



ICND2

Curriculum

200-101

Interconnecting Cisco Networking Devices Part 2
Version 2.0

Labs powered by



Interconnecting Cisco Networking Devices Part 2

200-101 Curriculum

Boson[®] NetSim

NETWORK SIMULATOR

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Module 1: Cisco Device Management.....	1
Overview.....	2
Objectives.....	2
Understanding the IOS Boot Process.....	3
Loading IOS Images.....	4
Changing the IOS Image Load Location.....	5
Upgrading IOS.....	6
Troubleshooting IOS Upgrades.....	7
Understanding and Modifying the Configuration Register.....	8
Using the Configuration Register for Password Recovery.....	10
Managing Configuration Files.....	12
Managing Licensing.....	13
Using SNMP to Manage Licenses.....	14
Review Question 1.....	15
Review Question 2.....	17
Lab Exercises.....	19
Module 2: Troubleshooting and Data Collection.....	21
Overview.....	22
Objectives.....	22
Understanding the Systematic Approach.....	23
Understanding Troubleshooting Techniques.....	25
Understanding the OSI Model.....	25
Implementing the OSI Techniques.....	26
The Bottom Up Troubleshooting Technique.....	26
The Divide and Conquer Troubleshooting Technique.....	26
The Follow the Path Troubleshooting Technique.....	28
The Move the Problem Troubleshooting Technique.....	28
The Spot the Difference Troubleshooting Technique.....	29
Implementing the Non-OSI Techniques.....	28
The Follow the Path Troubleshooting Technique.....	28
The Move the Problem Troubleshooting Technique.....	28
The Spot the Difference Troubleshooting Technique.....	29
Understanding show Commands.....	30
Understanding debug Commands.....	32
Understanding Syslog.....	33
Configuring Log Severity Levels.....	34
Understanding the ping Command.....	35
Understanding the traceroute Command.....	36
Understanding SNMP.....	38
Configuring SNMP.....	39
Understanding NetFlow.....	40
Using NetFlow Data.....	41
Configuring NetFlow.....	42
Verifying NetFlow.....	43
Analyzing NetFlow Data.....	46
Solving Common Network Problems.....	48

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Troubleshooting Connectivity.....	49
Troubleshooting Physical Layer Connectivity	50
Troubleshooting Data Link Layer Connectivity.....	52
Troubleshooting Network Layer Connectivity	53
Network Addressing	54
IPv4 Connectivity	55
IPv6 Connectivity	56
Path Selection	57
InterVLAN Routing	60
Troubleshooting Beyond Layer 3	62
Troubleshooting Layer 4	63
Using Telnet to Troubleshoot Layer 4	64
Resolving Layer 4 Connectivity	65
Troubleshooting Beyond Layer 4	66
Review Question 1.....	67
Review Question 2.....	69
Review Question 3.....	71
Lab Exercises	73
Module 3: Network Addressing.....	75
Overview.....	76
Objectives.....	77
Understanding IPv4 Subnets	78
Understanding IPv4 Subnetting	79
Understanding VLSMs.....	80
Understanding IPv6 Addressing	83
IPv6 Address Composition.....	84
IPv6 Address Prefixes.....	85
IPv6 Address Types	86
IPv6 Address Configuration	88
EUI-64 Interface IDs	89
Review Question 1.....	91
Review Question 2.....	93
Lab Exercises	95
Module 4: VLANs and Trunking	97
Overview.....	98
Objectives.....	98
What Do VLANs Do?.....	99
Creating and Configuring VLANs	101
Verifying VLANs	102
Configuring Access Ports	103
Verifying VLAN Membership	104
Understanding Trunk Ports.....	105
Configuring Trunk Ports.....	107
Verifying Trunk Ports	108

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Understanding and Configuring DTP	110
Common VLAN and Trunk Problems	112
Review Question 1	113
Review Question 2	115
Lab Exercises	117
Module 5: Spanning Tree Protocol.....	119
Overview.....	120
Objectives.....	120
Understanding STP	121
Root Switch Election	122
Verifying the Root Switch	125
Path Costs	128
Determining Port Roles.....	129
Root Port	129
Designated Port.....	129
STP Port States.....	130
STP Timers.....	131
Understanding RSTP.....	132
Understanding RSTP Port States.....	133
RSTP Alternate and Backup Port Roles.....	136
Understanding Cisco Implementations of STP	137
Per-VLAN Spanning Tree Plus	138
PVST+ Bridge IDs.....	139
Per-VLAN Rapid Spanning Tree Plus.....	140
Multiple Spanning Tree Protocol.....	141
Cisco Enhancements to STP	142
PortFast.....	143
BPDU Guard	144
Loop Guard.....	145
Root Guard.....	146
Review Question 1	147
Review Question 2.....	149
Lab Exercises	151
Module 6: Advanced Switch Redundancy.....	153
Overview.....	154
Objectives.....	154
Understanding EtherChannel	155
Understanding EtherChannel Protocols.....	156
Understanding PAgP and LACP Modes.....	157
<i>The On Mode</i>	157
<i>PAgP Modes</i>	157
<i>LACP Modes</i>	158
Configuring EtherChannel	159

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Configuring PAgP EtherChannel 161

Configuring LACP EtherChannel 162

Understanding EtherChannel's Effects on STP 163

Verifying EtherChannel 165

Troubleshooting EtherChannel 167

 Aggregation Protocol Mismatches 167

 Bundle Configuration Mismatches 169

Understanding Gateway Redundancy 170

Understanding HSRP 172

Configuring HSRP 174

 Configuring Preemption and Interface Tracking 175

 Configuring Multigroup HSRP 177

Verifying HSRP 179

Understanding GLBP 181

Configuring GLBP 182

Configuring GLBP Options 183

Verifying GLBP 185

Review Question 1 187

Review Question 2 189

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Module 10: Securing Switches 193

Overview 194

Objectives 194

Establishing Written Security Policies 195

Securing Access 196

 Restricting Physical Access to the Switch 197

 Creating Secure Passwords for Console and Remote Access 198

Configuring ACLs to Control Remote Access 199

 Creating a Secure Password for Privileged EXEC Mode Access 200

 Encrypting Passwords on the Switch 201

 Securing, Disabling, or Replacing Vulnerable Services 202

 Configuring Warning Banners 204

Securing Switch Ports 205

 Disabling Unused Ports 206

 Securing Trunk and Access Ports 207

 Restricting Ports by Client MAC Address 208

 Verifying Port Security 211

 Understanding 802.1X Port-based Authentication 213

How 802.1X Port-based Authentication Works 214

Configuring 802.1X Port-based Authentication 215

Securing VLAN 1 216

Securing Spanning Tree Protocol 217

 Configuring Root Guard 218

 Configuring BPDU Guard 219

 Logging 220

<i>Configuring Accurate Time</i>	221
<i>Configuring Log Severity Levels</i>	222
<i>Configuring and Using a Logging Server</i>	223
Review Question 1	225
Review Question 2	227
Lab Exercises	229
Module 8: Routing Fundamentals	231
Overview	232
Objectives	232
Understanding Router Path Selection	233
Understanding Static Routes	234
Understanding Dynamic Routes	236
Understanding Administrative Distance	237
Understanding Routing Metrics	239
Understanding Autonomous Systems	240
Understanding Routing Protocols	241
Understanding the Types of IGPs	242
Understanding Distance-Vector Routing Protocols	243
Updating Distance-Vector Routes	244
Preventing Distance-Vector Problems	245
Understanding the Counting to Infinity Problem	246
<i>Understanding Maximum Counts</i>	247
Understanding Routing Loops	249
<i>Preventing Routing Loops</i>	250
Understanding Link-State Routing Protocols	251
Understanding Link-State Relationships	252
Understanding the LSDB	253
Learning Link-State Routes	254
Review Question 1	255
Review Question 2	257
Lab Exercises	259
Module 9: OSPF Configuration	261
Overview	263
Objectives	264
Understanding OSPF	265
Understanding OSPF Areas	266
Understanding Nonbackbone Areas	267
Understanding Single-Area and Multiarea Configurations	268
Understanding OSPF Router Roles	269
Autonomous System Boundary Routers	270
Area Border Routers	270
Backbone and Nonbackbone Routers	271
Configuring OSPF	272

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Configuring Single-Area OSPFv2	273
Configuring Multiarea OSPFv2	273
Configuring Areas in OSPFv3	274
Verifying OSPF	275
Understanding OSPF Router IDs	277
Understanding OSPF Adjacencies	278
Understanding DR and BDR Elections	280
Understanding the LSDB	281
Verifying OSPF Adjacencies.....	283
Verifying OSPF Link States	286
Troubleshooting OSPF Adjacencies	287
Using Cost to Load Balance OSPF	289
Review Question 1.....	293
Review Question 2.....	295
Review Question 3.....	297
Lab Exercises	299
Module 10: EIGRP Configuration	301
Overview.....	302
Content in these modules is available in the full version of the	302
curriculum. Please visit www.boson.com for more information.	302
Understanding EIGRP	303
Choosing Between OSPF and EIGRP	304
Understanding EIGRP Adjacencies.....	305
Configuring Hello and Hold Timers	306
Understanding EIGRP Path Selection	307
Understanding Advertised Distance and Feasible Distance	310
Understanding EIGRP Tables	312
Configuring EIGRP	314
Verifying and Troubleshooting EIGRP	316
Understanding EIGRP Load Balancing	318
Using Variance to Load Balance EIGRP	319
Understanding EIGRP Route Summarization.....	321
Review Question 1.....	323
Review Question 2.....	325
Review Question 3.....	327
Review Question 4.....	329
Lab Exercises	331
Module 11: PPP WANs.....	333
Overview.....	334
Objectives.....	334
Implementing PPP	335
Establishing PPP Links	336
Configuring PPP on a Router Interface	337
Configuring PPP Authentication	338

Configuring Router Host Names, User Names, and Passwords.....	339
Configuring PAP Authentication.....	340
Configuring CHAP Authentication.....	342
Configuring PAP and CHAP on the Same Interface.....	343
Review Question 1.....	345
Review Question 2.....	347
Lab Exercises.....	349
Module 12: Frame Relay WANs	351
Overview.....	352
Objectives.....	352
Connecting to a Frame Relay Network.....	353
Understanding Frame Relay Packets.....	354
Understanding Virtual Circuits.....	355
Enabling Frame Relay.....	356
Understanding Frame Relay Topologies.....	357
Full-Mesh Topology.....	357
Partial-Mesh Topology.....	358
Hub-and-Spoke Topology.....	359
Working Around Split Horizons.....	360
Configuring Subinterfaces.....	361
Configuring Multipoint Frame Relay.....	362
Creating a Point-to-Point Subinterface.....	363
Configuring Multipoint Frame Relay.....	364
Creating a Multipoint Subinterface.....	365
Configuring Frame Relay Maps.....	366
Configuring Static Frame Relay Maps.....	367
Automatic Frame Relay Map Configuration.....	368
Configuring LMI Signaling.....	369
Configuring Inverse ARP.....	370
Configuring DLCIs.....	371
Verifying Frame Relay Connections.....	372
Verifying the Frame Relay Encapsulation Type.....	373
Verifying the Frame Relay LMI Type.....	374
Verifying Frame Relay Mappings.....	376
Verifying Frame Relay DLCI Status.....	377
Performing a Loopback Test.....	379
Review Question 1.....	381
Review Question 2.....	383
Lab Exercises.....	385
Module 13: Secure VPNs and Tunneling	387
Overview.....	388
Objectives.....	388
Understanding the Purpose of a VPN.....	389
The Two Types of VPNs.....	390

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Understanding Site-to-Site VPNs.....	391
Understanding Remote Access VPNs.....	393
Understanding the IPSec Protocol.....	395
IPSec Encryption Methods.....	396
IPSec Data Integrity Methods.....	397
IPSec Authentication Methods.....	398
Understanding GRE Tunnels.....	399
Differences Between Secure VPNs and GRE Tunnels.....	400
Configuring GRE Tunnels.....	401
Verifying GRE Tunnels.....	405
Review Question 1.....	407
Review Question 2.....	409
Review Question 3.....	411
Review Question 4.....	413
Lab Exercises.....	415
Index.....	417

Content in these modules is available in the full version of the curriculum. Please visit www.boson.com for more information.

Module 1

Cisco Device Management

Cisco Device Management Overview

- Boot process
- Configuration register
- Managing files
- Licensing
- Backing up
- Recovering



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.

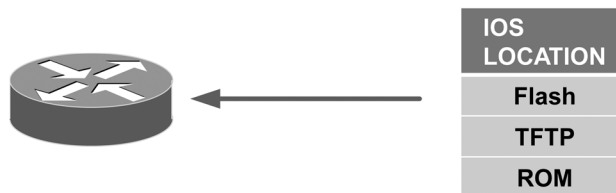
Objectives

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

- Loading IOS images
- Changing the IOS image load location
- Upgrading IOS



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; additionally, 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

- Images can be loaded from:
 - Flash memory
 - A TFTP server
- By default, images will be loaded from flash memory
- Devices can be configured to load images from a TFTP server

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

- The **boot system** command is used to change the IOS load location
- Load from flash:
 - **boot system flash** [*filename*]
- Load from TFTP:
 - **boot system tftp** *filename* [*ip-address*]
- Load from ROM:
 - **boot system rom**

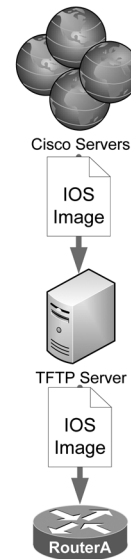
Changing the IOS Image Load Location

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

1. Configure a TFTP server
2. Download the IOS image from Cisco to TFTP
3. Verify TFTP server connectivity from the device
4. Issue the **copy tftp flash** command on the device
5. Check the IOS version and configuration register value
6. Reload the device



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 Web site. 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. Additionally, 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. Additionally, 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

- Boot to flash memory
- Load the NVRAM configuration
- Reset or record any forgotten passwords
- Save the new configuration to NVRAM
- Boot to NVRAM



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

- Loading IOS configuration files
 - From a TFTP server
 - **copy tftp running-config**
 - From NVRAM
 - **copy startup-config running-config**
- Saving IOS configuration files
 - To a TFTP server
 - **copy startup-config tftp**
 - To NVRAM
 - **copy running-config startup-config**

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

- Pre-installed activated licenses
 - Permanent license for purchased features
 - No activation required
- Pre-installed inactive licenses
 - Evaluation licenses for additional features
 - Activate using the **license boot module** command
- New purchases
 - New software packages and product features can be activated with:
 - CLM
 - CLI – **license install** command
 - SNMP

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

- Remotely monitor and manage network devices
- **snmp-server enable traps license** command
- SNMP license activation MIB

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

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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.

Lab Exercises

Module 1: Cisco Device Management

Lab 1.1 – Device Management

Labs powered by



The labs referenced in this book have been printed in the Boson Lab Guide, which is included with the purchase of the curriculum. These labs can be performed with real Cisco hardware or in the Boson NetSim Network Simulator. To learn more about the benefits of using NetSim or to purchase the software, please visit www.boson.com/netsim.

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