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ICND2 Curriculum

200-105

Interconnecting Cisco Networking Devices Part 2
Version 3.0

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Interconnecting Cisco Networking Devices Part 2

200-105 Curriculum

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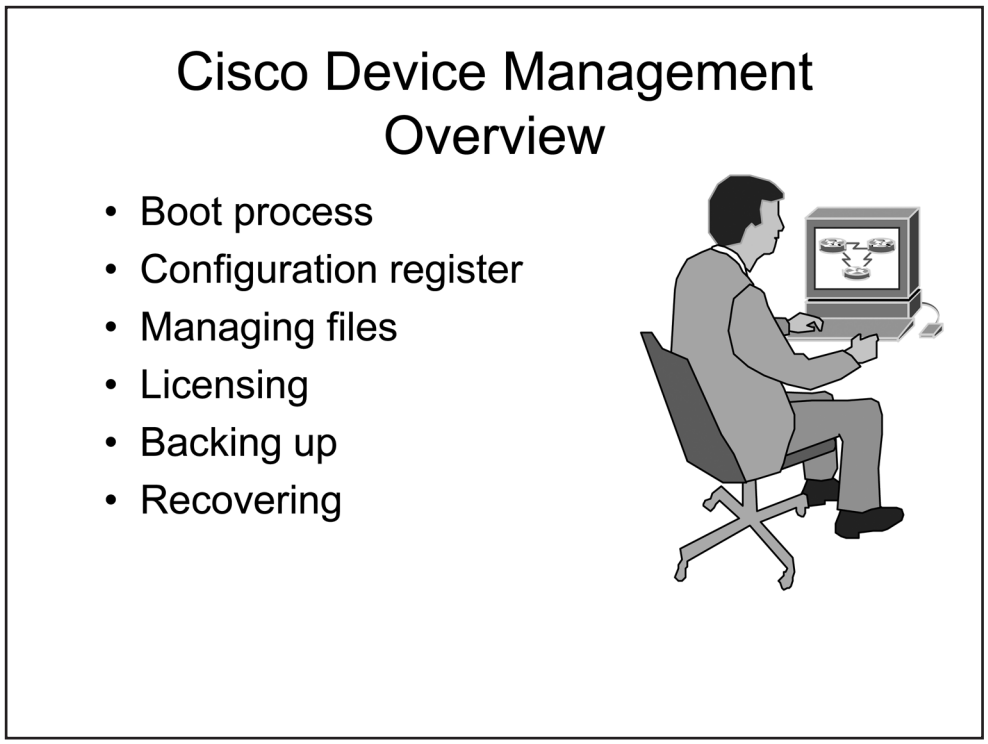
Module 1

Cisco Device Management



Overview

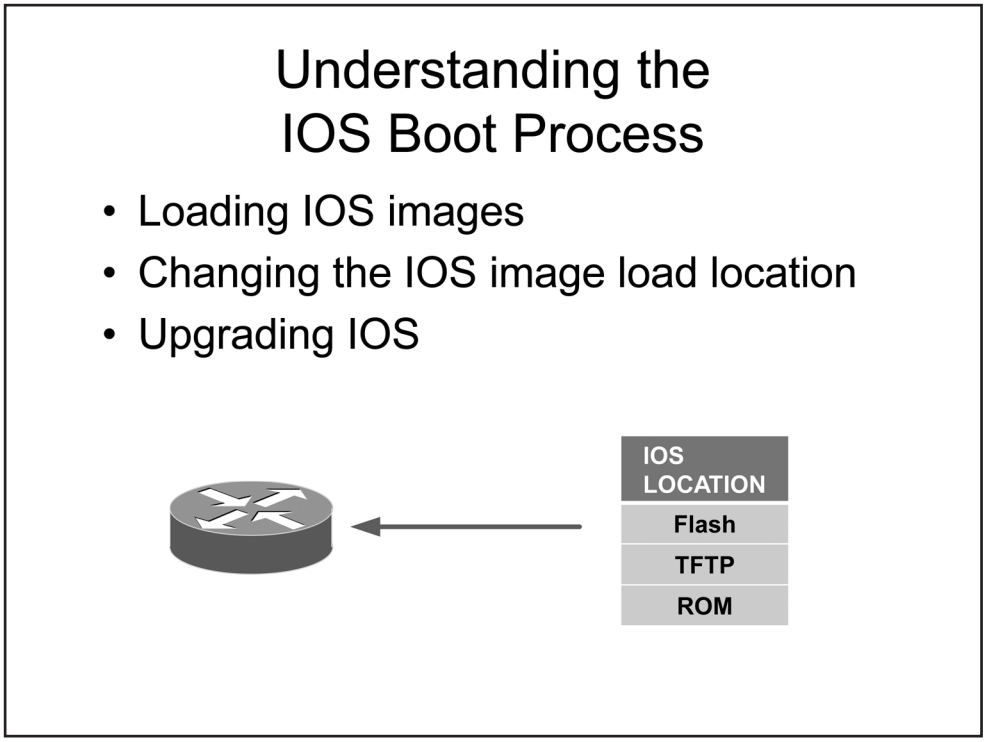
You can configure and manage Cisco devices by using the IOS software that ships with the devices. It is important to understand the process each device goes through, from the initial startup of a device to backing up its running configuration; each process is an important contribution toward ensuring an efficiently managed network. As a network evolves, this understanding will assist you as you make necessary changes to the configuration so that optimal configuration and peak performance of the network are consistently achieved.

In this module, you will learn about the basics of Cisco IOS as well as the options for configuring and managing the IOS on a device. You will also learn about how to install and manage licensing on Cisco devices.

Objectives

After completing this module, you should have the basic knowledge required to complete all of the following tasks:

- Understand the boot process for Cisco devices.
- Understand and modify the configuration register.
- Manage IOS image files and configuration files.
- Activate, install, back up, and uninstall Cisco software licenses.

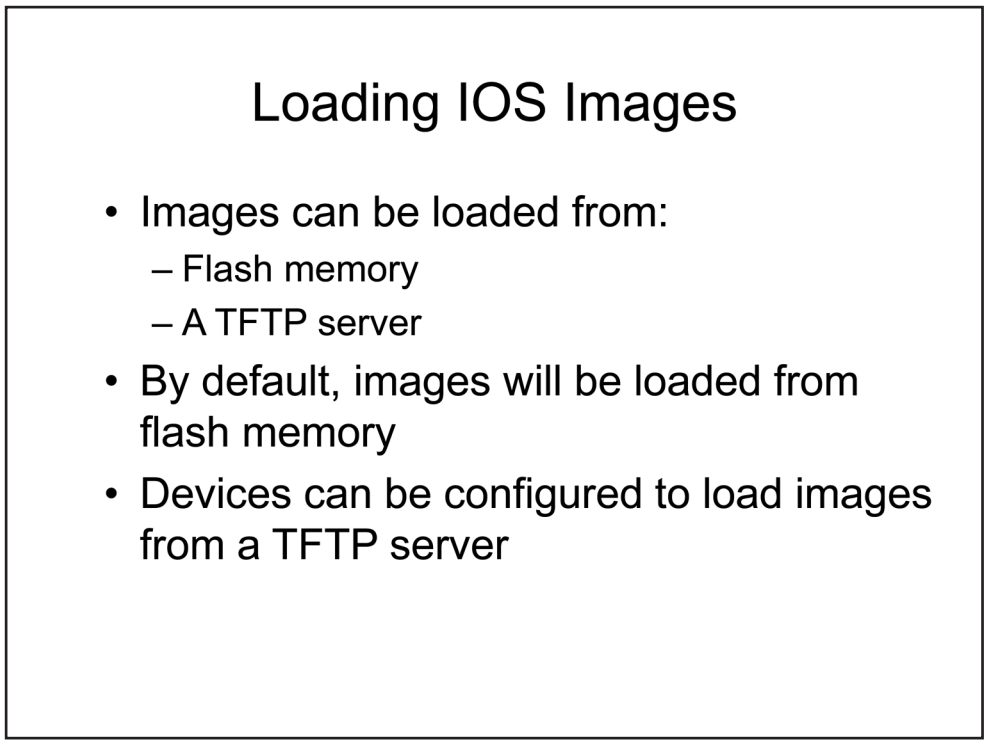


Understanding the IOS Boot Process

When a Cisco device is started, it performs the following actions:

1. The device performs power-on self test (POST) checks.
2. The bootstrap program is loaded and executed.
3. The bootstrap program loads an IOS image.
4. The IOS loads a configuration file from non-volatile random access memory (NVRAM) and places it into dynamic random access memory (DRAM) for operation; if no configuration file is present, the device starts the System Configuration Dialog.
5. The device is placed in user EXEC mode.

This section covers the details of step 3, loading an IOS image. For a Cisco device to function, it must be able to load an IOS image. These images can be stored locally in flash memory or remotely on a network server; in addition, a limited IOS image is stored in read-only memory (ROM) and will be used if a full IOS image cannot be found.



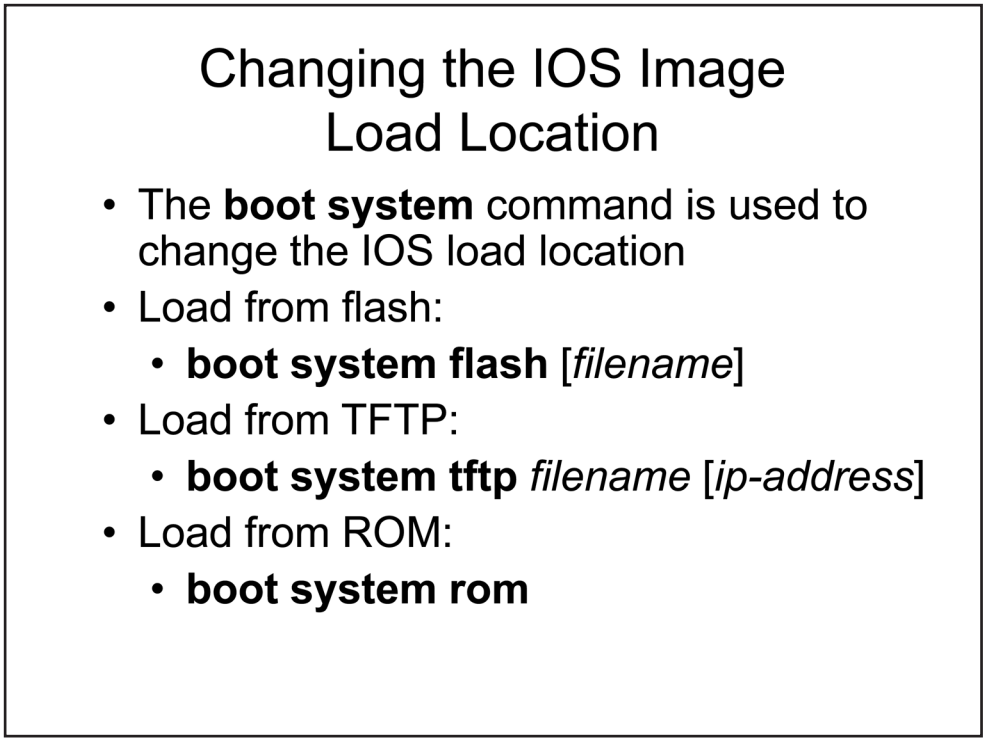
Loading IOS Images

A full version of the Cisco IOS can be loaded at startup from flash memory or from a Trivial File Transfer Protocol (TFTP) server. The Cisco IOS is normally located in flash memory. If the flash memory is empty or the file system is corrupt, you will receive an error message stating `boot: cannot open "flash:"`.

By default, when a Cisco device is unable to locate a valid Cisco IOS image in flash memory during the boot process, it will attempt to locate a valid IOS image on a TFTP server on the local network. If it cannot locate a TFTP server, it will enter ROM monitor (ROMmon) mode. When a router enters ROMmon mode, the `rommon>` prompt will be displayed instead of the standard prompt that is displayed on devices that are properly configured. The device will then load a limited version of the IOS from ROM.

ROM does not contain a full version of the Cisco IOS. The boot image loaded from ROM will enable you to download a valid IOS image from a specific TFTP server. To load a boot image while the router is in ROMmon mode, you should issue the **confreg 0x2101** command from the `rommon>` prompt. Then you should issue the **reset** command to force the router to boot to the boot image. You can then configure one of the device's local area network (LAN) interfaces to connect to a network containing a TFTP server that stores a valid IOS image.

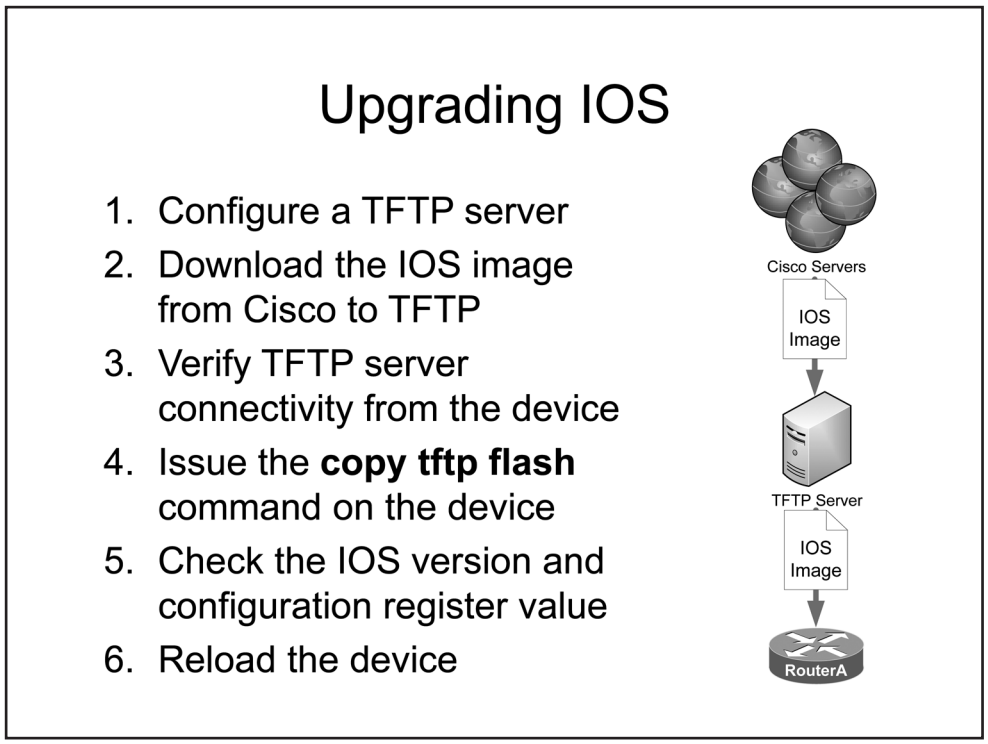
After downloading the IOS image, you should change the configuration register setting back to 0x2102, which will enable the router to boot to the new IOS image.



Changing the IOS Image Load Location

You can modify where a Cisco device loads the IOS from by issuing the **boot system** command. The **boot system flash** [*filename*] command configures the device to load the designated IOS from flash memory; if you do not specify the *filename*, the first bootable IOS image is loaded. The **boot system** [**tftp**] *filename* [*ip-address*] command configures the device to load the designated IOS from a TFTP server; if you do not specify the *ip-address*, the IP broadcast address of 255.255.255.255 will be used. The **boot system rom** command configures the device to load the IOS from ROM. If you issue multiple **boot system** commands, the router will attempt to load the IOS in the order that you issued the commands.

NVRAM is used to store configuration files. If no configuration file is present in NVRAM, the device will start the System Configuration Dialog, or setup mode. Alternatively, to enter setup mode, you could issue the **setup** command. The System Configuration Dialog enables you to configure basic settings, such as the host name, the enable password, the enable secret password, the virtual terminal (VTY) password, and interface IP addressing information.



Upgrading IOS

You might need to upgrade IOS on a Cisco router or switch when you need additional features that are not available in the version of IOS that you are currently using. Before you can upgrade IOS, you must configure a TFTP server at a network location that can be accessed by the router or switch. The TFTP server can be run from any supported device on the network as long as the router or switch to be upgraded can connect to the device. You can verify that the TFTP server is reachable from the device to be upgraded by issuing the **ping** *ip-address* command on the device, where *ip-address* is the IP address of the TFTP server.

After you configure the TFTP server, you should download the new version of IOS from Cisco's website. You can use the Cisco Feature Navigator on Cisco's site to determine which version of IOS you need based on the hardware you have, the flash memory that is installed in the hardware, and the feature set that you want to implement. You should issue the **show version** command or the **show flash** command on the device to be upgraded to verify that enough flash memory space is available to support the new image.

After you download the new version of IOS to the TFTP server, you should issue the **copy tftp flash** command on the device to be upgraded to begin the upgrade process. After you issue the **copy tftp flash** command, you will be prompted to provide the IP address of the TFTP server, the filename of the IOS image that you want to copy, and the filename that you want to use for the IOS image on the device to be upgraded.

After you have entered the appropriate information at the prompts, IOS will display the `Erase flash: before copying? [confirm]` prompt. If you confirm that you want to erase flash memory, everything that is currently stored in flash memory will be erased before the new IOS image is copied. You can choose to not erase flash memory before copying the new image. However, you should first ensure that enough space exists in flash memory to store both the new IOS image and the current flash memory contents.

After you have either confirmed or dismissed the erase prompt, the file copy process begins. Depending on the size of the IOS image and the speed of the connection to the TFTP server, the copy process can take several minutes. The copy process is tracked by a series of `!` symbols that are repeated as data is transferred.

After the data has been transferred, you should issue the **show version** command to verify that the configuration register is set to the default value of 0x2102. In addition, you should issue the **dir flash:** command to view the contents of flash memory. If the first file listed in flash memory is not the new IOS image, you might need to issue the **no boot system** command followed by the **boot system** *filename* command, where *filename* is the name of the new IOS image. The **boot system** command ensures that the device finds the correct IOS image upon reload.

Finally, you should issue the **reload** command to reboot the router or switch with the new IOS image. After the device reboots, you should issue the **show version** command to ensure that the correct version of IOS is running on the device.

Troubleshooting IOS Upgrades

Two common problems can occur during an IOS upgrade procedure: lack of flash memory space and lack of connectivity to the TFTP server. For example, if you were attempting to copy a new image named newimage.bin to a device that did not have enough free flash memory to support the new image, you might see the following message:

```
%Error copying tftp://10.10.10.10/newimage.bin
(Not enough space on device)
```

The error message above indicates that the **copy tftp flash** command was not able to copy a file named newimage.bin from a TFTP server with the IP address 10.10.10.10 because there was not enough space in flash memory to accommodate the file.

If you were attempting to copy an image named newimage.bin from a TFTP server that was either down or unreachable on the network, you might see the following message:

```
%Error opening tftp://10.10.10.10/newimage.bin (Timed out)
```

The error message above indicates that the **copy tftp flash** command was not able to connect to the TFTP server at 10.10.10.10 to retrieve the file named newimage.bin.

To avoid problems such as those described above, always check flash memory space limitations before attempting to upgrade IOS. In addition, use the **ping** command to verify that the device being upgraded can connect to the TFTP server.

Understanding and Modifying the Configuration Register

- The configuration register can determine how a router boots, the speed of the console, and what options are enabled while booting
- Issue the **show version** command to view the current configuration register setting
- Issue the **config-register** command to change the configuration register setting

Understanding and Modifying the Configuration Register

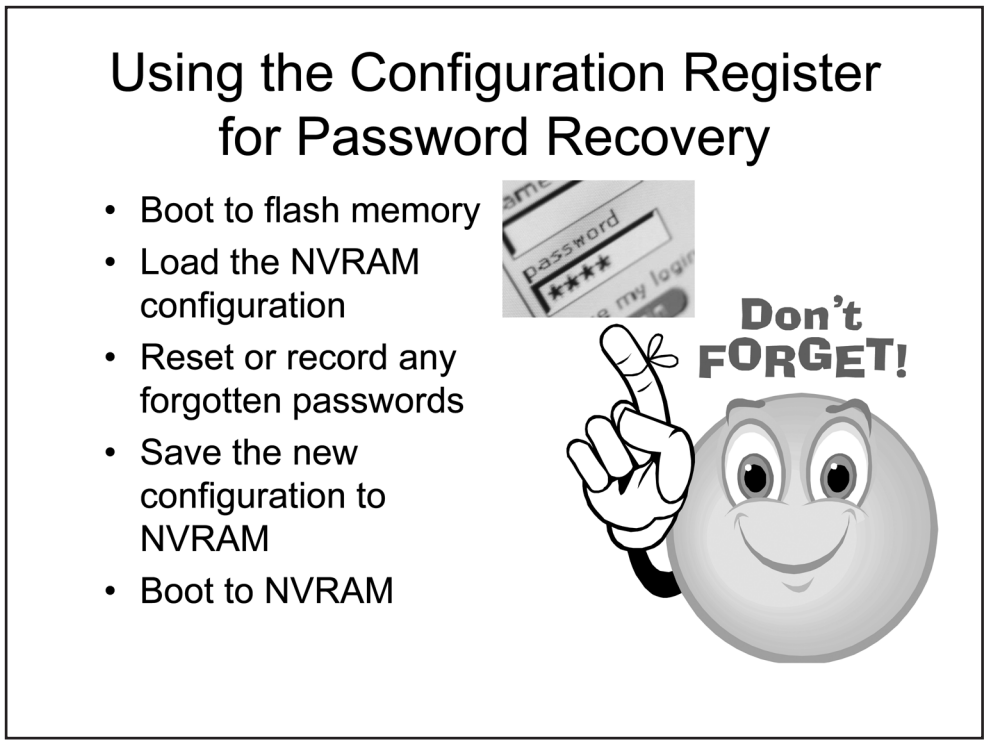
The configuration register can be changed to modify how a Cisco device boots. For example, you can configure the device to boot to ROM, to a bootstrap prompt, or to IOS. You can also modify the configuration register to change the console speed for terminal emulation sessions or to cause the device to disable boot messages. To view the current configuration register setting, you should issue the **show version** command. To change the configuration register setting, you should issue the **config-register** *value* command, where *value* is a hexadecimal value preceded by **0x**.

By default, the configuration register value is set to **0x2102**. This setting configures the device to boot normally, which means it boots to the IOS image stored in flash memory if a valid image exists. If a valid image does not exist, the device will boot to ROM. This value also configures a console speed of 9600 baud for terminal emulation sessions.

Other commonly used configuration register values include the following:

- **0x2101** – configures the device to boot to the bootstrap program, which is a program that can be used to run diagnostics on the router. This setting configures the device to boot using a speed of 9600 baud.
- **0x2120** – configures the device to boot to a `rommon>` prompt. When at a `rommon>` prompt, you can load a boot image, which will enable you to download a valid IOS image from a TFTP server.
- **0x2122** – configures the device to boot to an IOS image stored in flash memory, if one exists in flash memory. Otherwise, the device boots into ROM. The console speed when this setting is configured will be 19200 baud.

- **0x2142** – configures the device to disregard the contents of NVRAM when the router is rebooted. With this setting, any configuration information will be ignored and you will be prompted to create an initial configuration for the router.
- **0x3122** – configures the device to boot to an IOS image if a valid image exists. Otherwise, the device boots into ROM. This setting will also configure the device to boot using a console speed of 57600 baud.



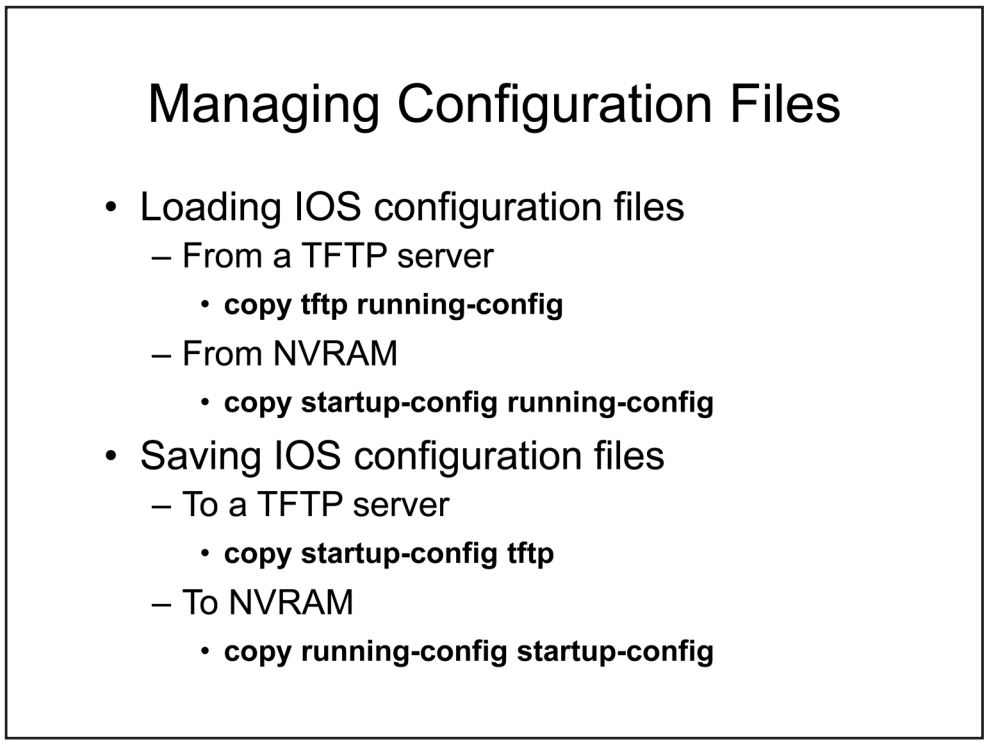
Using the Configuration Register for Password Recovery

The ability to modify how the device boots can be useful in emergencies, such as when you need to recover or change the enable password on a device for which the enable password has been lost. For example, if you had forgotten the enable password to a Cisco router named Router1, you could use a console cable to connect a terminal to the router, access the Router1 console, and perform the following steps:

1. Issue the **show version** command from user EXEC mode, and record the value of the configuration register. You will need to restore the router's configuration register to this value after you have completed the password recovery process.
2. Power cycle the device, and press the Break key on the terminal's keyboard within one minute after power is restored. This should boot the device into ROMmon mode.
3. In ROMmon mode, configure the device to boot from flash memory by issuing the **confreg 0x2142** command. Note that the ROMmon mode command for modifying the configuration register is different than the command you issue in global configuration mode. The **config-register** *value* command does not work in ROMmon mode.
4. Type **reset** to reboot the router.
5. You might be prompted with the configuration setup script because the 0x2142 configuration register setting disregards the contents of NVRAM. Press Ctrl+C on the keyboard after reboot to cancel the setup procedure.
6. From the console prompt, enter privileged EXEC mode by issuing the **enable** command. Because the router has ignored the NVRAM configuration, you should not be prompted for a password.
7. In privileged EXEC mode, issue the **copy startup-config running-config** command, which will load the contents of NVRAM into the running configuration. The router will remain in privileged EXEC mode.

After the router has loaded the configuration from NVRAM, you can either issue the **show running-config** command to display unencrypted passwords or you can place the device into global configuration mode and issue the appropriate commands to modify any encrypted or unencrypted passwords. You might also need to issue the **no shutdown** command on any interfaces that should be in the up state when the device is rebooted and the configuration is loaded.

Next, you should issue the **config-register 0x2102** command in global configuration mode to configure the device to boot from NVRAM. Finally, issue the **copy running-config startup-config** command from privileged EXEC mode to ensure that the configuration changes are saved to NVRAM and reboot the router.



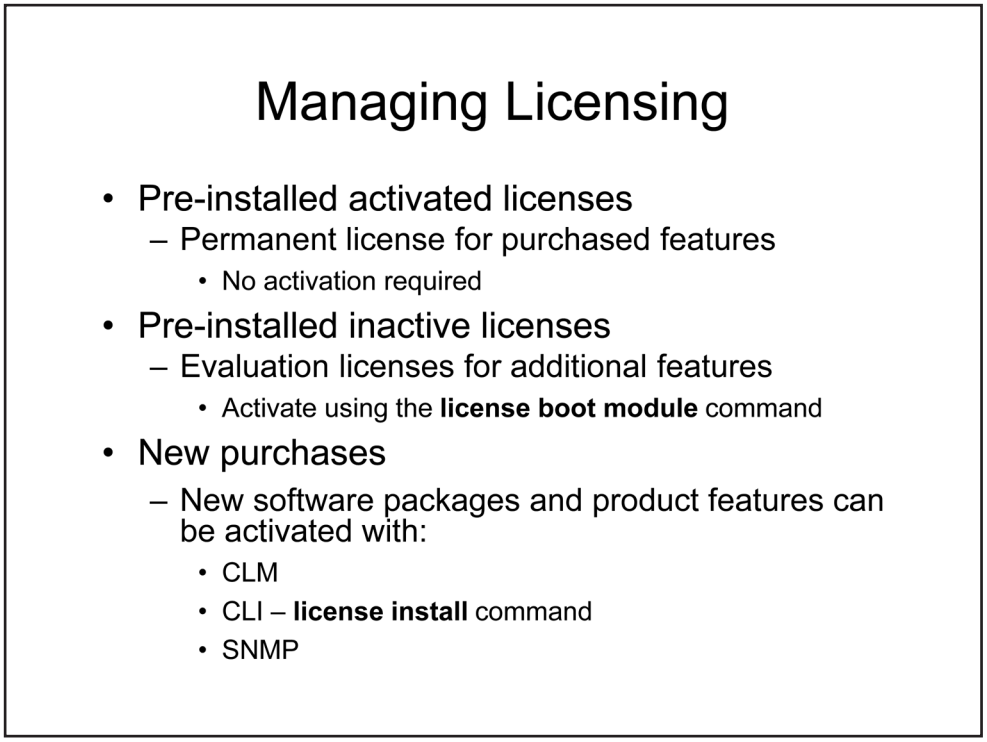
Managing Configuration Files

Cisco IOS provides the ability to load or save configuration files. Configuration files can be loaded from local storage, such as NVRAM, or from a remote location, such as a TFTP server. The **service config** command must be issued to load configuration files from a TFTP server. When the **service config** command is issued, the device will attempt to download the configuration files by using the default broadcast IP address of 255.255.255.255. To change this default, you should issue the **boot network** *url* and **boot host** *url* commands, where *url* is the complete Uniform Resource Locator (URL) of the configuration file on the TFTP server, including any user names and passwords.

Configuration files can also be saved to a TFTP server or to NVRAM. For example, if you make changes to a configuration file, you can save the changes to NVRAM so that the changes are loaded the next time the device is restarted.

To load an existing IOS configuration file, you should issue the **copy tftp running-config** command or the **copy startup-config running-config** command. Issuing the **copy tftp running-config** command replaces the current configuration with the configuration file stored on the TFTP server. Conversely, you could issue the **copy startup-config running-config** command to replace the current configuration with the configuration that is stored in NVRAM. Loading an existing configuration allows you to revert to a previous configuration in the event that you have made a number of changes that you want to erase.

To save the current running configuration file, you should issue either the **copy running-config startup-config** command or the **copy startup-config tftp** command. The **copy running-config startup-config** command is used to save the currently running configuration file to NVRAM. Running configurations, in addition to the running IOS software, are stored in DRAM. DRAM stores the routing tables, switching cache, and packet data when the device is in operation. The **copy startup-config tftp** command stores the current startup configuration file to a TFTP server.

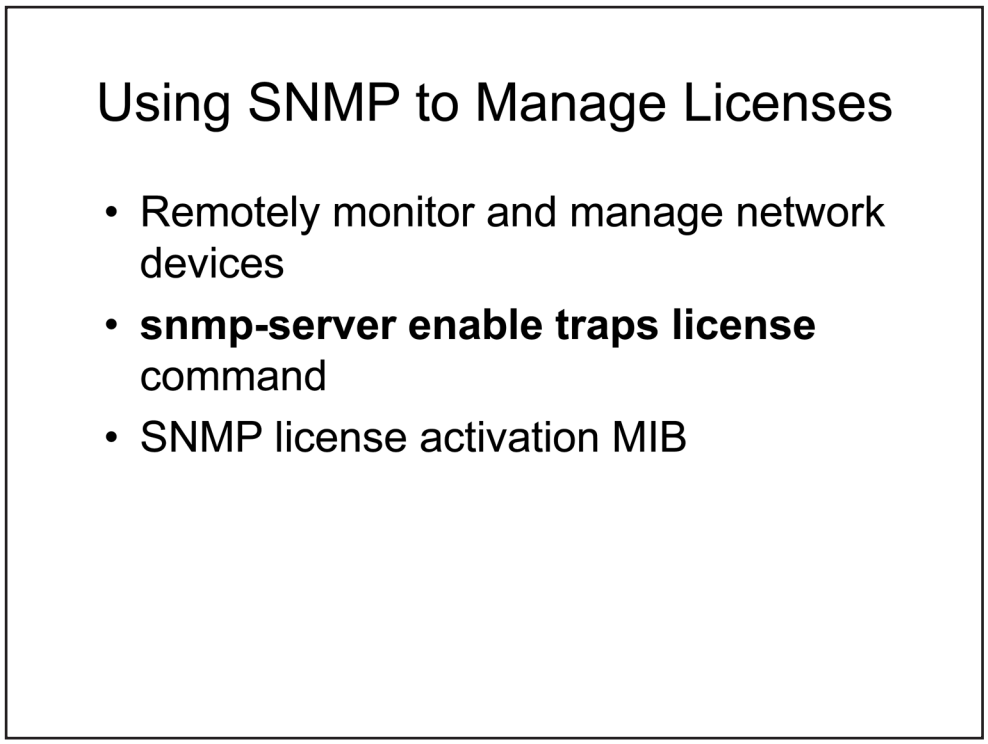


Managing Licensing

Cisco devices come with a permanent license installed for the features you selected when you ordered the device; no activation is required for those feature sets. If you need to know which licenses are available on a device, the Cisco License Manager (CLM), the **show version** command, or the **show license** command can provide information about the licenses on a system. That information includes a list of the features that are enabled by using a permanent license, the features that are enabled by using a temporary license, and the features that are inactive.

Most Cisco devices come with evaluation, or temporary, licenses for the additional software and features supported by the device that were not initially purchased with the device. In order to test any given feature, you need to activate the temporary license for that feature by using the **license boot module** command. If you determine that you want to continue using the feature, you will first need to purchase the software package or device feature from cisco.com. When you make a purchase, you will receive a product activation key (PAK), which you will use along with the product ID and serial number of the device in order to obtain a license file. Once you have registered the purchased software package or device feature, you can use the CLM, the Cisco IOS command-line interface (CLI), or Simple Network Management Protocol (SNMP) to install and manage active licenses.

After permanent licenses have been installed and activated, you can use the **license save** command to make copies of the licenses for backup and recovery purposes. To remove a license from a device, use the **license clear** command. If a permanent license needs to be reinstalled after the **license clear** command has been issued, use the **license install** command along with the copy of the license previously made using the **license save** command. Temporary and built-in licenses cannot be removed by using the **license clear** command and therefore do not require a reinstall process.



Using SNMP to Manage Licenses

Some devices can use an SNMP agent, such as the Cisco IOS Software Activation feature, which will allow installation of licenses by using SNMP. The SNMP agent accesses the CISCO-LICENSE-MGMT-MIB on the device to determine which licenses are active. The CISCO-LICENSE-MGMT-MIB is a management information base (MIB) that contains information about Cisco licenses available on the device.

This use of an SNMP agent offers administrators an additional method of license installation and increases flexibility in managing licenses. SNMP is typically used to remotely monitor and manage network devices by collecting statistical data about those devices. SNMP uses User Datagram Protocol (UDP) ports 161 and 162 by default.

SNMP version 1 (SNMPv1) and SNMPv2 use community strings to provide authentication. However, neither SNMPv1 nor SNMPv2 uses encryption; all data and community strings are sent in clear text. A malicious user can sniff an SNMP community string and use it to access and modify network devices. SNMPv3 is an enhancement to the SNMP protocol that uses encryption to provide confidentiality, integrity, and authentication.

To enable SNMP licensing notifications, you can use the **snmp-server enable traps** command with the **license** keyword by itself or in conjunction with the keywords **deploy**, **error**, **imagelevel**, or **usage**, depending on the level of information desired.

Review Question 1

You issue the **show version** command on a router and observe the following line at the end of the output:

```
Configuration register is 0x2102
```

Which of the following will occur as a result of this configuration the next time that the router is booted?

A. The router will boot into ROMmon mode using a console speed of 9600 baud.
B. The router will boot into the bootstrap program.
C. The router will boot normally using a console speed of 9600 baud.
D. The router will boot normally using a console speed of 19200 baud.
E. The router will boot into ROMmon mode using a console speed of 19200 baud.
F. The router will boot normally using a console speed of 57600 baud.

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E. The router will boot into ROMmon mode using a console speed of 19200 baud.
F. The router will boot normally using a console speed of 57600 baud.

By default, the configuration register value is set to **0x2102**. This setting configures the router to boot normally, which means it boots to the IOS image stored in flash memory if a valid image exists. If a valid image does not exist, the router will boot to read-only memory (ROM). This value also configures a console speed of 9600 baud for terminal emulation sessions.

The configuration register can be changed to modify how a router boots. For example, by changing the configuration register setting, you can configure the router to boot to ROM, to a bootstrap prompt, or to the IOS. You can also modify the configuration register to change the console speed for terminal emulation sessions or to cause the router to disable boot messages. To view the current configuration register setting, you should issue the **show version** command. To change the configuration register setting, you should issue the **config-register** *value* command, where *value* is a hexadecimal value preceded by **0x**.

Review Question 2

From which locations can a full version of the Cisco IOS be loaded at startup?

A. flash memory
B. a TFTP server
C. ROM
D. NVRAM

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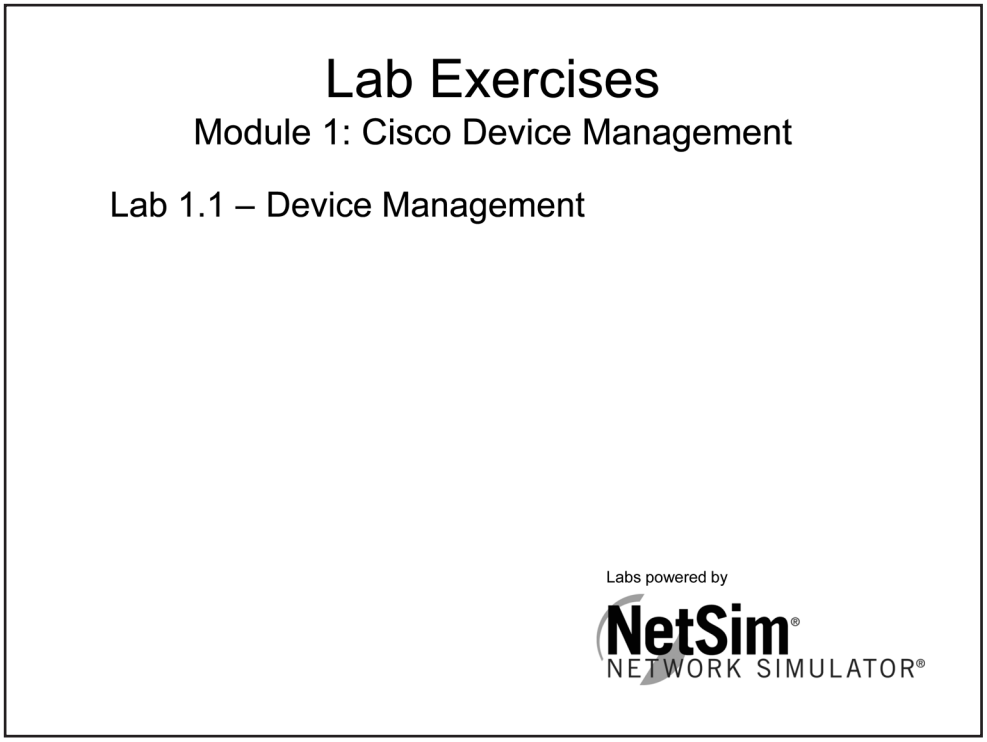
A full version of the Cisco IOS can be loaded at startup from flash memory or from a Trivial File Transfer Protocol (TFTP) server. The Cisco IOS is normally located in flash memory. If the flash memory is empty or the file system is corrupt, you will receive an error message stating `boot: cannot open "flash:"`. The router will then attempt to load IOS from a TFTP server. If IOS cannot be loaded from a TFTP server, the device will load a limited version of the IOS from read-only memory (ROM). ROM does not contain a full version of the Cisco IOS.



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