jbedit`(1m) syntax:

`jbedit -d -f` *device_name* `[-s` *nw_server* `] [-j` *jukebox* `]`

`jbedit -a -f` *device_name* `-E` *element_addr* `[-s` *nw_server* `] [-j` *jukebox* `]`

In the slide, a library was initially dedicated to the NetWorker server, **oboe**. To assign the 2nd drive to storage node **flute**, `jbedit` is used with the `-d` option to remove the 2nd drive (**/dev/rmt/1cbn**) from the jukebox resource. `jbedit` is then used again with the `-a` option to add the drive back into the jukebox resource with a device name appropriate for **flute**.

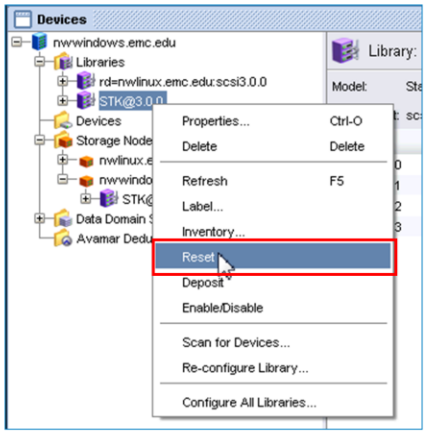
`jbedit` can also be used for tasks other than configuring library sharing or dynamic drive sharing. These include:

- Physically adding a new tape drive to a library.
- Physically removing a tape drive from a library.

Note: For more information, see the `jbedit` topic in the **EMC NetWorker Command Reference Guide** or the UNIX/Linux man page.

Resetting a Library

- Performed if the library and NetWorker software become out of sync.
- Can be done using the Administration interface or `nsrjb`.



OR

Use `nsrjb -HE` from a command prompt

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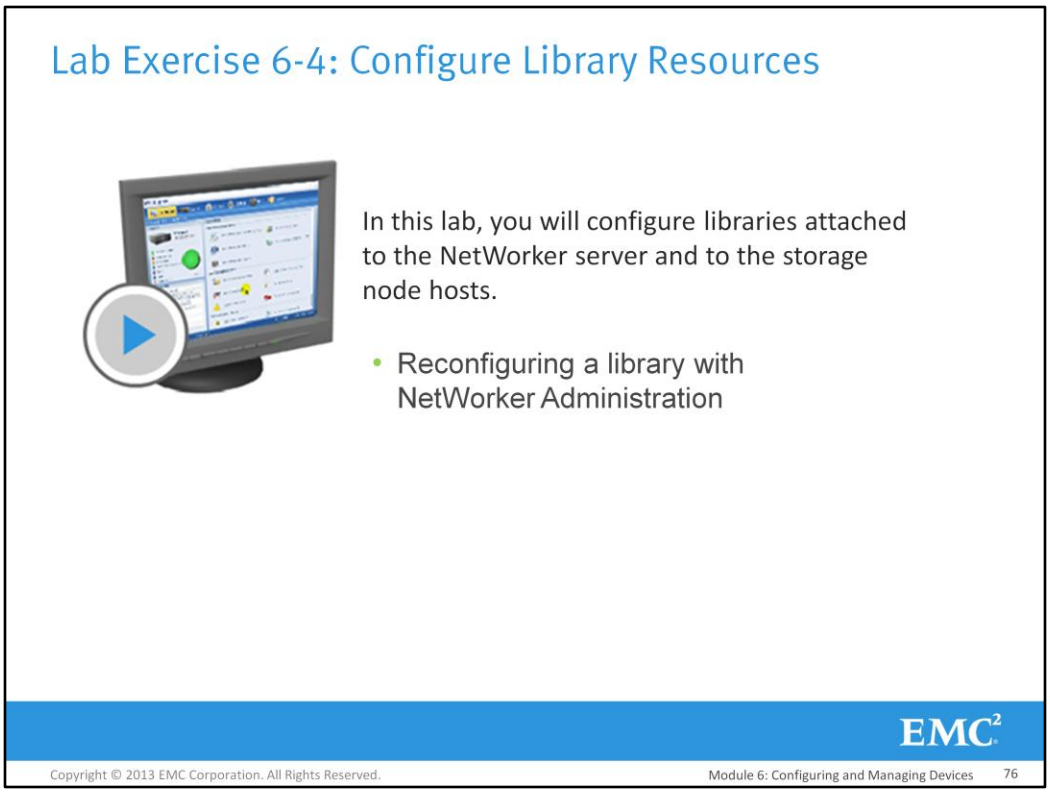
A library must be reset each time the library and the NetWorker software become out of sync. A library reset can be done using either the Administration interface or the command prompt.

To reset a library from NetWorker Administration, right-click the library in the ***Devices*** window and select **Reset**, as shown on the slide.

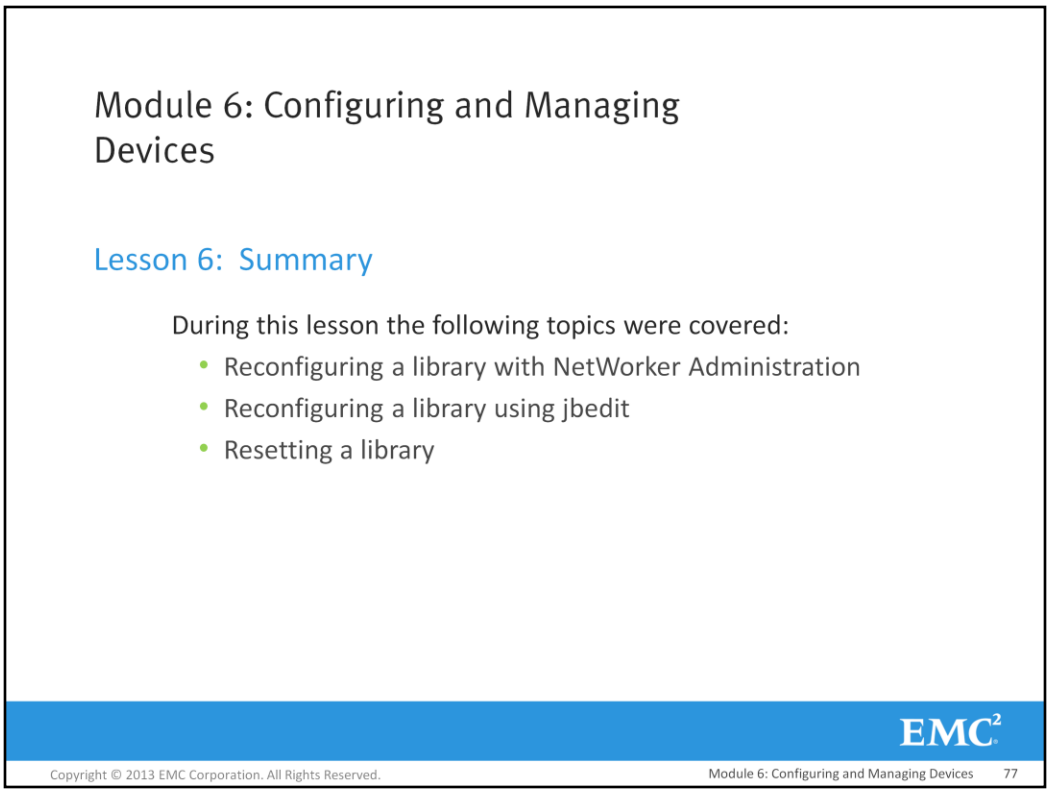
To reset a library from the command prompt, use the **`nsrjb -HE`** command.

See the `nsrjb` topic in the *EMC NetWorker Command Reference Guide* or the UNIX/Linux man page for more information and a description of additional features.

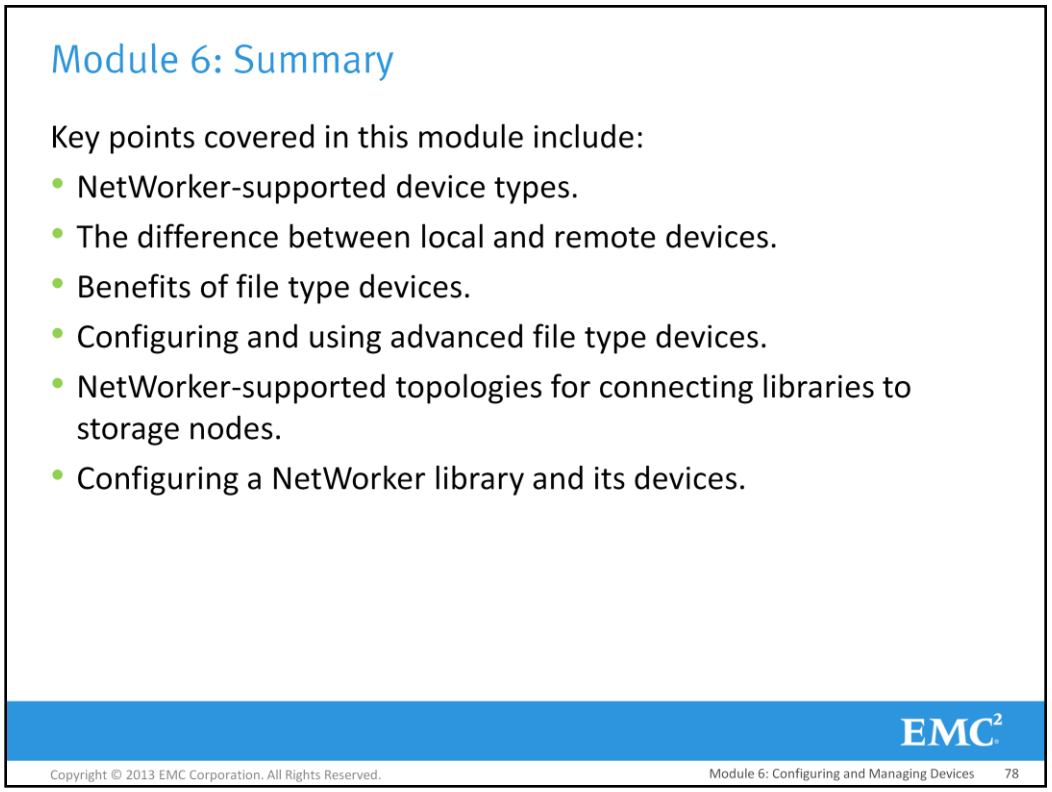


In this lab, you will:

- Configure a dedicated library attached to the storage node host.
- Configure a library attached to the NetWorker server.
- Perform a backup using devices in the libraries.



This lesson covers how to reconfigure and reset a library using various NetWorker interfaces.



This module covered the various types of NetWorker backup storage devices, including a discussion of advanced file type devices, the different topologies for connecting tape libraries, and how to configure library and drive resources.