

CCNP SWITCH

Portable Command Guide

All the SWITCH 642-813 Commands
in One Compact, Portable Resource

CCNP SWITCH Portable Command Guide

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Introduction

Welcome to *CCNP SWITCH Portable Command Guide*. When Cisco Press approached me about updating the four-volume *CCNP Portable Command Guides*, two thoughts immediately jumped into my head: “Is it time for revisions already?” and “Yikes! I am in the middle of pursuing my master’s degree. Where will I find the time?” Because of those thoughts, two more soon followed: “I wonder what Hans is up to?” and “I hope Carol is in a good mood, as I am about to ask to take Hans away again....” The result is what you now have before you: a new *Portable Command Guide* for the latest version of the CCNP exam that focuses on switching: CCNP SWITCH.

For those of you who have worked with my books before, thank you for looking at this one. I hope that it will help you as you prepare for the vendor exam, or assist you in your daily activities as a Cisco network administrator/manager.

For those of you who are new to my books, you are reading what is essentially a cleaned-up version of my own personal engineering journals—a small notebook that I carry around with me that contains little nuggets of information; commands that I use but then forget; IP address schemes for the parts of the network I work with only occasionally; and quick refreshers for those concepts that I work with only once or twice a year. Although I teach these topics to postsecondary students, the classes I teach sometimes occur only once a year; as you can attest to, it is extremely difficult to remember all those commands all the time. Having a journal of commands at your fingertips, without having to search the Cisco website, can be a real time-saver (or a job-saver if the network is down and you are responsible for getting it back online).

With the creation of the new CCNP exam objectives, there is always something new to read, or a new podcast to listen to, or another slideshow from CiscoLive that you missed or want to review. The engineering journal can be that central repository of information that won’t weigh you down as you carry it from the office or cubicle to the server and infrastructure rooms in some remote part of the building or some branch office.

To make this guide a more realistic one for you to use, the folks at Cisco Press have decided to continue with an appendix of blank pages—pages on which you can write your own personal notes, such as your own configurations, commands that are not in this book but are needed in your world, and so on. That way, this book will look less like the authors’ journals and more like your own.

Networking Devices Used in the Preparation of This Book

To verify the commands that are in this new series of *CCNP Portable Command Guides*, many different devices were used. The following is a list of the equipment used in the preparation of these books:

- C2620 router running Cisco IOS Release 12.3(7)T, with a fixed Fast Ethernet interface, a WIC 2A/S serial interface card, and an NM-1E Ethernet interface
- C2811 ISR bundle with PVDM2, CMME, a WIC-2T, FXS and FXO VICs, running Cisco IOS Release 12.4(3g)
- C2821 ISR bundle with HWICD 9ESW, a WIC 2A/S, running 12.4(16) Advanced Security IOS

- WS-C3560-24-EMI Catalyst Switch, running Cisco IOS Release 12.2(25)SE
- WS-C3550-24-EMI Catalyst Switch, running Cisco IOS Release 12.1(9)EA1c
- WS-2960-24TT-L Catalyst Switch, running Cisco IOS Release 12.2(25)SE
- WS-2950-12 Catalyst Switch, running version C2950-C3.0(5.3)WC(1) Enterprise Edition Software
- WS-C3750-24TS Catalyst Switches, running ipservicesk9 release 12.2(52)SE
- C1760-V Voice Router with PVDm-256K-20, WIC-4ESW, VIC-2FXO, VIC-2FXS running ENTservicesk9 release 12.4(11)T2

You might notice that some of the devices were not running the latest and greatest IOS. Some of them are running code that is quite old.

Those of you familiar with Cisco devices will recognize that a majority of these commands work across the entire range of the Cisco product line. These commands are not limited to the platforms and IOS versions listed. In fact, in most cases, these devices are adequate for someone to continue their studies beyond the CCNP level as well. We have endeavored to identify throughout the book commands that are specific to a platform and/or IOS version.

Who Should Read This Book?

This book is for those people preparing for the CCNP SWITCH exam, whether through self-study, on-the-job training and practice, study within the Cisco Academy Program, or study through the use of a Cisco Training Partner. This book includes some handy hints and tips along the way to make life a bit easier for you in this endeavor. It is small enough that you will find it easy to carry around with you. Big, heavy textbooks might look impressive on your bookshelf in your office, but can you really carry them all around with you when you are working in a server room or equipment closet somewhere?

Strategies for Exam Preparation

The strategy that you use for CCNP SWITCH might be slightly different from strategies that other readers use, mainly based on the skills, knowledge, and experience you already have obtained. For example, if you have attended the SWITCH course, you might take a different approach than someone who learned routing via on-the-job training.

Regardless of the strategy you use or the background you have, the book is designed to help you get to the point where you can pass the exam with the least amount of time required. For instance, there is no need for you to practice or read about VLANs or Spanning Tree if you fully understand it already. However, many people like to make sure they truly know a topic, and thus read over material they already know. Several book features help you gain the confidence you need to be convinced that you know some material already, and determine which topics you need to study more.

Organization of This Book

Although this book could be read cover to cover, we strongly advise against it. The book is designed to be a simple listing of those commands that you need to understand to pass the SWITCH exam. Very little theory is included in the Portable Command Guides; they are designed to list commands needed at this level of study.

This book roughly follows the list of objectives for the CCNP SWITCH exam:

- **Chapter 1: “Analyzing Campus Network Designs”**—This chapter shows the Cisco Hierarchical Model of Network Design; the Cisco Enterprise Composite Network Model, the Cisco Service-Oriented Network Architecture (SONA), and the PPDIOO network lifecycle.
- **Chapter 2: “Implementing VLANs in a Campus Network”**—This chapter provides information on creating, verifying, and troubleshooting Virtual LANs, along with private VLANs and EtherChannel.
- **Chapter 3: “Implementing Spanning Tree”**—This chapter provides information on the configuration of Spanning Tree, along with commands used to verify the protocol and to configure enhancements to Spanning Tree, such as Rapid Spanning Tree and Multiple Spanning Tree.
- **Chapter 4: “Implementing Inter-VLAN Routing”**—This chapter shows the different ways to enable inter-VLAN communication—using an external router or using SVIs on a multilayer switch. DHCP and CEF are also covered in this chapter.
- **Chapter 5: “Implementing a Highly Available Network”**—This chapter covers topics such as network logging and syslog, SNMP managed nodes, and Cisco IOS Service Level Agreements.
- **Chapter 6: “Implementing a First Hop Redundancy Protocols Solution”**—This chapter provides information needed to ensure you have first hop redundancy—HSRO, VRRP, and GLBP are covered here.
- **Chapter 7: “Minimizing Service Loss and Data Theft in a Campus Network”**—Security is the focus of this chapter. Topics covered include port security, 802.1x authentication, mitigating VLAN hopping, DHCP snooping, DAI, CDP security issues, LLDP configuration, SSH, restricting access to telnet as web interface sessions with ACLs, how to disable unneeded ports, and securing end-device access ports.
- **Chapter 8: “Accommodating Voice and Video in Campus Networks”**—This chapter covers topics such as configuring and verifying voice VLANs, Power over Ethernet (POE), High Availability for Voice and Video, and configuring and verifying AutoQoS.
- **Chapter 9: “Integrating Wireless LANs into a Campus Network”**—This chapter provides information on topics such as switch configuration for standalone APs and HREAPs as well as controller-based APs; configuration for a WLAN controller; configuration for WiSM controllers; and configuring a wireless client.

Did We Miss Anything?

As educators, we are always interested in hearing how our students, and now readers of our books, do on both vendor exams and future studies. If you would like to contact either of us and let us know how this book helped you in your certification goals, please do so. Did we miss anything? Let us know. Contact us at ccnpguide@empson.ca or through the Cisco Press website, www.ciscopress.com.



Implementing Inter-VLAN Routing

This chapter provides information and commands concerning the following topics:

Inter-VLAN communication

- Inter-VLAN communication using an external router: router-on-a-stick
- Inter-VLAN communication tips
- Inter-VLAN communication on a multilayer switch through a switch virtual interface
 - Removing L2 switchport capability of a switch port
 - Configuring SVI Autostate
 - Configuring a Layer 3 EtherChannel
 - Configuring inter-VLAN communication
- Configuration example: inter-VLAN communication

DHCP

- Configuring DHCP server on a Router or Layer 3 Switch
- Verifying and troubleshooting DHCP configuration
- Configuring a DHCP helper address
- DHCP client on a Cisco IOS Software Ethernet interface
- Configuration example: DHCP

CEF

- Configuring Cisco Express Forwarding (CEF)
- Verifying CEF
- Troubleshooting CEF

Inter-VLAN Communication Using an External Router: Router-on-a-Stick

Router(config)# interface fastethernet 0/0	Moves to interface configuration mode.
Router(config-if)# duplex full	Sets interface to full duplex.
Router(config-if)# no shutdown	Enables interface.
Router(config-if)# interface fastethernet 0/0.1	Creates subinterface 0/0.1 and moves to subinterface configuration mode.

Router(config-subif)# description Management VLAN 1	(Optional) Sets locally significant descriptor of the subinterface.
Router(config-subif)# encapsulation dot1q 1 native	Assigns VLAN 1 to this subinterface. VLAN 1 is the native VLAN. This subinterface uses the 802.1Q trunking protocol.
Router(config-subif)# ip address 192.168.1.1 255.255.255.0	Assigns IP address and netmask.
Router(config-subif)# interface fastethernet 0/0.10	Creates subinterface 0/0.10 and moves to subinterface configuration mode.
Router(config-subif)# description Accounting VLAN 10	(Optional) Sets locally significant descriptor of the subinterface.
Router(config-subif)# encapsulation dot1q 10	Assigns VLAN 10 to this subinterface. This subinterface uses the 802.1Q trunking protocol.
Router(config-subif)# ip address 192.168.10.1 255.255.255.0	Assigns IP address and netmask.
Router(config-subif)# exit	Returns to interface configuration mode.
Router(config-if)# exit	Returns to global configuration mode.
Router(config)#	

NOTE: The subnets of the VLANs are directly connected to the router. Routing between these subnets does not require a dynamic routing protocol. In a more complex topology, these routes need to either be advertised with whatever dynamic routing protocol is used, or be redistributed into whatever dynamic routing protocol is used.

NOTE: Routes to the subnets associated with these VLANs appear in the routing table as directly connected networks.

Inter-VLAN Communication Tips

- Although most routers support both Inter-Switch Link (ISL) and Dot1Q encapsulation, some switch models support only Dot1Q, such as the 2950 and 2960 series.
- If you need to use ISL as your trunking protocol, use the command **encapsulation isl** *x*, where *x* is the number of the VLAN to be assigned to that subinterface.

- Recommended best practice is to use the same number of the VLAN number for the subinterface number. It is easier to troubleshoot VLAN 10 on subinterface fastethernet0/0.10 than on fastethernet0/0.2.
- The native VLAN (usually VLAN 1) cannot be configured on a subinterface for Cisco IOS releases that are earlier than 12.1(3)T. Native VLAN IP addresses will, therefore, need to be configured on the physical interface. Other VLAN traffic will be configured on subinterfaces:

```
Router(config)#interface fastethernet 0/0
Router(config-if)#encapsulation dot1q 1 native
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#interface fastethernet 0/0.10
Router(config-subif)#encapsulation dot1q 10
Router(config-subif)#ip address 192.168.10.1 255.255.255.0
```

Inter-VLAN Communication on a Multilayer Switch Through a Switch Virtual Interface

Rather than using an external router to provide inter-VLAN communication, a multilayer switch can perform the same task through the use of a switched virtual interface (SVI).

Removing L2 Switchport Capability of a Switch Port

3750Switch(config)# interface fastethernet 0/1	Moves to interface configuration mode.
3750Switch(config-if)# no switchport	Creates a Layer 3 port on the switch.
	NOTE: The no switchport command can be used on physical ports only on a Layer 3–capable switch.

Configuring SVI Autostate

3750Switch(config)# interface fastethernet 0/1	Moves to interface configuration mode.
3750Switch(config-if)# switchport auto-state exclude	Excludes the access port/trunk in defining the status of an SVI as up or down.
	NOTE: This command is commonly used for ports that are used for monitoring, for example, so that a monitoring port does not cause the SVI to remain “up” when no other ports are active in the VLAN.

NOTE: For the SVI line state to be up, at least one port in the VLAN must be up and forwarding. The **switchport auto-state exclude** command excludes a port from the SVI interface line-state up-or-down calculation.

Configuring a Layer 3 EtherChannel

Switch(config)# interface port-channel 1	Creates a virtual Layer 2 interface.
Switch(config-if)# no switchport	Changes interface to Layer 3 to enable the use of the IP address command.
Switch(config-if)# ip address 172.32.52.10 255.255.255.0	Assigns an IP address to the Layer 3 port-channel interface.
Switch(config)# interface range fastethernet 5/4 - 5	Moves to interface range configuration mode.
Switch(config-if-range)# no switchport	Creates Layer 3 ports on a switch.
Switch(config-if-range)# channel-protocol pagp	Configures port aggregation protocol.
Switch(config-if-range)# channel-group 1 mode desirable	Assigns the physical interfaces in the range to the EtherChannel group.

Configuring Inter-VLAN Communication

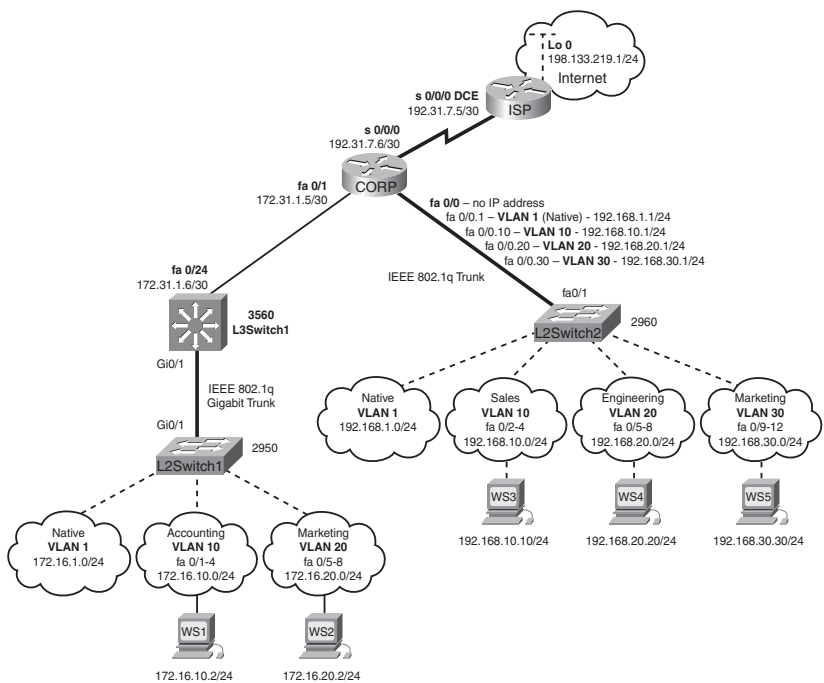
3550Switch(config)# interface vlan 1	Creates a virtual interface for VLAN 1 and enters interface configuration mode.
3550Switch(config-if)# ip address 172.16.1.1 255.255.255.0	Assigns IP address and netmask.
3550Switch(config-if)# no shutdown	Enables the interface.
3550Switch(config)# interface vlan 10	Creates a virtual interface for VLAN 10 and enters interface configuration mode.
3550Switch(config-if)# ip address 172.16.10.1 255.255.255.0	Assigns IP address and netmask.
3550Switch(config-if)# no shutdown	Enables the interface.
3550Switch(config)# interface vlan 20	Creates a virtual interface for VLAN 20 and enters interface configuration mode.

3550Switch(config-if)#ip address 172.16.20.1 255.255.255.0	Assigns IP address and netmask.
3550Switch(config-if)#no shutdown	Enables the interface.
3550Switch(config-if)#exit	Returns to global configuration mode.
3550Switch(config)#ip routing	Enables routing on the switch.

Configuration Example: Inter-VLAN Communication

Figure 4-1 shows the network topology for the configuration that follows, which shows how to configure inter-VLAN communication using commands covered in this chapter. Some commands used in this configuration are from previous chapters.

Figure 4-1 Network Topology for Inter-VLAN Communication Configuration



ISP Router

Router> enable	Moves to privileged mode.
Router> #configure terminal	Moves to global configuration mode.
Router(config)# hostname ISP	Sets the host name.
ISP(config)# interface loopback 0	Moves to interface configuration mode.
ISP(config-if)# description simulated address representing remote website	Sets the locally significant interface description.
ISP(config-if)# ip address 198.133.219.1 255.255.255.0	Assigns IP address and netmask.
ISP(config-if)# interface serial 0/0/0	Moves to interface configuration mode.
ISP(config-if)# description WAN link to the Corporate Router	Sets the locally significant interface description.
ISP(config-if)# ip address 192.31.7.5 255.255.255.252	Assigns IP address and netmask.
ISP(config-if)# clock rate 56000	Assigns a clock rate to the interface—DCE cable is plugged in to this interface.
ISP(config-if)# no shutdown	Enables the interface.
ISP(config-if)# exit	Returns to global configuration mode.
ISP(config-if)# router eigrp 10	Creates Enhanced Interior Gateway Routing Protocol (EIGRP) routing process 10.
ISP(config-router)# network 198.133.219.0	Advertises directly connected networks (classful address only).
ISP(config-router)# network 192.31.7.0	Advertises directly connected networks (classful address only).
ISP(config-router)# no auto-summary	Disables auto summarization.
ISP(config-router)# exit	Returns to global configuration mode.

ISP(config)# exit	Returns to privileged mode.
ISP# copy running-config startup-config	Saves the configuration to NVRAM.

CORP Router

Router> enable	Moves to privileged mode.
Router># configure terminal	Moves to global configuration mode.
Router(config)# hostname CORP	Sets the host name.
ISP(config)# interface serial 0/0/0	Moves to interface configuration mode.
CORP(config-if)# description link to ISP	Sets the locally significant interface description.
CORP(config-if)# ip address 192.31.7.6 255.255.255.252	Assigns IP address and netmask.
CORP(config-if)# no shutdown	Enables the interface.
CORP(config)# interface fastethernet 0/1	Moves to interface configuration mode.
CORP(config-if)# description link to 3560 Switch	Sets the locally significant interface description.
CORP(config-if)# ip address 172.31.1.5 255.255.255.252	Assigns the IP address and netmask.
CORP(config-if)# no shutdown	Enables the interface.
CORP(config-if)# exit	Returns to global configuration mode.
CORP(config)# interface fastethernet 0/0	Enters interface configuration mode.
CORP(config-if)# duplex full	Enables full-duplex operation to ensure trunking will take effect between here and L2Switch2.
CORP(config-if)# no shutdown	Enables the interface.

CORP(config-if)# interface fastethernet 0/0.1	Creates a virtual subinterface and moves to subinterface configuration mode.
CORP(config-subif)# description Management VLAN 1 – Native VLAN	Sets the locally significant interface description.
CORP(config-subif)# encapsulation dot1q 1 native	Assigns VLAN 1 to this subinterface. VLAN 1 is the native VLAN. This subinterface uses the 802.1Q trunking protocol.
CORP(config-subif)# ip address 192.168.1.1 255.255.255.0	Assigns the IP address and netmask.
CORP(config-subif)# interface fastethernet 0/0.10	Creates a virtual subinterface and moves to subinterface configuration mode.
CORP(config-subif)# description Sales VLAN 10	Sets the locally significant interface description.
CORP(config-subif)# encapsulation dot1q 10	Assigns VLAN 10 to this subinterface. This subinterface uses the 802.1Q trunking protocol.
CORP(config-subif)# ip address 192.168.10.1 255.255.255.0	Assigns the IP address and netmask.
CORP(config-subif)# interface fastethernet 0/0.20	Creates a virtual subinterface and moves to subinterface configuration mode.
CORP(config-subif)# description Engineering VLAN 20	Sets the locally significant interface description.
CORP(config-subif)# encapsulation dot1q 20	Assigns VLAN 20 to this subinterface. This subinterface uses the 802.1Q trunking protocol.
CORP(config-subif)# ip address 192.168.20.1 255.255.255.0	Assigns the IP address and netmask.
CORP(config-subif)# interface fastethernet 0/0.30	Creates a virtual subinterface and moves to subinterface configuration mode.

CORP(config-subif)# description Marketing VLAN 30	Sets the locally significant interface description.
CORP(config-subif)# encapsulation dot1q 30	Assigns VLAN 30 to this subinterface. This subinterface uses the 802.1Q trunking protocol.
CORP(config-subif)# ip add 192.168.30.1 255.255.255.0	Assigns the IP address and netmask.
CORP(config-subif)# exit	Returns to interface configuration mode.
CORP(config-if)# exit	Returns to global configuration mode.
CORP(config)# router eigrp 10	Creates EIGRP routing process 10 and moves to router configuration mode.
CORP(config-router)# network 192.168.1.0	Advertises the 192.168.1.0 network.
CORP(config-router)# network 192.168.10.0	Advertises the 192.168.10.0 network.
CORP(config-router)# network 192.168.20.0	Advertises the 192.168.20.0 network.
CORP(config-router)# network 192.168.30.0	Advertises the 192.168.30.0 network.
CORP(config-router)# network 172.31.0.0	Advertises the 172.31.0.0 network.
CORP(config-router)# network 192.31.7.0	Advertises the 192.31.7.0 network.
CORP(config-router)# no auto-summary	Turns off automatic summarization at classful boundary.
CORP(config-router)# exit	Returns to global configuration mode.
CORP(config)# exit	Returns to privileged mode.
CORP# copy running-config startup-config	Saves the configuration in NVRAM.

L2Switch2 (Catalyst 2960)

Switch> enable	Moves to privileged mode.
Switch# configure terminal	Moves to global configuration mode.
Switch(config)# hostname L2Switch2	Sets the host name.
L2Switch2(config)# vlan 10	Creates VLAN 10 and enters VLAN-configuration mode.
L2Switch2(config-vlan)# name Sales	Assigns a name to the VLAN.
L2Switch2(config-vlan)# exit	Returns to global configuration mode.
L2Switch2(config)# vlan 20	Creates VLAN 20 and enters VLAN-configuration mode.
L2Switch2(config-vlan)# name Engineering	Assigns a name to the VLAN.
L2Switch2(config-vlan)# vlan 30	Creates VLAN 30 and enters VLAN-configuration mode. Note that you do not have to exit back to global configuration mode to execute this command.
L2Switch2(config-vlan)# name Marketing	Assigns a name to the VLAN.
L2Switch2(config-vlan)# exit	Returns to global configuration mode.
L2Switch2(config)# interface range fastethernet 0/2 - 4	Enables you to set the same configuration parameters on multiple ports at the same time.
L2Switch2(config-if-range)# switchport mode access	Sets ports 2–4 as access ports.
L2Switch2(config-if-range)# switchport access vlan 10	Assigns ports 2–4 to VLAN 10.
L2Switch2(config-if-range)# interface range fastethernet 0/5 - 8	Enables you to set the same configuration parameters on multiple ports at the same time.
L2Switch2(config-if-range)# switchport mode access	Sets ports 5–8 as access ports.

L2Switch2(config-if-range)#switchport access vlan 20	Assigns ports 5–8 to VLAN 20.
L2Switch2(config-if-range)#interface range fastethernet 0/9 - 12	Enables you to set the same configuration parameters on multiple ports at the same time.
L2Switch2(config-if-range)#switchport mode access	Sets ports 9–12 as access ports.
L2Switch2(config-if-range)#switchport access vlan 30	Assigns ports 9–12 to VLAN 30.
L2Switch2(config-if-range)#exit	Returns to global configuration mode.
L2Switch2(config)#interface fastethernet 0/1	Moves to interface configuration mode.
L2Switch2(config)#description Trunk Link to CORP Router	Sets locally significant interface description.
L2Switch2(config-if)#switchport mode trunk	Puts the interface into trunking mode and negotiates to convert the link into a trunk link.
L2Switch2(config-if)#exit	Returns to global configuration mode.
L2Switch2(config)#interface vlan 1	Creates virtual interface for VLAN 1 and enters interface configuration mode.
L2Switch2(config-if)#ip address 192.168.1.2 255.255.255.0	Assigns the IP address and netmask.
L2Switch2(config-if)#no shutdown	Enables the interface.
L2Switch2(config-if)#exit	Returns to global configuration mode.
L2Switch2(config)#ip default-gateway 192.168.1.1	Assigns the default gateway address.
L2Switch2(config)#exit	Returns to privileged mode.
L2Switch2#copy running-config startup-config	Saves the configuration in NVRAM.

L3Switch1 (Catalyst 3560)

Switch> enable	Moves to privileged mode.
Switch# configure terminal	Moves to global configuration mode.
Switch(config)# hostname L3Switch1	Sets the host name.
L3Switch1(config)# vtp mode server	Changes the switch to VTP server mode.
L3Switch1(config)# vtp domain testdomain	Configures the VTP domain name to testdomain.
L3Switch1(config)# vlan 10	Creates VLAN 10 and enters VLAN-configuration mode.
L3Switch1(config-vlan)# name Accounting	Assigns a name to the VLAN.
L3Switch1(config-vlan)# exit	Returns to global configuration mode.
L3Switch1(config)# vlan 20	Creates VLAN 20 and enters VLAN-configuration mode.
L3Switch1(config-vlan)# name Marketing	Assigns a name to the VLAN.
L3Switch1(config-vlan)# exit	Returns to global configuration mode.
L3Switch1(config)# interface gigabitethernet 0/1	Moves to interface configuration mode.
L3Switch1(config-if)# switchport trunk encapsulation dot1q	Specifies 802.1Q encapsulation on the trunk link.
L3Switch1(config-if)# switchport mode trunk	Puts the interface into trunking mode and negotiates to convert the link into a trunk link.
L3Switch1(config-if)# exit	Returns to global configuration mode.
L3Switch1(config)# ip routing	Enables IP routing on this device.
L3Switch1(config)# interface vlan 1	Creates a virtual interface for VLAN 1 and enters interface configuration mode.

L3Switch1(config-if)# ip address 172.16.1.1 255.255.255.0	Assigns the IP address and netmask.
L3Switch1(config-if)# no shutdown	Enables the interface.
L3Switch1(config-if)# interface vlan 10	Creates a virtual interface for VLAN 10 and enters interface configuration mode.
L3Switch1(config-if)# ip address 172.16.10.1 255.255.255.0	Assigns the IP address and mask.
L3Switch1(config-if)# no shutdown	Enables the interface.
L3Switch1(config-if)# interface vlan 20	Creates a virtual interface for VLAN 20 and enters interface configuration mode.
L3Switch1(config-if)# ip address 172.16.20.1 255.255.255.0	Assigns the IP address and mask.
L3Switch1(config-if)# no shutdown	Enables the interface.
L3Switch1(config-if)# exit	Returns to global configuration mode.
L3Switch1(config)# interface fastethernet 0/24	Enters interface configuration mode.
L3Switch1(config-if)# no switchport	Creates a Layer 3 port on the switch.
L3Switch1(config-if)# ip address 172.31.1.6 255.255.255.252	Assigns the IP address and netmask.
L3Switch1(config-if)# exit	Returns to global configuration mode.
L3Switch1(config)# router eigrp 10	Creates EIGRP routing process 10 and moves to router config mode.
L3Switch1(config-router)# network 172.16.0.0	Advertises the 172.16.0.0 classful network.
L3Switch1(config-router)# network 172.31.0.0	Advertises the 172.31.0.0 classful network.

L3Switch1(config-router)# no auto-summary	Turns off automatic summarization at classful boundary.
L3Switch1(config-router)# exit	Applies changes and returns to global configuration mode.
L3Switch1(config)# exit	Returns to privileged mode.
L3Switch1# copy running-config startup-config	Saves configuration in NVRAM.

L2Switch1 (Catalyst 2960)

Switch> enable	Moves to privileged mode.
Switch# configure terminal	Moves to global configuration mode.
Switch(config)# hostname L2Switch1	Sets the host name.
L2Switch1(config)# vtp domain testdomain	Configures the VTP domain name to testdomain.
L2Switch1(config)# vtp mode client	Changes the switch to VTP client mode.
L2Switch1(config)# interface range fastethernet 0/1 - 4	Enables you to set the same configuration parameters on multiple ports at the same time.
L2Switch1(config-if-range)# switchport mode access	Sets ports 1–4 as access ports.
L2Switch1(config-if-range)# switchport access vlan 10	Assigns ports 1–4 to VLAN 10.
L2Switch1(config-if-range)# interface range fastethernet 0/5 - 8	Enables you to set the same configuration parameters on multiple ports at the same time.
L2Switch1(config-if-range)# switchport mode access	Sets ports 5–8 as access ports.
L2Switch1(config-if-range)# switchport access vlan 20	Assigns ports 5–8 to VLAN 20.
L2Switch1(config-if-range)# exit	Returns to global configuration mode.

L2Switch1(config)# interface gigabitethernet 0/1	Moves to interface configuration mode.
L2Switch1(config-if)# switchport mode trunk	Puts the interface into trunking mode and negotiates to convert the link into a trunk link.
L2Switch1(config-if)# exit	Returns to global configuration mode.
L2Switch1(config)# interface vlan 1	Creates a virtual interface for VLAN 1 and enters interface configuration mode.
L2Switch1(config-if)# ip address 172.16.1.2 255.255.255.0	Assigns the IP address and netmask.
L2Switch1(config-if)# no shutdown	Enables the interface.
L2Switch1(config-if)# exit	Returns to global configuration mode.
L2Switch1(config)# ip default-gateway 172.16.1.1	Assigns the default gateway address.
L2Switch1(config)# exit	Returns to privileged mode.
L2Switch1# copy running-config startup-config	Saves the configuration in NVRAM.

Configuring DHCP Server on a Router or Layer 3 Switch

Router(config)# ip dhcp pool internal	Creates a DHCP pool called internal.
Router(dhcp-config)# network 172.16.10.0 255.255.255.0	Defines the range of addresses to be leased.
Router(dhcp-config)# default-router 172.16.10.1	Defines the address of the default router for the client.
Router(dhcp-config)# dns-server 172.16.10.10	Defines the address of the Domain Name System (DNS) server for the client.

Router(dhcp-config)# netbios-name-server 172.16.10.10	Defines the address of the NetBIOS server for the client.
Router(dhcp-config)# domain-name fakedomainname.ca	Defines the domain name for the client.
Router(dhcp-config)# lease 14 12 23	Defines the lease time to be 14 days, 12 hours, 23 minutes.
Router(dhcp-config)# lease infinite	Sets the lease time to infinity; the default time is 1 day.
Router(dhcp-config)# exit	Returns to global configuration mode.
Router(config)# ip dhcp excluded-address 172.16.10.1 172.16.10.9	Specifies the range of addresses not to be leased out to clients.
Router(config)# service dhcp	Enables the DHCP service and relay features on a Cisco IOS router.
Router(config)# no service dhcp	Turns off the DHCP service. DHCP service is enabled by default in Cisco IOS Software.

Verifying and Troubleshooting DHCP Configuration

Router# show ip dhcp binding	Displays a list of all bindings created.
Router# show ip dhcp binding w.x.y.z	Displays the bindings for a specific DHCP client with an IP address of w.x.y.z.
Router# clear ip dhcp binding a.b.c.d	Clears an automatic address binding from the DHCP server database.
Router# clear ip dhcp binding *	Clears all automatic DHCP bindings.
Router# show ip dhcp conflict	Displays a list of all address conflicts recorded by the DHCP server.
Router# clear ip dhcp conflict a.b.c.d	Clears address conflict from the database.
Router# clear ip dhcp conflict *	Clears conflicts for all addresses.

Router# show ip dhcp database	Displays recent activity on the DHCP database.
Router# show ip dhcp server statistics	Displays a list of the number of messages sent and received by the DHCP server.
Router# clear ip dhcp server statistics	Resets all DHCP server counters to 0.
Router# debug ip dhcp server {events packets linkage class}	Displays the DHCP process of addresses being leased and returned.

Configuring a DHCP Helper Address

NOTE: For the SVI line state to be up, at least one port in the VLAN must be up and forwarding. The **switchport auto-state exclude** command excludes a port from the SVI interface line-state up-or-down calculation.

Router

Router(config)# interface fastethernet 0/0	Moves to interface configuration mode.
Router(config-if)# ip helper-address 172.16.20.2	DHCP broadcasts will be forwarded as a unicast to this specific address rather than be dropped by the router.

Layer 3 Switch

Switch(config)# interface vlan 10	Moves to SVI configuration mode.
Switch(config-if)# ip helper-address 172.16.20.2	DHCP broadcasts will be forwarded as a unicast to this specific address rather than be dropped by the router.

NOTE: The **ip helper-address** command forwards broadcast packets as a unicast to eight different UDP ports by default:

- TFTP (port 69)
- DNS (port 53)
- Time service (port 37)

- NetBIOS name server (port 137)
- NetBIOS datagram server (port 138)
- Boot Protocol (BOOTP) client and server datagrams (ports 67 and 68)
- TACACS service (port 49)
- Host Name Service (port 42)

To close some of these ports, use the **no ip forward-protocol udp x** command at the global configuration prompt, where *x* is the port number you want to close. The following command stops the forwarding of broadcasts to port 49:

```
Router(config)#no ip forward-protocol udp 49
```

To open other UDP ports, use the **ip forward-helper udp x** command, where *x* is the port number you want to open:

```
Router(config)#ip forward-protocol udp 517
```

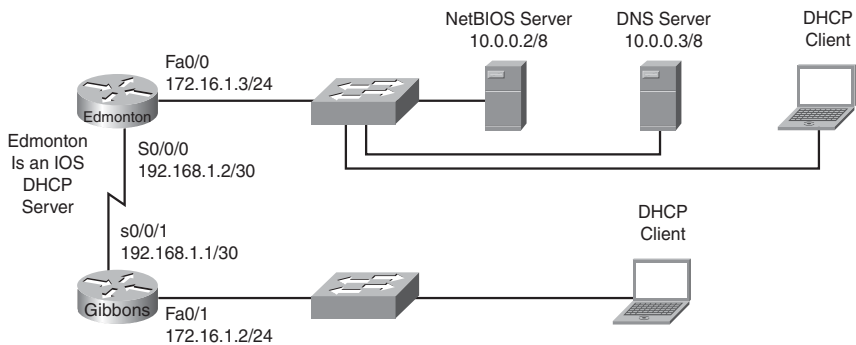
DHCP Client on a Cisco IOS Software Ethernet Interface

Router(config)# interface fastethernet 0/0	Moves to interface configuration mode.
Router(config-if)# ip address dhcp	Specifies that the interface acquire an IP address through DHCP.
	NOTE: The ip address dhcp command can also be applied on an L3 switch at the SVI as well as any port where the no switchport command has been used.

Configuration Example: DHCP

Figure 4-2 illustrates the network topology for the configuration that follows, which shows how to configure DHCP services on a Cisco IOS router using the commands covered in this chapter.

Figure 4-2 Network Topology for DHCP Configuration



Edmonton Router

router> enable	Moves to privileged mode.
router# configure terminal	Moves to global configuration mode.
router(config)# host Edmonton	Sets the host name.
Edmonton(config)# interface fastethernet 0/0	Moves to interface configuration mode.
Edmonton(config-if)# description LAN Interface	Sets the local description of the interface.
Edmonton(config-if)# ip address 10.0.0.1 255.0.0.0	Assigns an IP address and netmask.
Edmonton(config-if)# no shutdown	Enables the interface.
Edmonton(config-if)# interface serial 0/0/0	Moves to interface configuration mode.
Edmonton(config-if)# description Link to Gibbons Router	Sets the local description of the interface.
Edmonton(config-if)# ip address 192.168.1.2 255.255.255.252	Assigns an IP address and netmask.
Edmonton(config-if)# clock rate 56000	Assigns the clock rate to the DCE cable on this side of link.
Edmonton(config-if)# no shutdown	Enables the interface.
Edmonton(config-if)# exit	Returns to global configuration mode.
Edmonton(config)# router eigrp 10	Enables the EIGRP routing process for autonomous system 10.
Edmonton(config-router)# network 10.0.0.0	Advertises the 10.0.0.0 network.
Edmonton(config-router)# network 192.168.1.0	Advertises the 192.168.1.0 network.
Edmonton(config-router)# exit	Returns to global configuration mode.
Edmonton(config)# service dhcp	Verifies that the router can use DHCP services and that DHCP is enabled.
Edmonton(config)# ip dhcp excluded-address 10.0.0.1 10.0.0.5	Specifies the range of addresses not to be leased out to clients.

Edmonton(config)# ip dhcp pool 10 network	Creates a DHCP pool called 10network.
Edmonton(dhcp-config)# network 10.0.0.0 255.0.0.0	Defines the range of addresses to be leased.
Edmonton(dhcp-config)# default-router 10.0.0.1	Defines the address of the default router for clients.
Edmonton(dhcp-config)# netbios-name-server 10.0.0.2	Defines the address of the NetBIOS server for clients.
Edmonton(dhcp-config)# dns-server 10.0.0.3	Defines the address of the DNS server for clients.
Edmonton(dhcp-config)# domain-name fakedomainname.ca	Defines the domain name for clients.
Edmonton(dhcp-config)# lease 12 14 30	Sets the lease time to be 12 days, 14 hours, 30 minutes.
Edmonton(dhcp-config)# exit	Returns to global configuration mode.
Edmonton(config)# ip dhcp pool 192.168.3network	Creates a DHCP pool called the 192.168.3network.
Edmonton(dhcp-config)# network 192.168.3.0 255.255.255.0	Defines the range of addresses to be leased.
Edmonton(dhcp-config)# default-router 192.168.3.1	Defines the address of the default router for clients.
Edmonton(dhcp-config)# netbios-name-server 10.0.0.2	Defines the address of the NetBIOS server for clients.
Edmonton(dhcp-config)# dns-server 10.0.0.3	Defines the address of the DNS server for clients.
Edmonton(dhcp-config)# domain-name fakedomainname.ca	Defines the domain name for clients.
Edmonton(dhcp-config)# lease 12 14 30	Sets the lease time to be 12 days, 14 hours, 30 minutes.
Edmonton(dhcp-config)# exit	Returns to global configuration mode.
Edmonton(config)# exit	Returns to privileged mode.
Edmonton# copy running-config startup-config	Saves the configuration to NVRAM.

Gibbons Router

router> enable	Enters privileged mode.
router# configure terminal	Enters global configuration mode.
router(config)# host Gibbons	Sets the host name.
Gibbons(config)# interface fastethernet 0/0	Enters interface configuration mode.
Gibbons(config-if)# description LAN Interface	Sets the local description of the interface.
Gibbons(config-if)# ip address 192.168.3.1 255.255.255.0	Assigns an IP address and netmask.
Gibbons(config-if)# ip helper-address 192.168.1.2	DHCP broadcasts will be forwarded as a unicast to this address rather than be dropped.
Gibbons(config-if)# no shutdown	Enables the interface.
Gibbons(config-if)# interface serial 0/0/1	Enters interface configuration mode.
Gibbons(config-if)# description Link to Edmonton Router	Sets the local description of the interface.
Gibbons(config-if)# ip address 192.168.1.1 255.255.255.252	Assigns an IP address and netmask.
Gibbons(config-if)# no shutdown	Enables the interface.
Gibbons(config-if)# exit	Returns to global configuration mode.
Gibbons(config)# router eigrp 10	Enables the EIGRP routing process for autonomous system 10.
Gibbons(config-router)# network 192.168.3.0	Advertises the 192.168.3.0 network.
Gibbons(config-router)# network 192.168.1.0	Advertises the 192.168.1.0 network.
Gibbons(config-router)# exit	Returns to global configuration mode.
Gibbons(config)# exit	Returns to privileged mode.
Gibbons# copy running-config startup-config	Saves the configuration to NVRAM.

NOTE: The subnets of the VLANs are directly connected to the switch. Routing between these subnets does not require a dynamic routing protocol. If the switch is to be connected to a router and remote communication is desired, a routing protocol must be enabled and networks advertised:

```
3750Switch(config)#router eigrp 1  
3750Switch(config-router)#network 172.16.0.0  
3750Switch(config-router)#exit  
3750Switch(config)#
```

Configuring Cisco Express Forwarding

Switch(config)# ip cef	Enables standard CEF.
Switch(config)# ip cef distributed	Enables distributed CEF (dCEF).
Switch(config)# no ip cef	Disables CEF globally.
Switch(config)# interface fastethernet 0/1	Moves to interface configuration mode.
Switch(config-if)# ip route-cache cef	Enables CEF on the interface.

Verifying CEF

Switch# show ip cef	Displays entries in the Forwarding Information Base (FIB).
Switch# show ip cef summary	Displays a summary of the FIB.
Switch# show ip cef unresolved	Displays unresolved FIB entries.
Switch# show ip cef fastethernet 0/1	Displays the FIB entry for the specified interface.
Switch# show ip cef fastethernet 0/1 detail	Displays detailed information about the FIB for the interface.
Switch# show interface fastethernet 0/1 begin L3	Displays switching statistics for the interface beginning at the section for L3.

Switch# show interface gigabitethernet 1/1 include switched	Displays switching statistics that show statistics for each layer.
Switch# show adjacency fastethernet 0/20 detail	Displays the content of the information to be used during L2 encapsulation.
	NOTE: When using the show adjacency interface xx detail command, both the next hop-hop and local MAC addresses are displayed as well as the well-known Ethertype value of the encapsulation protocol (0x0800 for IP).
Switch# show cef drop	Displays packets that are dropped because adjacencies are incomplete or nonexistent.
Switch# show ip interface vlan10	Verifies whether CEF is enabled on an interface.

Troubleshooting CEF

Switch# debug ip cef	Displays debug information for CEF.
Switch# debug ip cef drops	Displays debug information about dropped packets.
Switch# debug ip cef drops x	Records CEF dropped packets that match access-list x.
Switch# debug ip cef receive	Displays packets that are not switched using information from the FIB but that are received and sent to the next switching layer.
Switch# debug ip cef events	Displays general CEF events.
Switch# debug ip cef prefix-ipc	Displays updates related to IP prefix information.
Switch# debug ip cef table	Produces a table showing events related to the FIB table.
Switch# ping ip	Performs an extended ping.