CCNA R&S: Introduction to Networks

Chapter 2:

Configuring a Network Operating System

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2.0.1.1 Introduction to Cisco IOS

Upon completion of this chapter you will be able to:

- Explain the purpose of Cisco IOS.
- Explain how to access and navigate Cisco IOS to configure network devices.
- Describe the command structure of Cisco IOS software.
- Configure hostnames on a Cisco IOS device using the CLI.
- Use Cisco IOS commands to limit access to device configurations.
- Use Cisco IOS commands to save the running configuration.
- Explain how devices communicate across network media.
- Configure a host device with an IP address.
- Verify connectivity between two end devices.

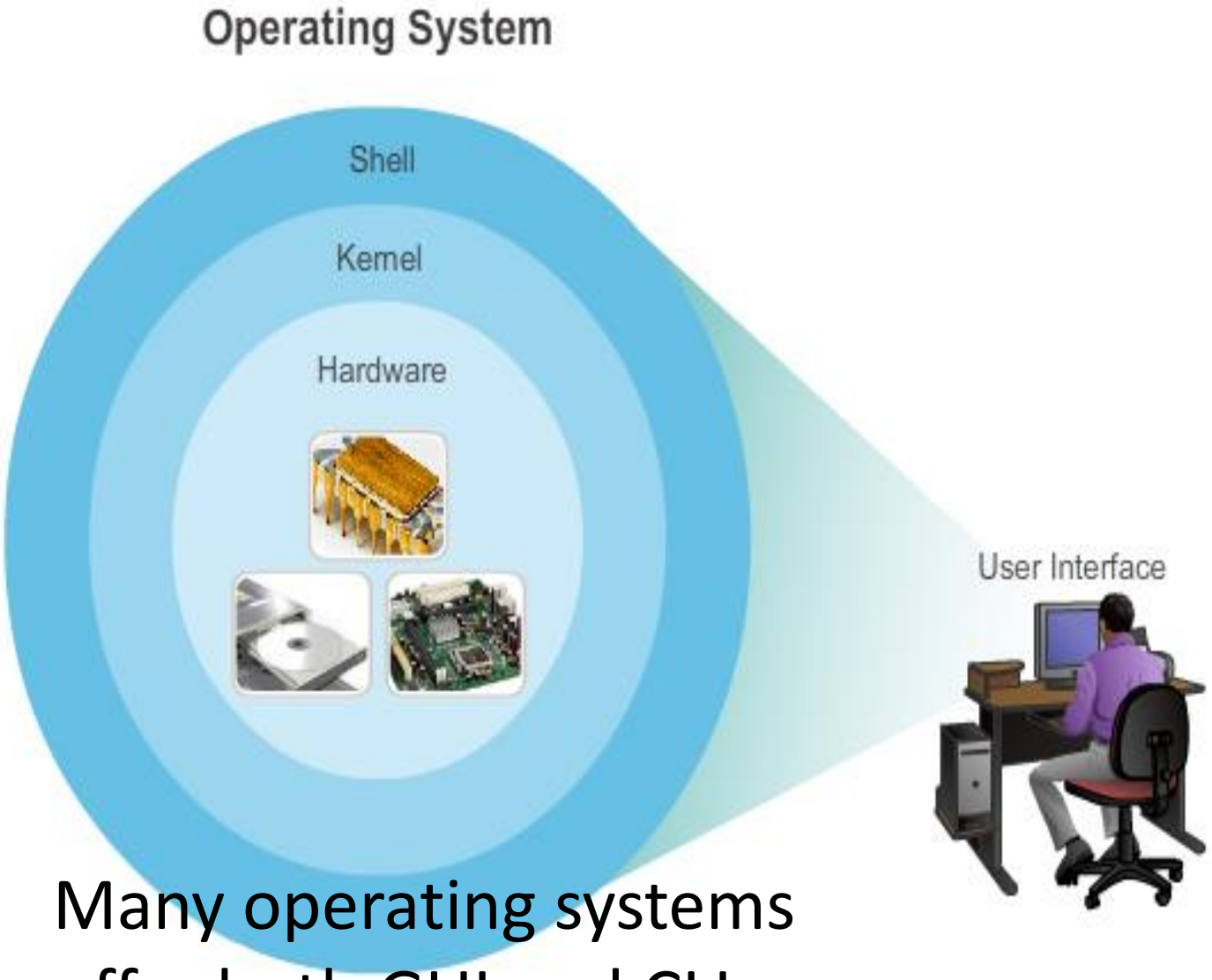
- Home networks typically interconnect a wide variety of end devices.
- All of these end devices are usually connected to a home router. Home routers are actually four devices in one:

Router - Forwards data packets to and receives data packets from the Internet
Switch - Connects end devices using network cables
Wireless access point - Consists of a radio transmitter capable of connecting end devices wirelessly
Firewall appliance - Secures outgoing traffic and restricts incoming traffic

2.0.1.2 Class Activity - It Is Just an Operating System

All Cisco network devices use an operating system otherwise known as an internetwork operating system or IOS.

2.1.1.1 Operating Systems



Many operating systems offer both GUI and CLI.

When using the CLI, the user interacts directly with the system in a text-based environment by entering commands on the keyboard at a command prompt. The system executes the command, often providing textual output.

- The "behind the scenes" functions for switches and routers are very similar.
- The IOS on a switch or router provides the network technician with an interface.
- The technician can enter commands to configure, or program, the device to perform various networking functions.
- The IOS operational details vary on internetworking devices, depending on the purpose of the device and the features supported.

2.1.1.3 Location of the Cisco IOS

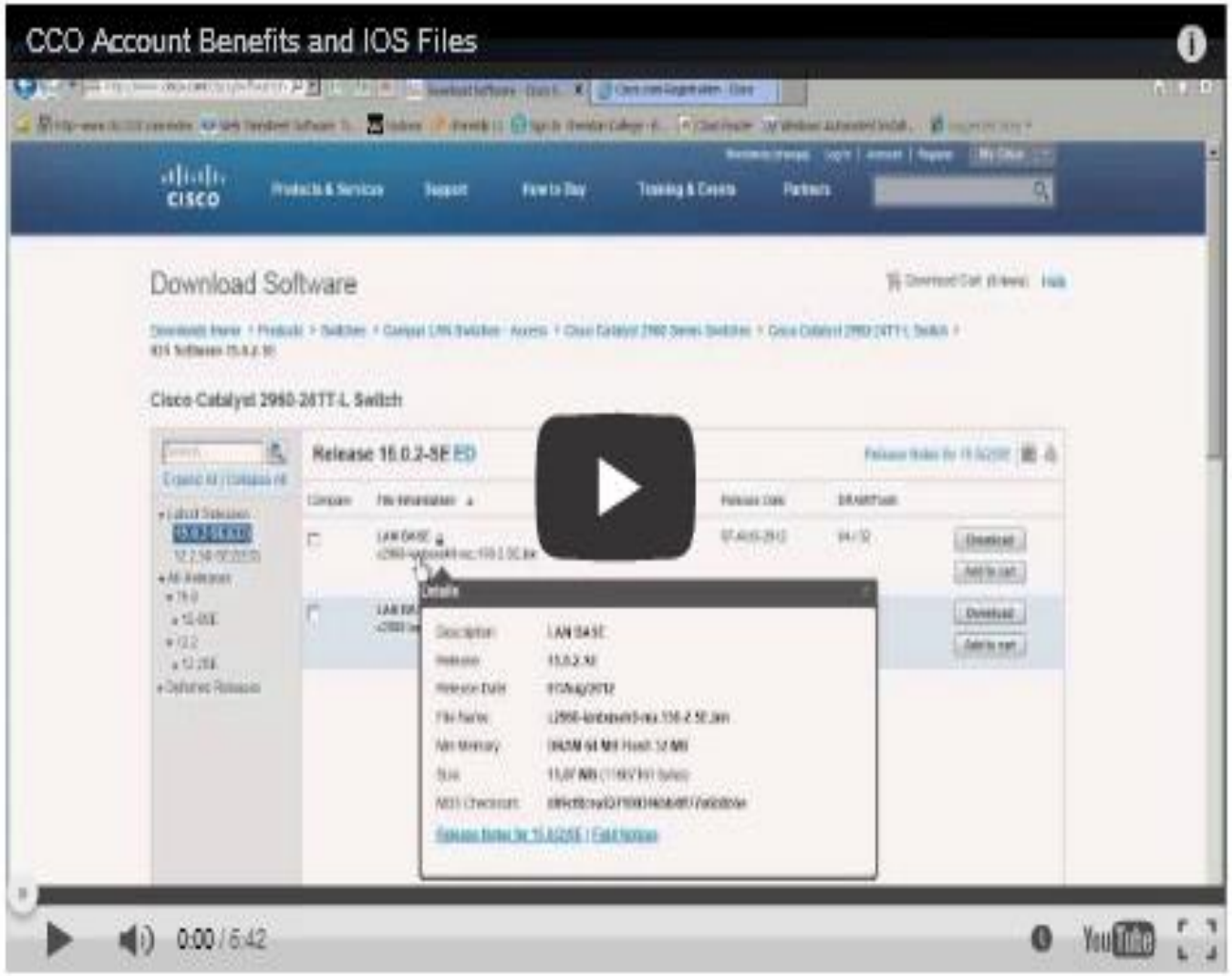
- The IOS file itself is several megabytes in size and is stored in a semi-permanent memory area called flash.
- Flash memory provides non-volatile storage
- In many Cisco devices, the IOS is copied from flash into random access memory (RAM) when the device is powered on

2.1.1.4 IOS Functions

- IP addressing
- Optimize use of media
- Routing
- Enabling quality of service (QoS)
- Supporting network

2.1.1.5 Video Demonstration - CCO Accounts and IOS Image Exploration

This video introduces Cisco Connection Online (CCO). CCO has a wealth of information available regarding Cisco products and services.



CONSOL PORT

There are several ways to access the CLI environment.

Console

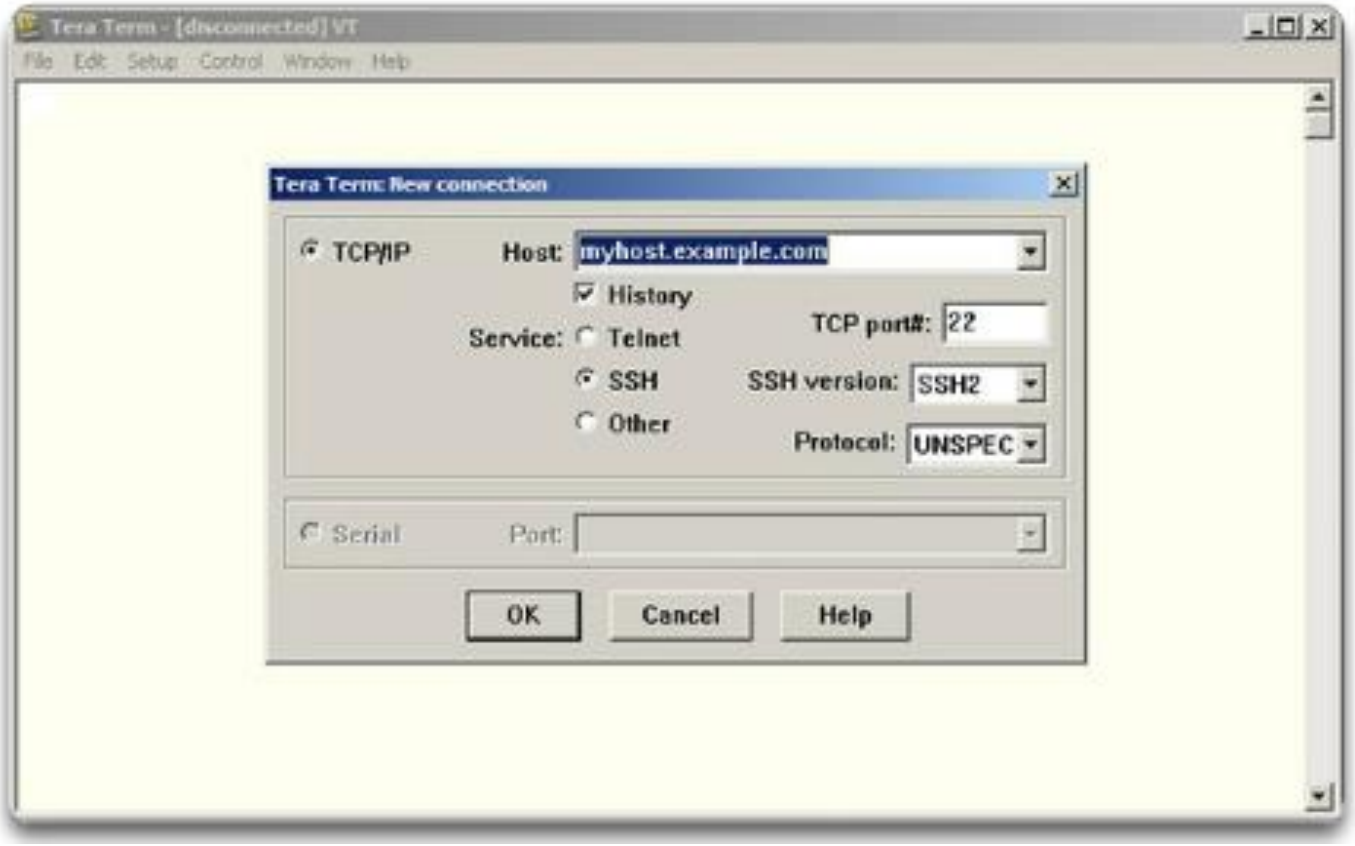
Telnet or SSH

AUX port

AUX PORT

An older way to establish a CLI session remotely is via a telephone dialup connection using a modem connected to the auxiliary (AUX) port of a router

2.1.2.3 Terminal Emulation Programs



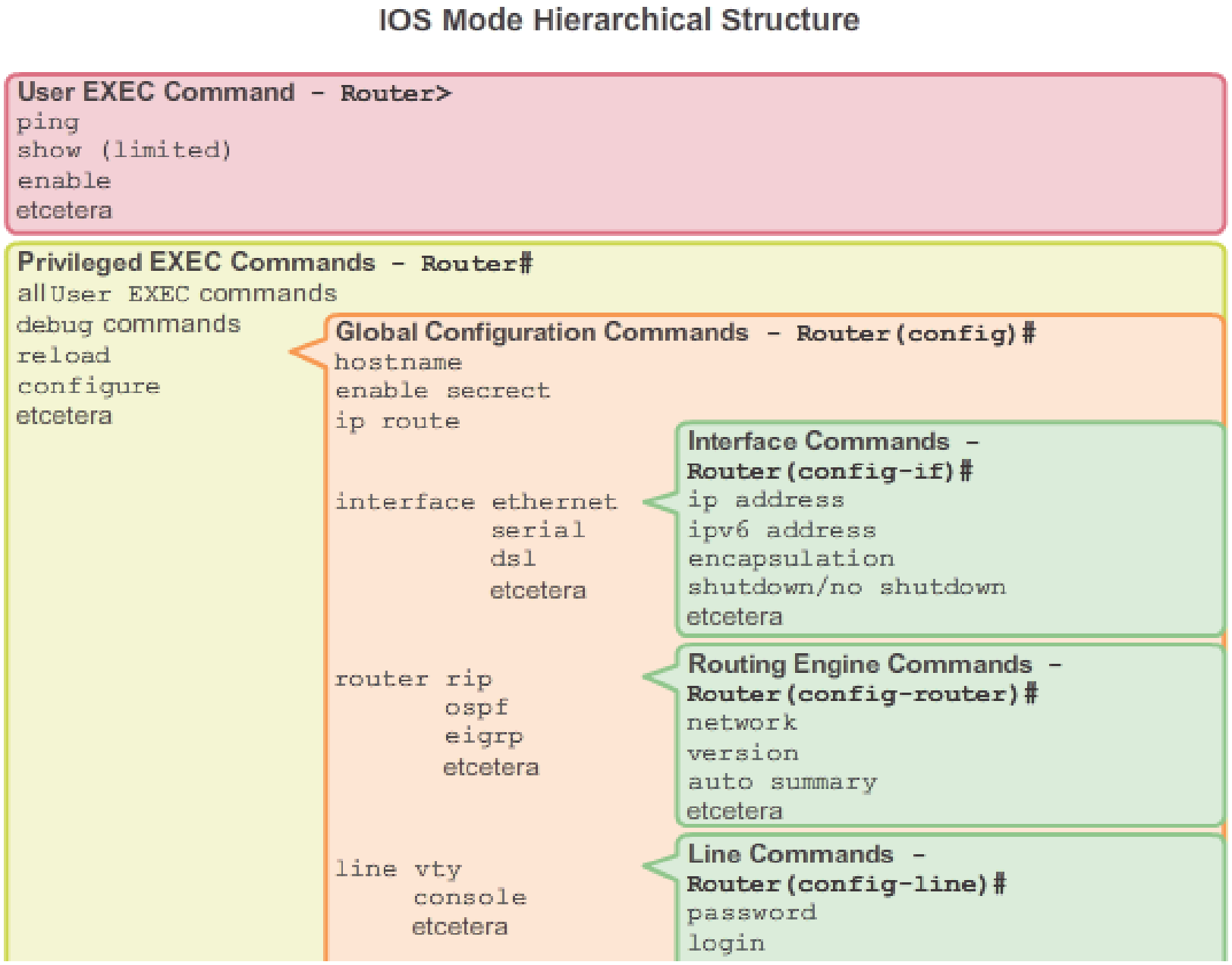
Terminal emulation programs

- PuTTY
- Tera Term
- SecureCRT
- HyperTerminal
- OS X Terminal

2.1.2.4 Activity – Accessing Devices

	Console	Telnet/SSH	AUX
1. You are in the equipment room with a new switch that needs to be configured.	✓		
2. The device you are configuring cannot be accessed by cable, because you are not in the building. You use a telephone to dial into it.			✓
3. Your manager gives you a special cable and tells you to use it to configure the switch.	✓		
4. You access the IOS by using another intermediary device over a network connection.		✓	
5. You are on vacation and need to check on one of your routers. The only access you have is your hotel analog phone.			✓
6. You do not need remote access services to the networking device to configure it because the device is physically accessible to you.	✓		
7. You call your manager to tell him you cannot access your router in another city over the Internet. He provides you with the information to access the switch through a telephone connection.			✓
8. The password for a device was changed. No one knows what the new password is and you need to reset a new password.	✓		

2.1.3.1 Cisco IOS Modes of Operation



2.1.3.2 Primary Modes

User EXEC Mode

Limited examination of router.
Remote access.

```
Switch>
Router>
```

The **User EXEC** mode allows only a limited number of basic monitoring commands and is often referred to as view-only mode.

Privileged EXEC Mode

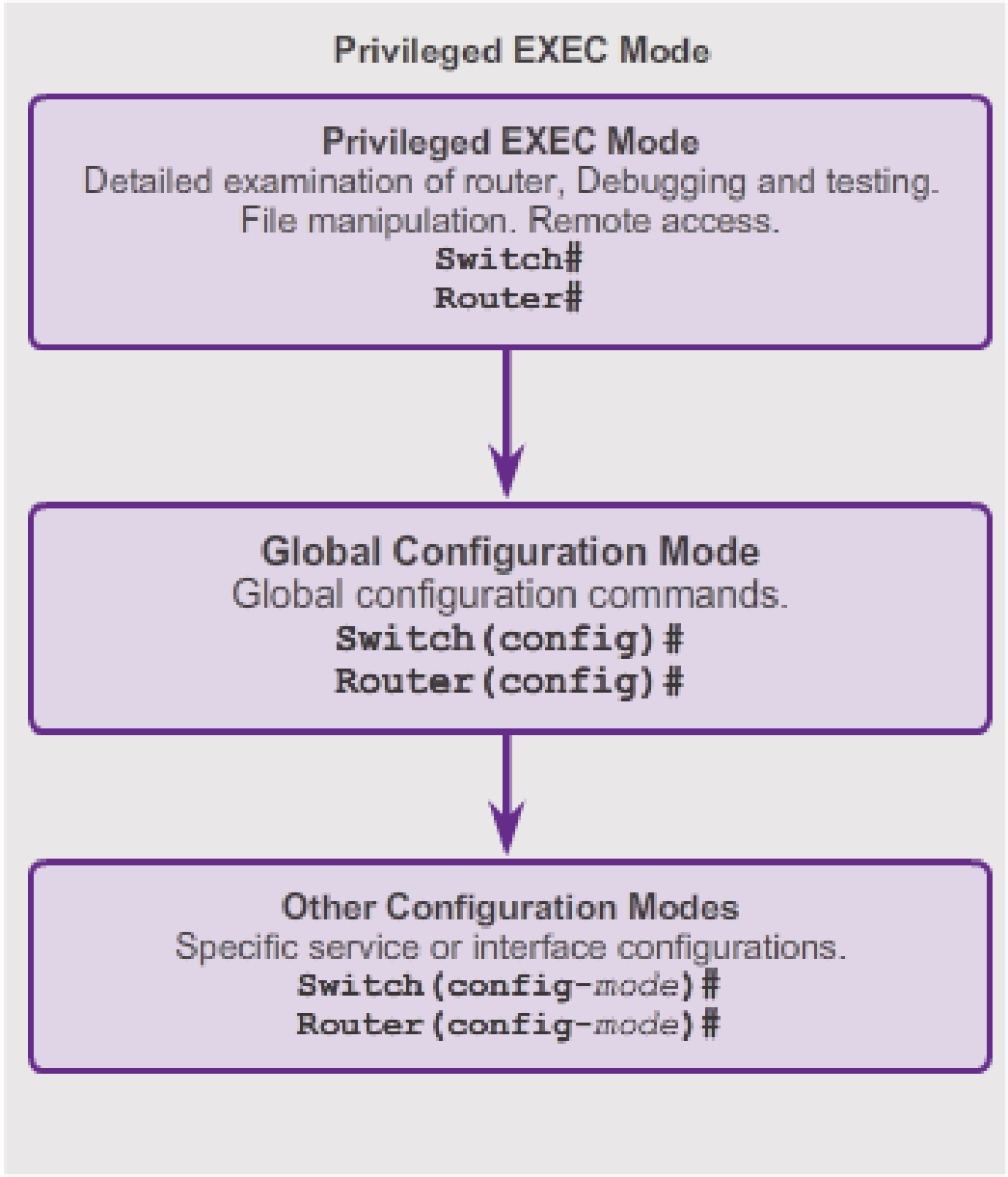
Detailed examination of router. Debugging and testing. File manipulation. Remote access.

```
Switch#
Router#
```

The **Privileged EXEC** mode, by default, allows all monitoring commands, as well as execution of configuration and management commands.

2.1.3.3 Global Configuration Mode and Submodes

Within Privileged EXEC mode, network administrators can access the global configuration mode and all other sub-configuration modes.



2.1.3.3 Global Configuration Mode and Submodes

Global Configuration Mode and Submodes

IOS Prompt Structure

```
Router>ping 192.168.10.5

Router#show running-config

Router(config)#Interface FastEthernet 0/0

Router(config-if)#ip address 192.168.10.1 255.255.255.0
```

The prompt changes to denote the current CLI mode.

```
Switch>ping 192.168.10.9

Switch#show running-config

Switch(config)#Interface FastEthernet 0/1

Switch(config-if)#Description connection to WEST LAN4
```

2.1.3.4 Navigating between IOS Modes

```
Router con0 is now available.

Press RETURN to get started.

User Access Verification
Password:
Router>
Router>enable
Password:
Router#
Router#disable
Router>
Router>exit
```

User EXEC Mode Prompt

Privileged EXEC Mode Prompt

User EXEC Mode Prompt

```
Switch con0 is now available.

Press RETURN to get started.

User Access Verification
Password:
Switch>
Switch>enable
Password:
Switch#
Switch#disable
Switch>
Switch>exit
```

User EXEC Mode Prompt

Privileged EXEC Mode Prompt

User EXEC Mode Prompt

2.1.3.5 Navigating between IOS Modes (Cont.)

```
Switch> enable
Switch# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)# interface vlan 1
Switch(config-if)# exit
Switch(config)# exit
Switch#
```

```
Switch# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)# vlan 1
Switch(config-vlan)# end
Switch#
```

2.1.3.5 Navigating between IOS Modes (Cont.)

```
Switch# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)# line vty 0 4
Switch(config-line)# interface fastethernet 0/1
Switch(config-if)# end
Switch#
```

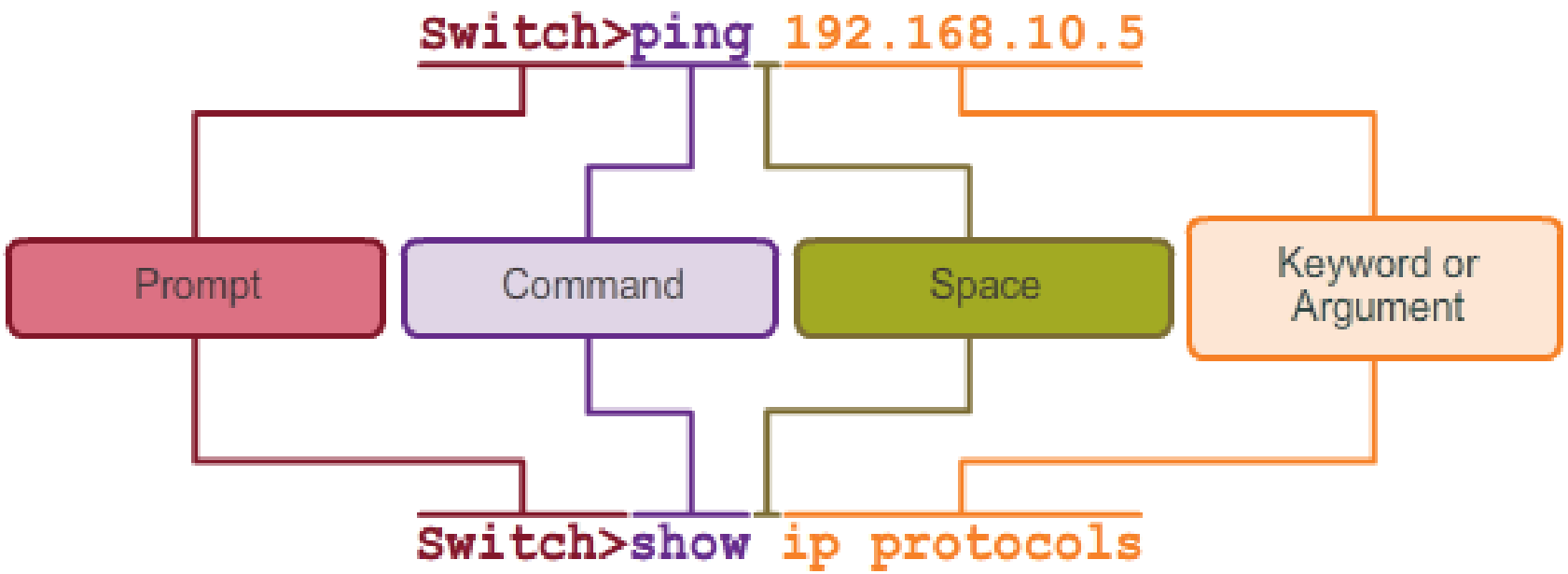
- **The number 0 4 is the number of the line vty:**
- **line vty 0, line vty 1, ...**
- **for telnet per default, there is five lines, 0 to 4,**
- **and for the console , there is one line the number 0**

2.1.3.6 Video Demonstration - Navigating the IOS

This video demonstrates navigation through the different CLI command modes of both a router and a switch using Cisco IOS

2.1.4.1 IOS Command Structure

Basic IOS Command Structure

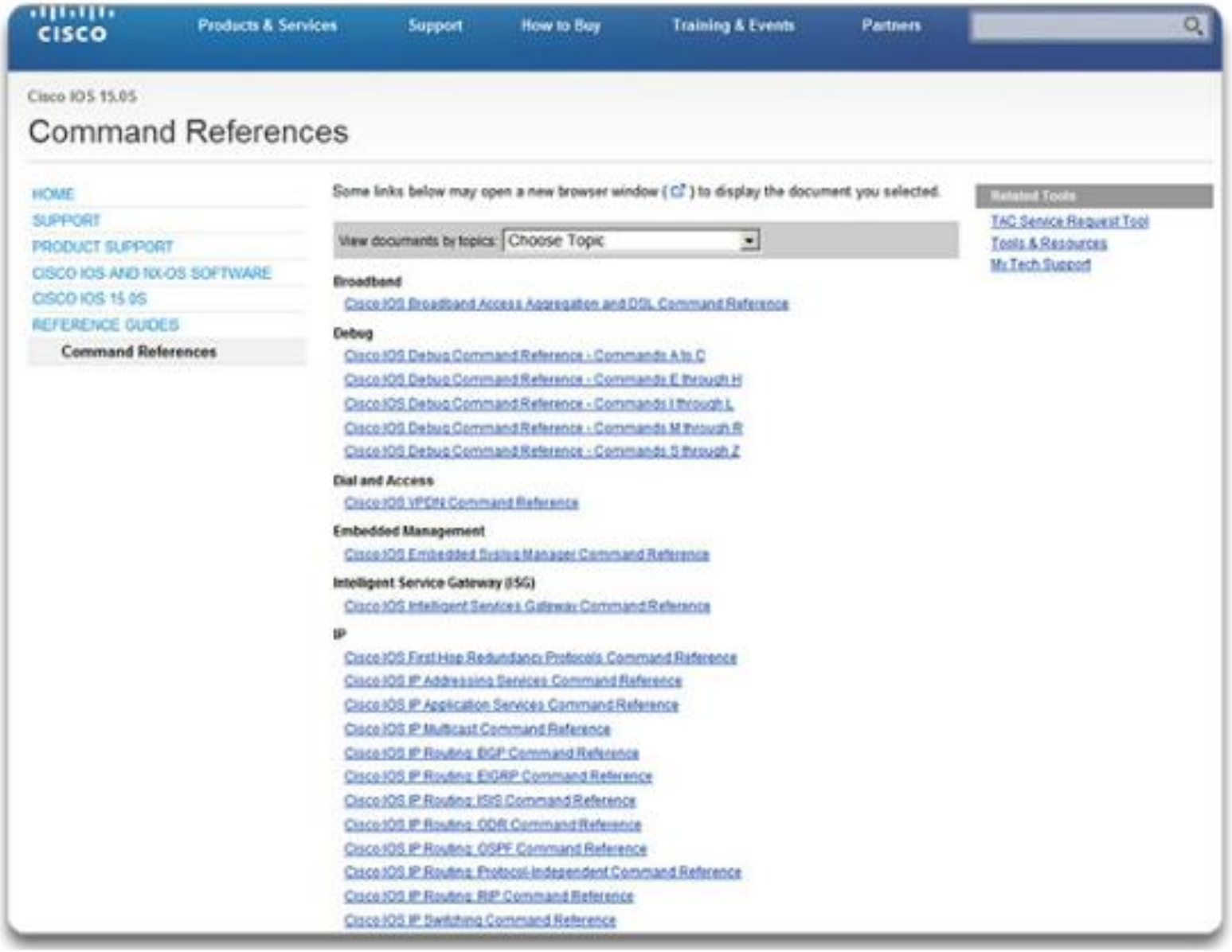


IOS Command Conventions

When describing the use of commands, we generally use these conventions.

Convention	Description
boldface	Boldface text indicates commands and keywords that you enter literally as shown.
italics	Italic text indicates arguments for which you supply values.
[x]	Square brackets indicate an optional element (keyword or argument).
{x}	Braces indicate a required element (keyword or argument).
[x {y | z}]	Braces and vertical lines within square brackets indicate a required choice within an optional element.

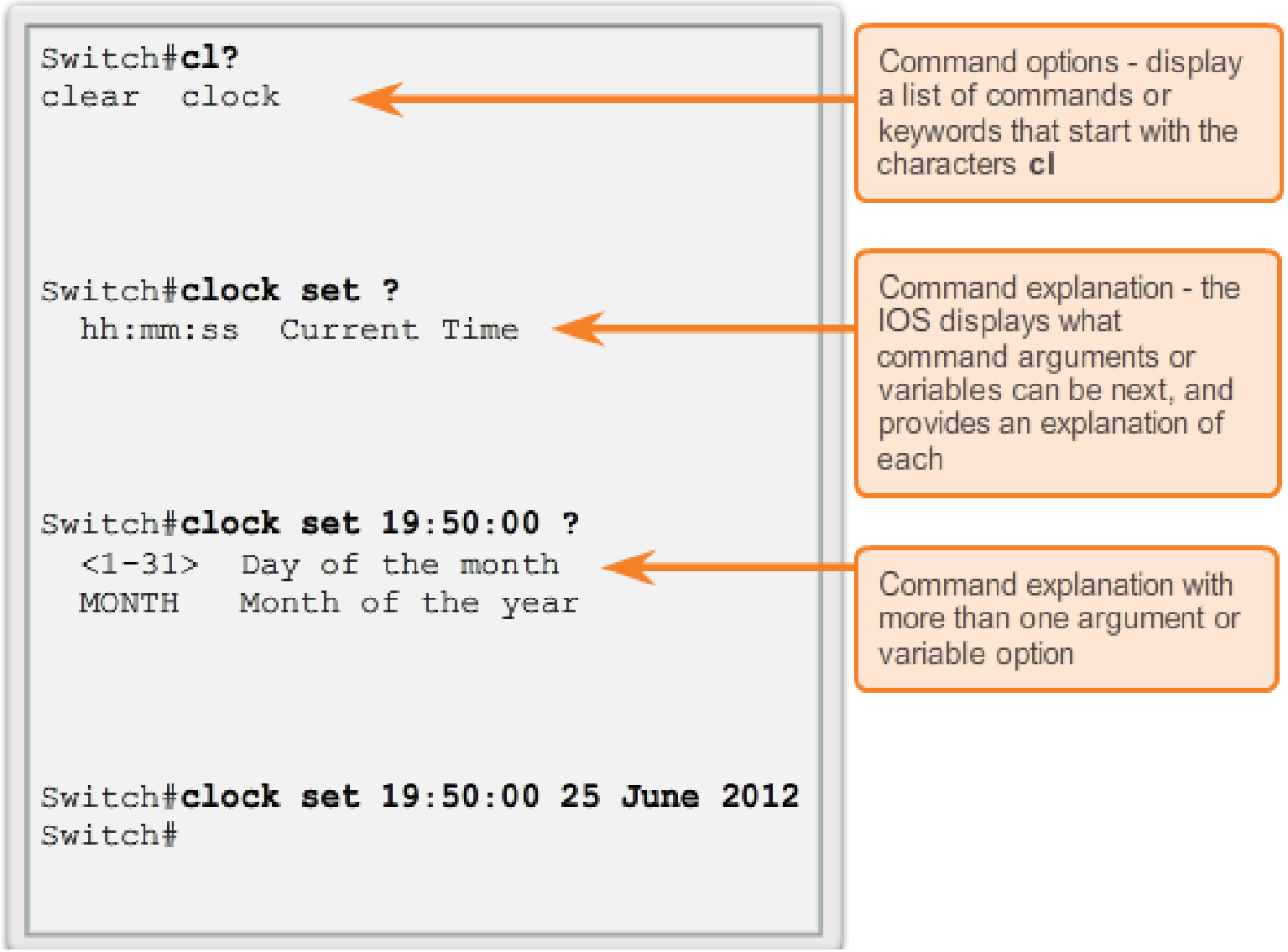
2.1.4.2 Cisco IOS Command Reference



This module explains various ways you can receive help with the IOS Commands

2.1.4.3 Context-Sensitive Help

Context-Sensitive Help



2.1.4.4 Command Syntax Check

Command Syntax Check Help

```
Switch#>clock set
% Incomplete command.
Switch#clock set 19:50:00
% Incomplete command.
```

The IOS returns a help message indicating that required keywords or arguments were left off the end of the command.

```
Switch#c
% Ambiguous command:'c'
```

The IOS returns a help message to indicate that there were not enough characters entered for the command interpreter to recognize the command.

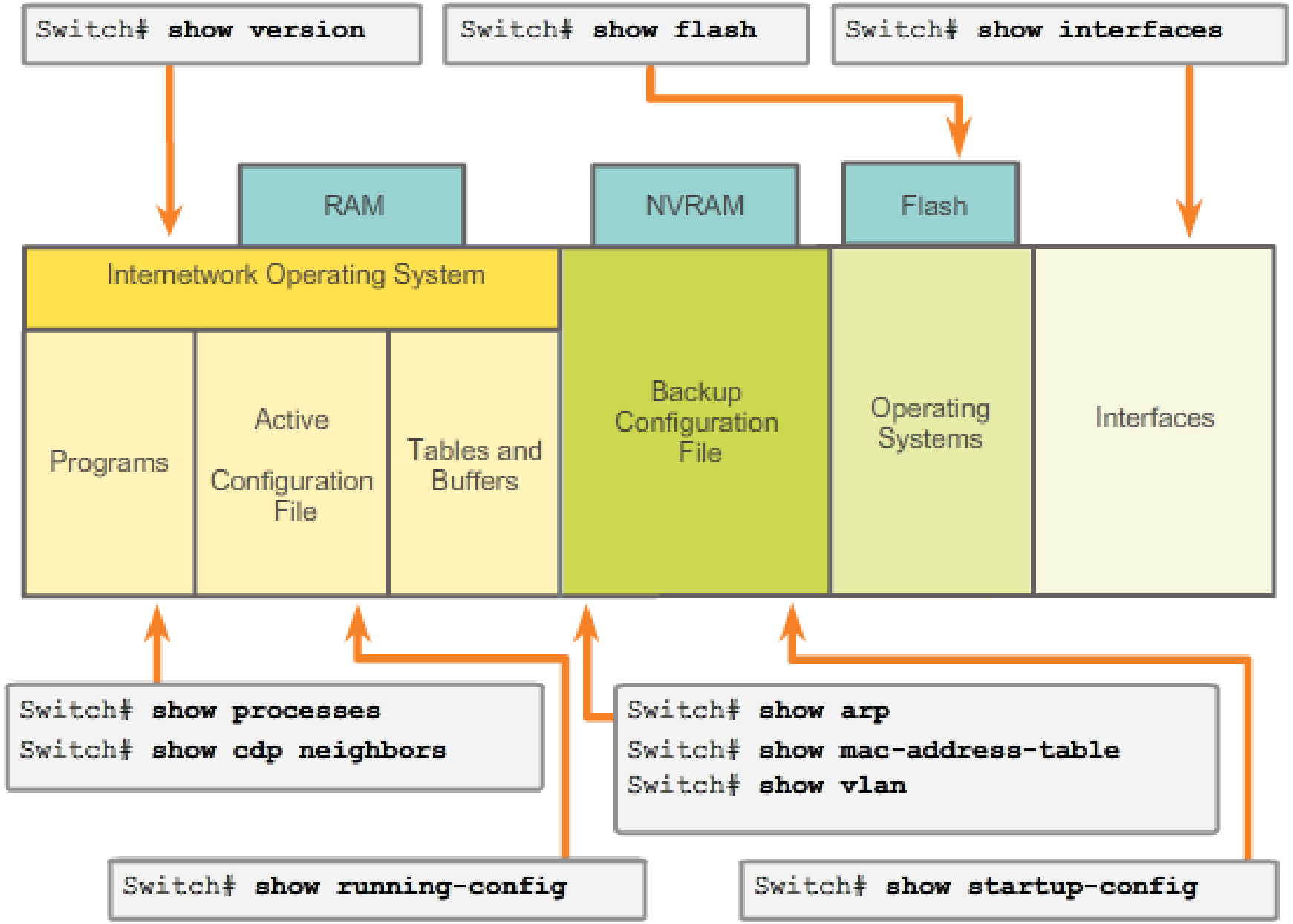
```
Switch#clock set 19:50:00 25 6
                          ^
% Invalid input detected at '^'
marker.
```

The IOS returns a **"^"** to indicate where the command interpreter can not decipher the command.

2.1.4.5 Hot Keys and Shortcuts

Down Arrow - Allows the user to scroll forward through former commands
Up Arrow - Allows the user to scroll backward through former commands
Tab - Completes the remainder of a partially typed command or keyword
Ctrl-A - Moves to the beginning of the line
Ctrl-E - Moves to the end of the line
Ctrl-R - Redisplays a line
Ctrl-Z - Exits the configuration mode and returns to user EXEC
Ctrl-C - Exits the configuration mode or aborts the current command
Ctrl-Shift-6 - Allows the user to interrupt an IOS process such as ping or traceroute

2.1.4.6 IOS Examination Commands



IOS show commands provide information about the configuration and status of parts of a Cisco Switch or Router

2.1.4.7 The show version Command

```
Router# show version
Cisco IOS Software, C1900 Software (C1900-UNIVERSALK9-M), Version
15.2(4)M1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Thu 26-Jul-12 19:34 by prod_rel_team

ROM: System Bootstrap, Version 15.0(1r)M15, RELEASE SOFTWARE (fc1)

cisco1941 uptime is 41 minutes
System returned to ROM by power-on
System image file is ""flash0:c1900-universalk9-mz.SPA.152-
4.M1.bin""
Last reload type: Normal Reload
Last reload reason: power-on



This product contains cryptographic features and is subject to
United
States and local country laws governing import, export, transfer
and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use
encryption.
```

```
Router# show version
```

Switch or Router

2.1.4.7 The show version Command

- Software version - IOS software version (stored in flash)
- Bootstrap version - Bootstrap version (stored in Boot ROM)
- System up-time - Time since last reboot
- System restart info - Method of restart (e.g., power cycle, crash)
- Software image name - IOS filename stored in flash
- Router type and processor type - Model number and processor type
- Memory type and allocation (shared/main) - Main Processor RAM and Shared Packet I/O buffering
- Software features - Supported protocols/feature sets
- Hardware interfaces - Interfaces available on the device
- Configuration register - Sets bootup specifications, console speed setting, and related parameters

2.1.4.8 Packet Tracer - Navigating the IOS

In this activity, you will practice skills necessary for navigating the Cisco IOS, including different user access modes, various configuration modes, and common commands you use on a regular basis. You also practice accessing the context-sensitive help by configuring the clock command

2.1.4.9 Lab - Establishing a Console Session with Tera Term

In this lab, you will complete the following objectives:

- Part 1: Access a Cisco Switch through the Serial Console Port
- Part 2: Display and Configure Basic Device Settings
- Part 3: (Optional) Access a Cisco Router Using a Mini-USB Console Cable

2.2.1.1 Why the Switch

Cisco IOS 2960 Switch

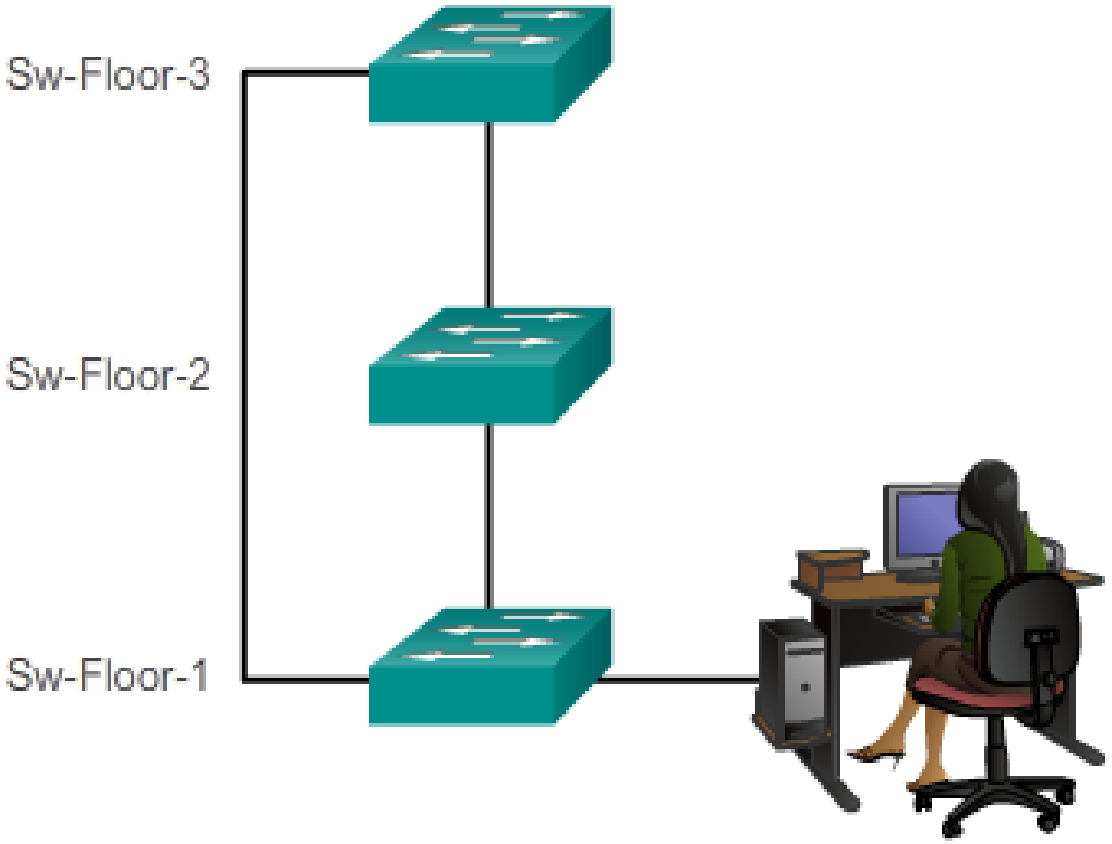
Cisco switches and Cisco routers have many similarities. They support a similar modal operating system support similar command structures, and support many of the same commands. In addition, both devices have identical initial configuration steps when implementing them in a network.

However, a Cisco IOS switch is one of the simplest devices that can be configured on a network. This is because there are no configurations that are required prior to the device functioning. At its most basic, a switch can be plugged in with no configuration, but it will still switch data between connected devices.

A switch is also one of the fundamental devices used in the creation of a small network. By connecting two PCs to a switch, those PCs will instantly have connectivity with one another

2.2.1.2 Device Names

Configuring Device Names



2.2.1.4 Configuring Hostnames

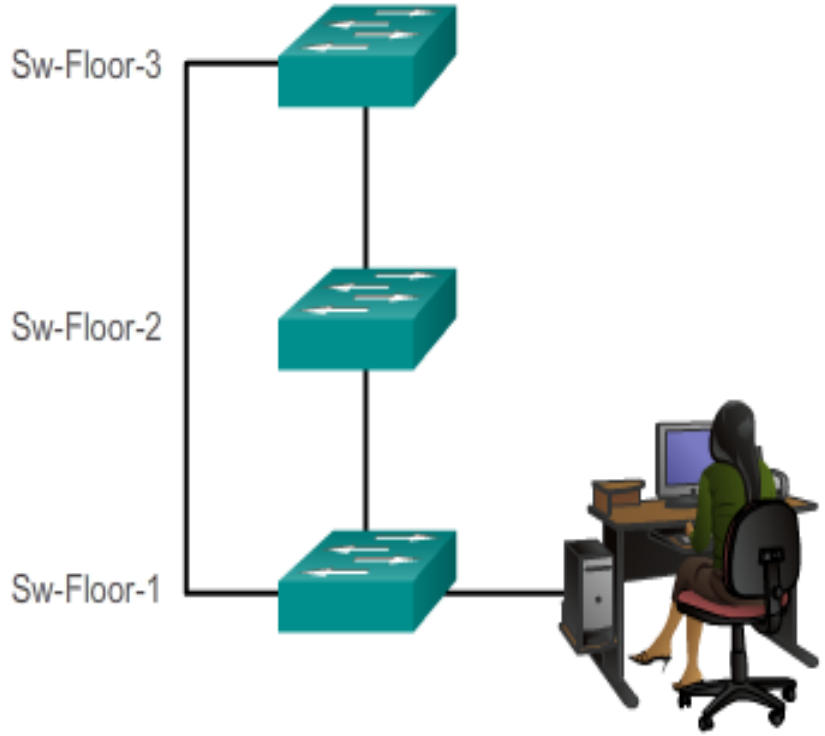
Configure a Hostname

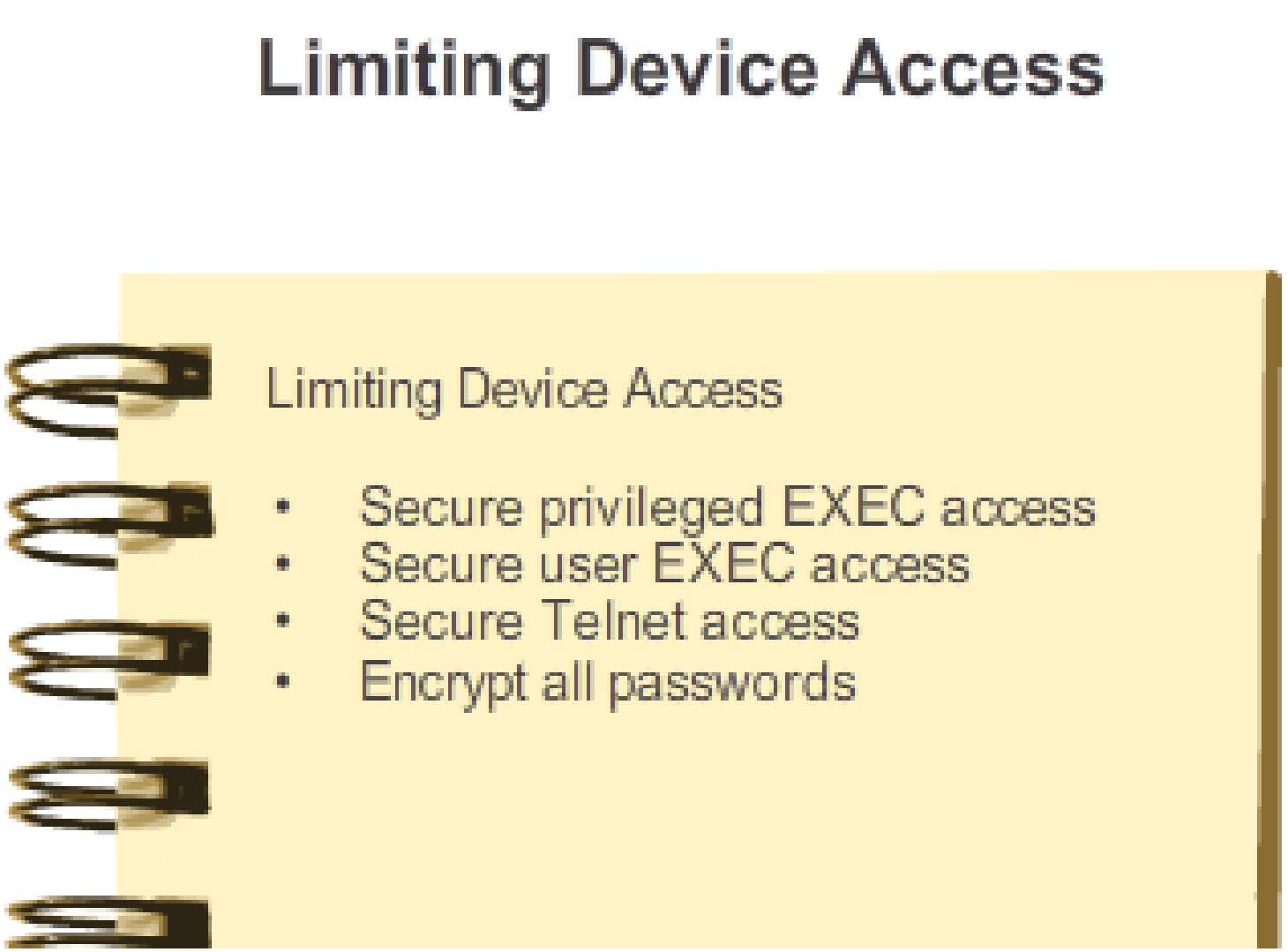
Configure the switch hostname to be 'Sw-Floor-1'.

```
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname Sw-Floor-1
Sw-Floor-1(config)#
```

You successfully configured the switch hostname.

Configuring Device Names





- Enable password - Limits access to the privileged EXEC mode
- Enable secret - Encrypted, limits access to the privileged EXEC mode
- Console password - Limits device access using the console connection
- VTY password - Limits device access over Telnet

Limiting Device Access

```
Sw-Floor-1>enable
Sw-Floor-1#
Sw-Floor-1#conf terminal
Sw-Floor-1(config)#enable secret class
Sw-Floor-1(config)#exit
Sw-Floor-1#
Sw-Floor-1#disable
Sw-Floor-1>enable
Password:
Sw-Floor-1#
```

2.2.2.3 Securing User EXEC Access

```
Sw-Floor-1(config)#line console 0
Sw-Floor-1(config-line)#password cisco
Sw-Floor-1(config-line)#login
Sw-Floor-1(config-line)#exit
Sw-Floor-1(config)#
Sw-Floor-1(config)#line vty 0 15
Sw-Floor-1(config-line)#password cisco
Sw-Floor-1(config-line)#login
Sw-Floor-1(config-line)#
```

2.2.2.4 Encrypting Password Display

Configuring Password Encryption

Enter the command to encrypt the plain text passwords.

```
Switch(config)#service password-encryption
```

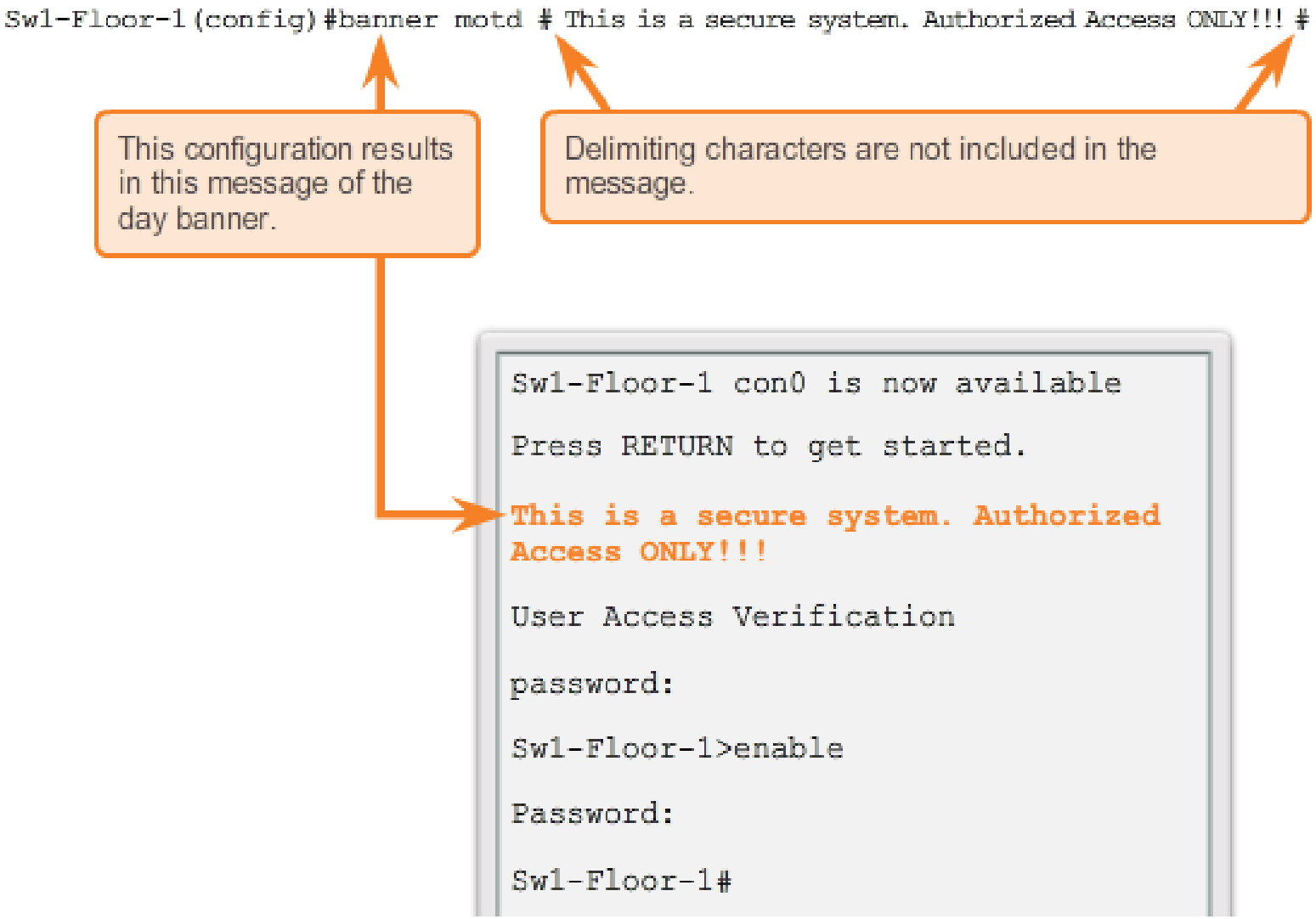
Exit global configuration mode and view the running configuration.

```
Switch(config)#exit

Switch# show running-config
!
<output omitted>
!
line con 0
 password 7 094F471A1A0A
 login
!
line vty 0 4
 password 7 03095A0F034F38435B49150A1819
 login
!
!
end

Switch#
```

Another useful command prevents passwords from showing up as plain text when viewing the configuration files. This is the service password-encryption command

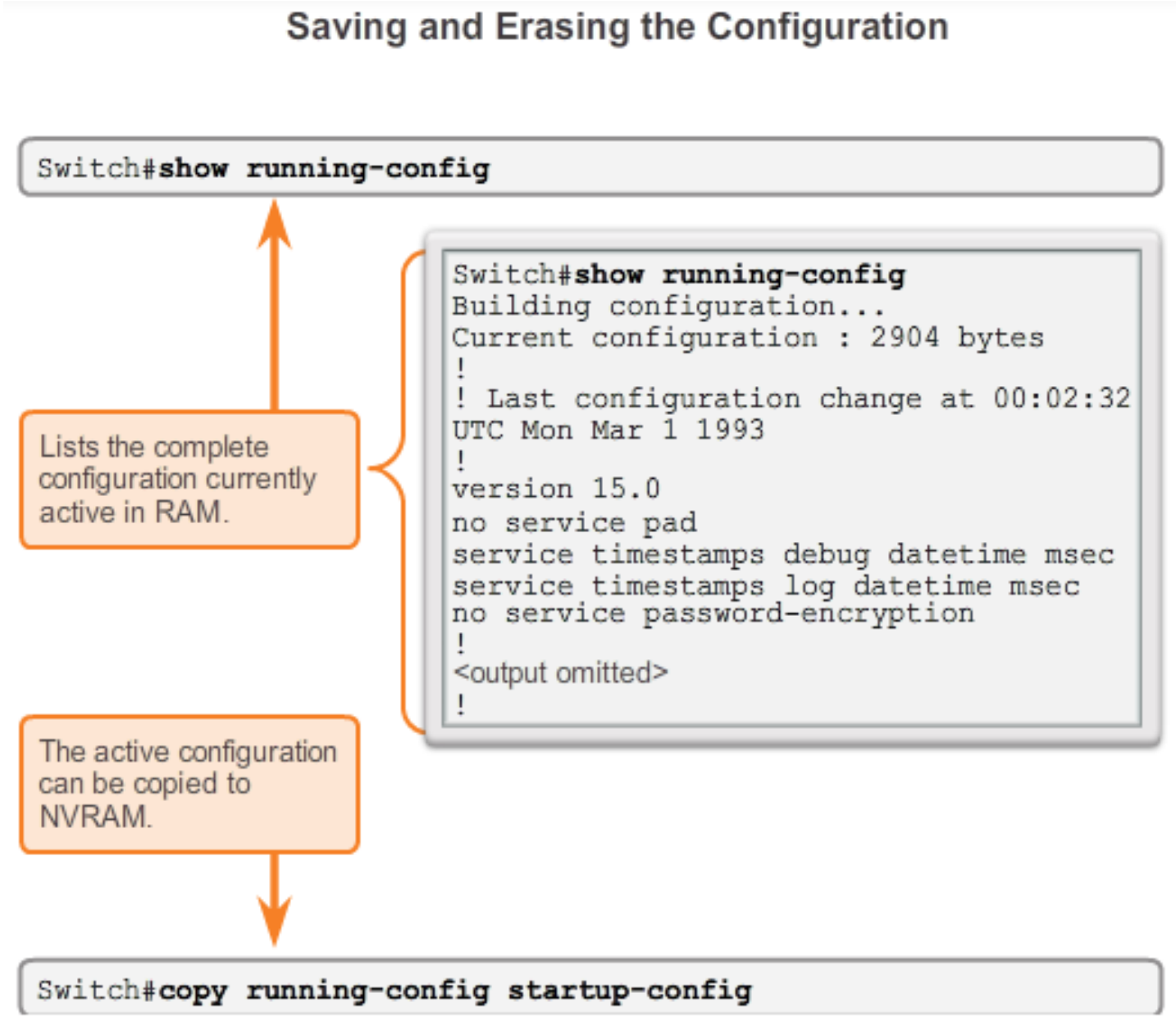
2.2.2.5 Banner Messages

Limiting Device Access - MOTD Banner



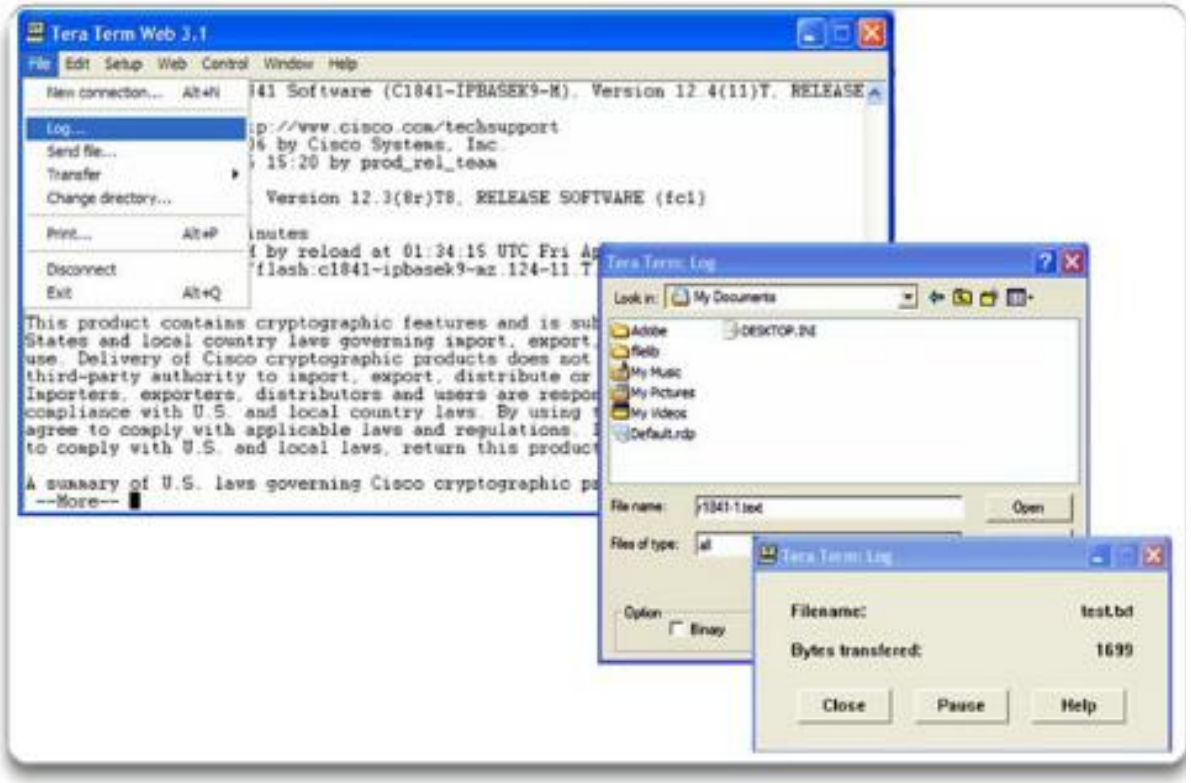
Banners can be an important part of the legal process in the event that someone is prosecuted for breaking into a device. Some legal systems do not allow prosecution, or even the monitoring of users, unless a notification is visible

2.2.3.1 Configuration Files



2.2.3.2 Capturing Text

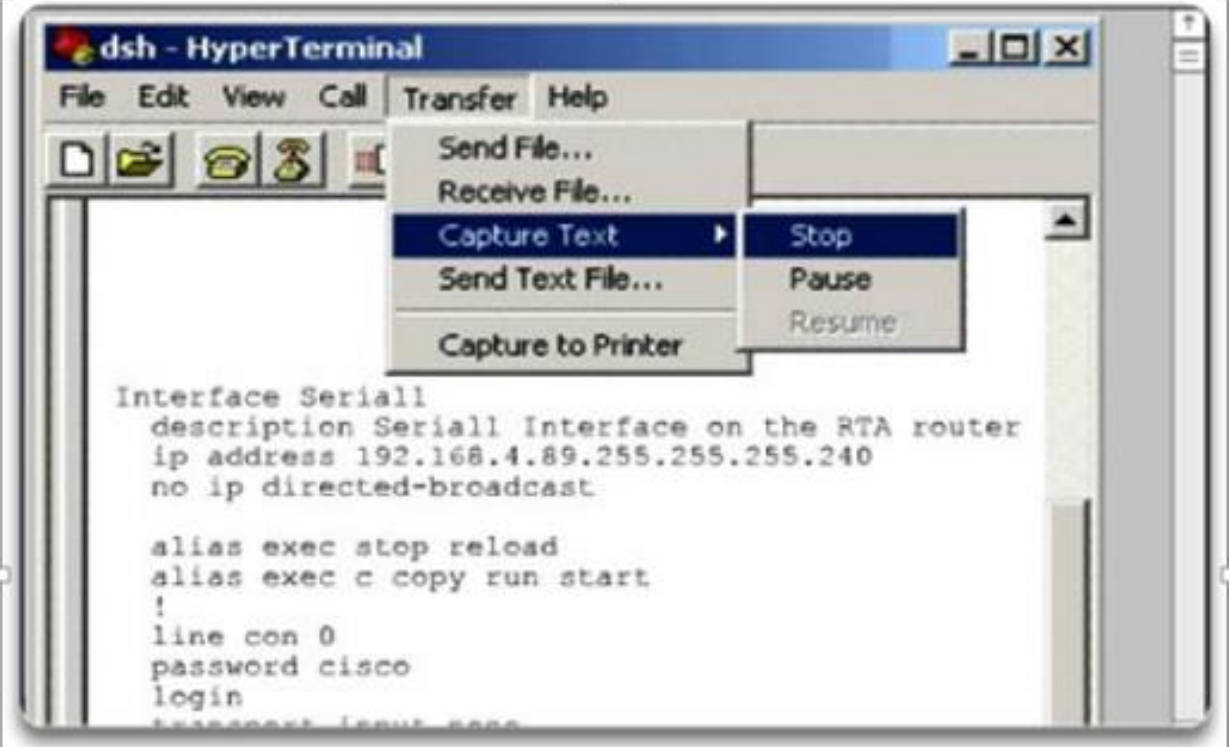
SAVING TO A TEXT FILE IN TERA TERM



In the terminal session:

1. Start the log process
2. Issue a **`show running-config`** command
3. Close the log

SAVING TO A TEXT FILE IN HYPER TERM



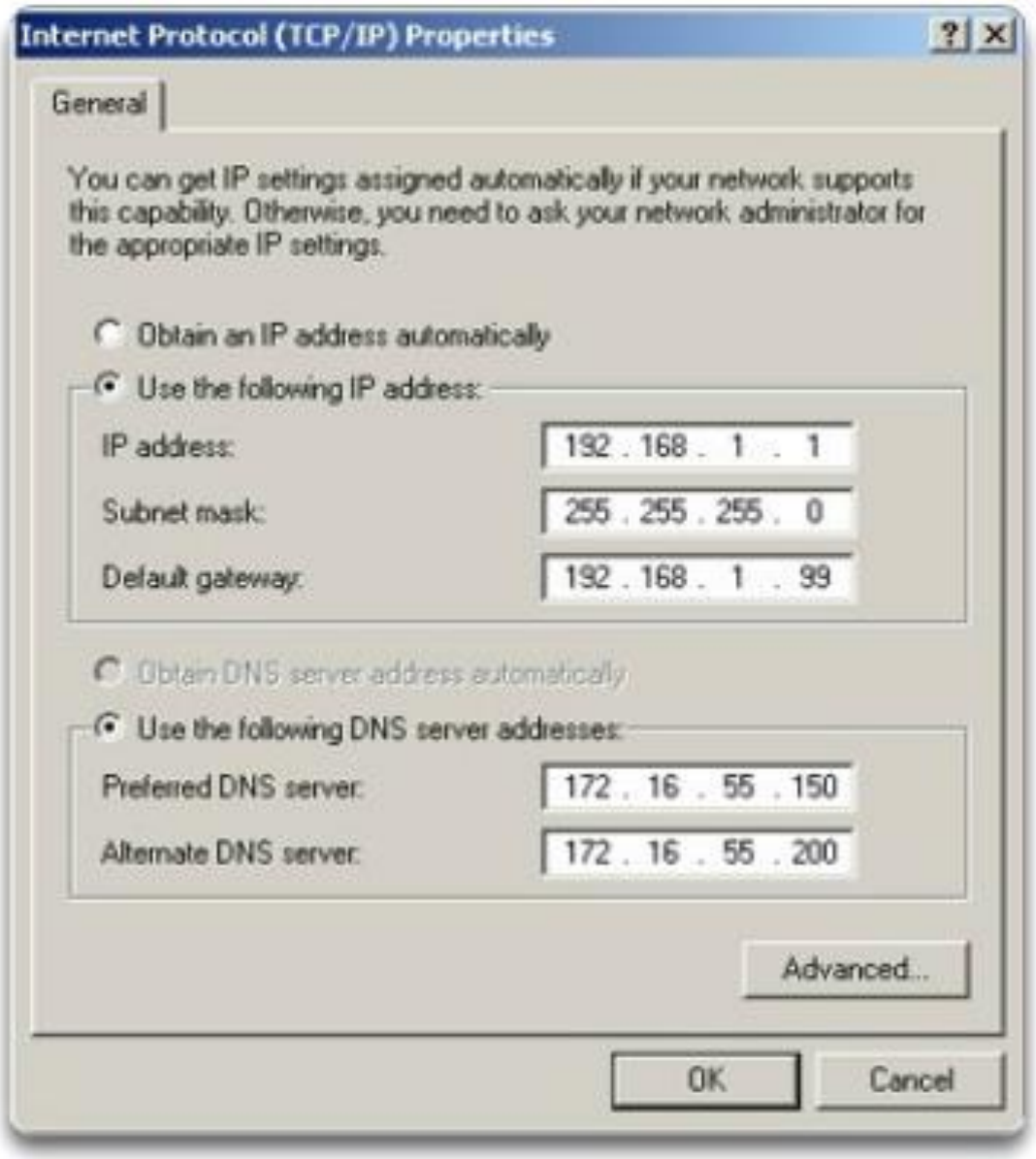
In the terminal session:

1. Start the text capture process
2. Issue a **`show running-config`** command
3. Stop the capture process
4. Save the text file

2.2.3.3 Packet Tracer - Configuring Initial Switch Settings

In this activity, you will perform basic switch configurations. You will secure access to the command-line interface (CLI) and console ports using encrypted and plain text passwords. You will also learn how to configure messages for users logging into the switch. These banners are also used to warn unauthorized users that access is prohibited.

2.3.1.1 IP Addressing of Devices



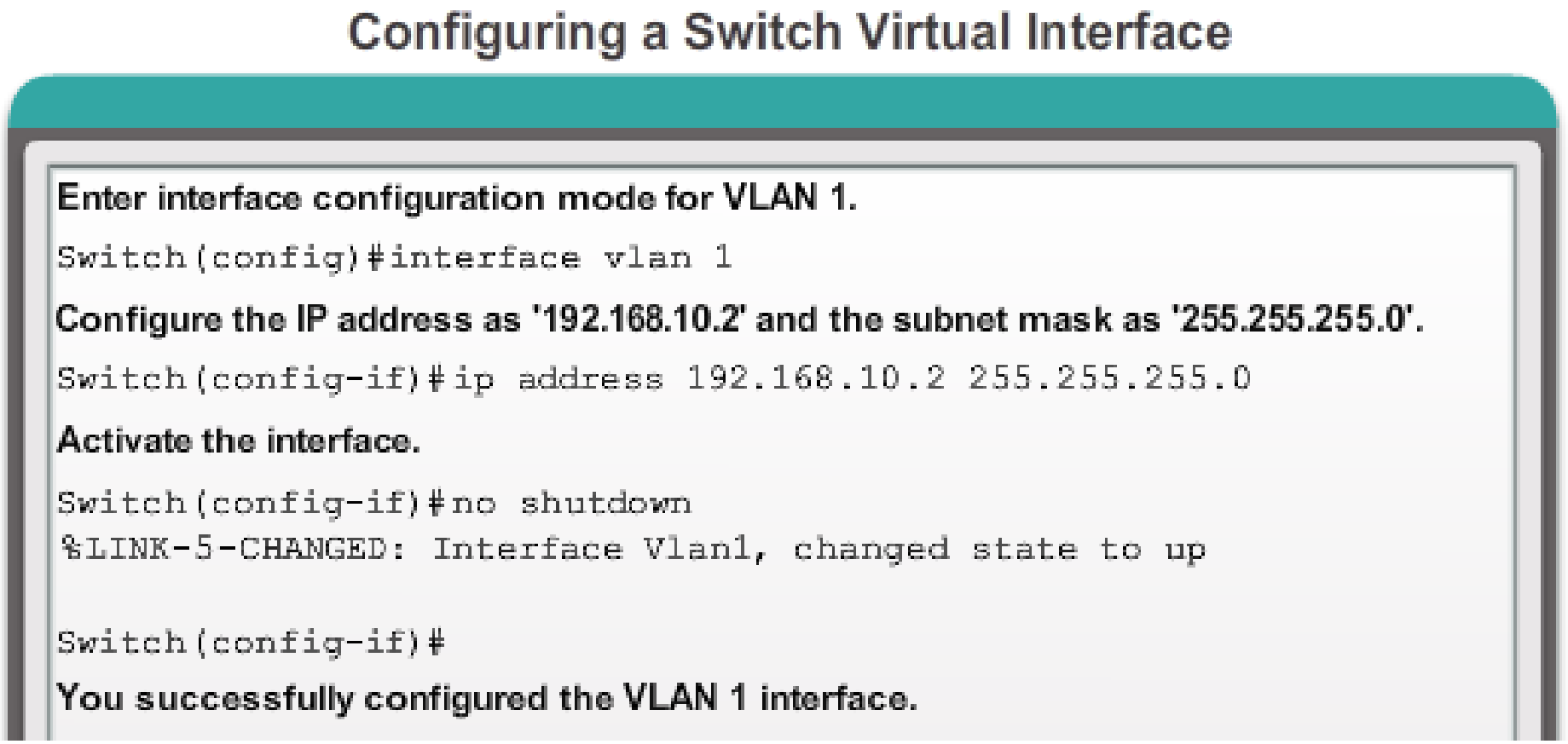
Each end device on a network must be configured with IP addresses. Some examples of end devices are:

- Computers (work stations, laptops, file servers, web servers)
- Network printers
- VoIP phones
- Security cameras
- Smart phones
- Mobile handheld devices (such as wireless barcode scanners)

2.3.1.2 Interfaces and Ports

Cisco IOS switches have physical ports for devices to connect to, but also have one or more switch virtual interfaces (SVIs). These are virtual interfaces, because there is no physical hardware on the device associated with it; an SVI is created in software. The virtual interface provides a means to remotely manage a switch over a network using IPv4. Each switch comes with one SVI appearing in the default configuration "out-of-the-box." The default SVI is interface VLAN1

2.3.2.1 Configuring a Switch Virtual Interface

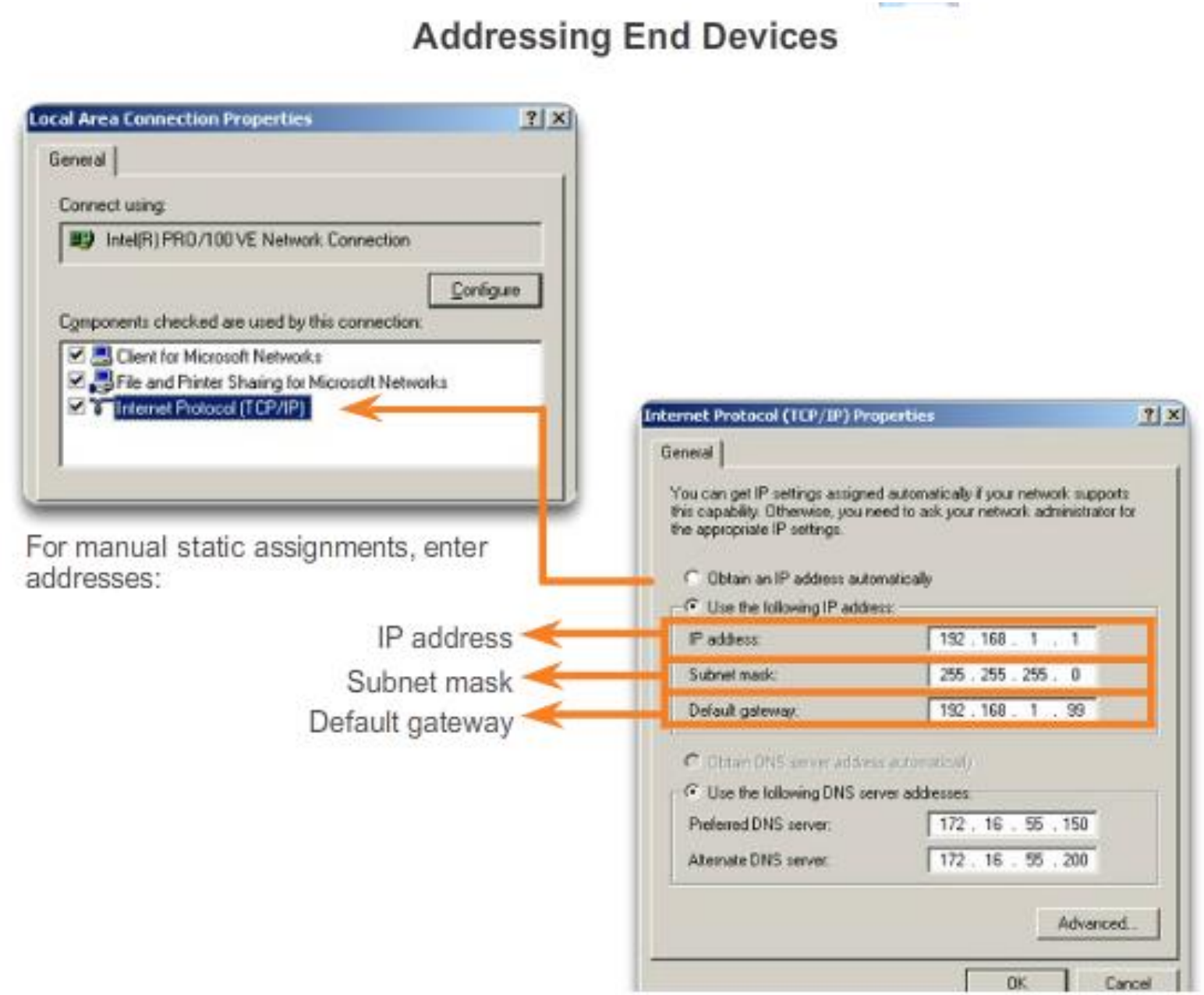


To access the switch remotely, an IP address and a subnet mask must be configured on the SVI:

- IP address - Together with subnet mask, uniquely identifies end device on the internetwork
- Subnet mask - Determines which part of a larger network is used by an IP address

For now the focus is IPv4; later you will explore IPv6

2.3.2.2 Manual IP Address Configuration for End Devices



In order for an end device to communicate over the network, it must be configured with the correct IP address information. Much like a switch SVI, the end device must be configured with an IP address and subnet mask. This information is configured on the PC settings.

2.3.2.3 Automatic IP Address Configuration for End Devices

Assigning Dynamic Addresses

This property will set the device to obtain an IP address automatically.

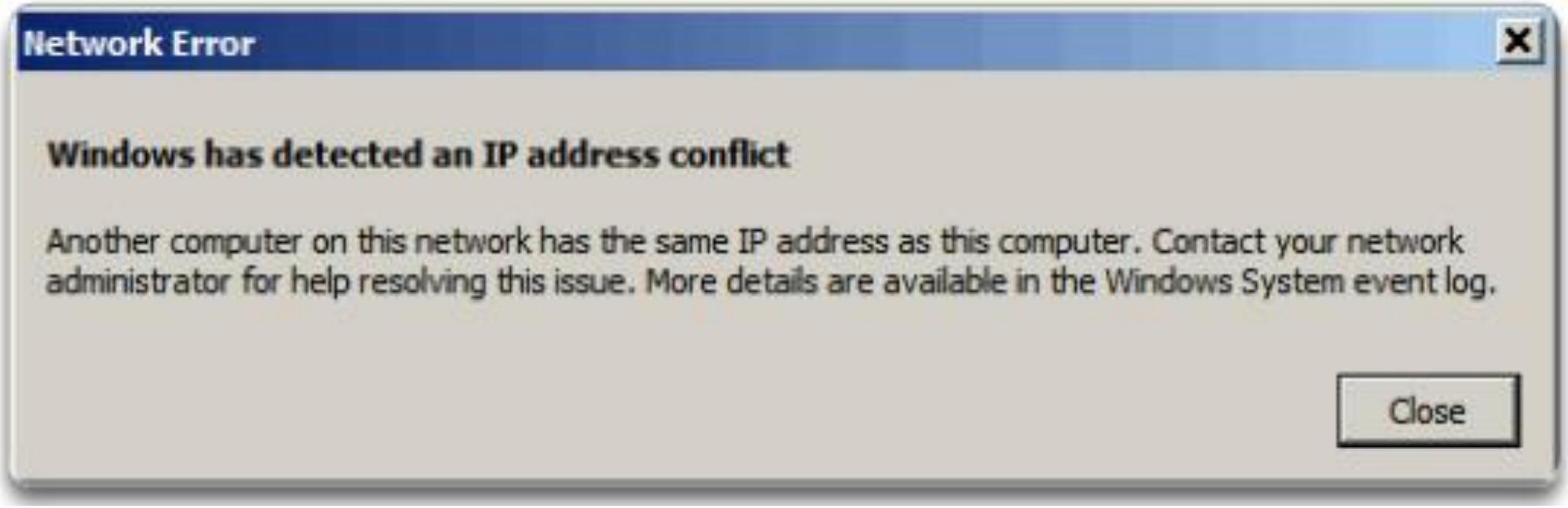
Verifying Windows PC IP Configuration

Enter the command to display the IP configuration on a Windows PC.

```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.
C:\> ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:

   Connection-specific DNS Suffix  . : cisco.com
   Link-local IPv6 Address . . . . . :
fe80::b0ef:ca42:af2c:c6c7%16
   IPv4 Address. . . . . . . . . . . : 10.82.240.197
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.82.240.198

-------------------------------------
```

You successfully displayed the IP configuration on a Windows PC.

2.3.2.4 IP Address Conflicts

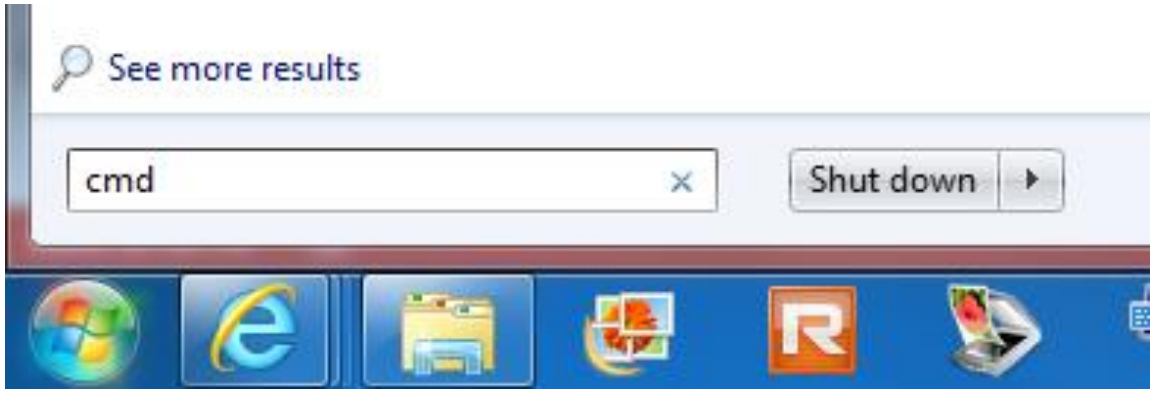


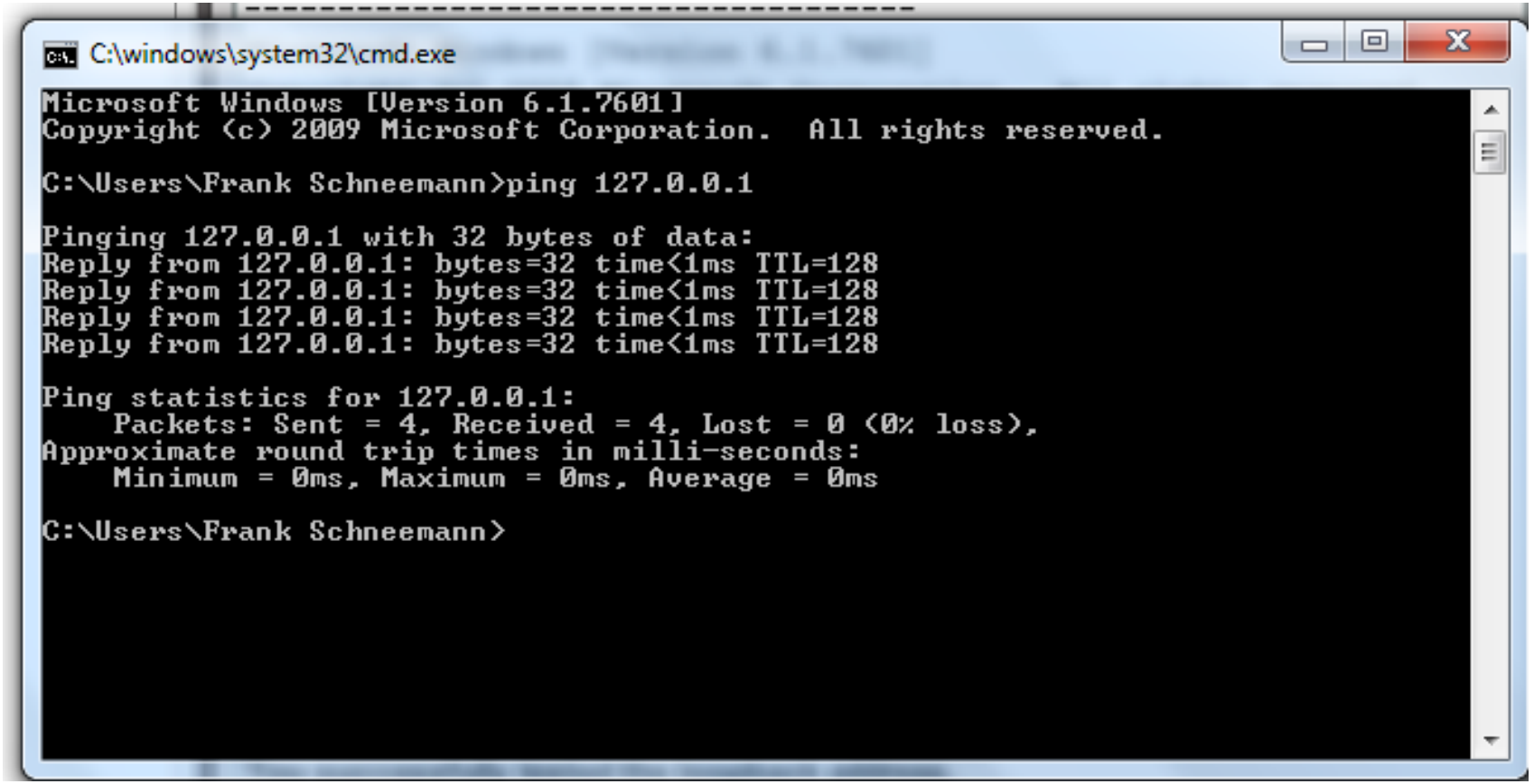
- To resolve such an IP addressing conflict convert the network device with the static IP address to a DHCP client; or on the DHCP server, exclude the static IP address of the end device from the DHCP scope.
- The second solution requires that you have administrative privileges on the DHCP server and that you are familiar with configuring DHCP on a server

2.3.2.5 Packet Tracer - Implementing Basic Connectivity

In this activity, you will first perform basic switch configurations. Then you will implement basic connectivity by configuring IP addressing on switches and PCs. When the IP addressing configuration is complete, you will use various show commands to verify configurations and use the ping command to verify basic connectivity between devices.

2.3.3.1 Test the Loopback Address on an End Device





2.3.3.2 Testing the Interface Assignment

Verifying the VLAN Interface Assignment

Enter the command to verify the interface configuration on S1.

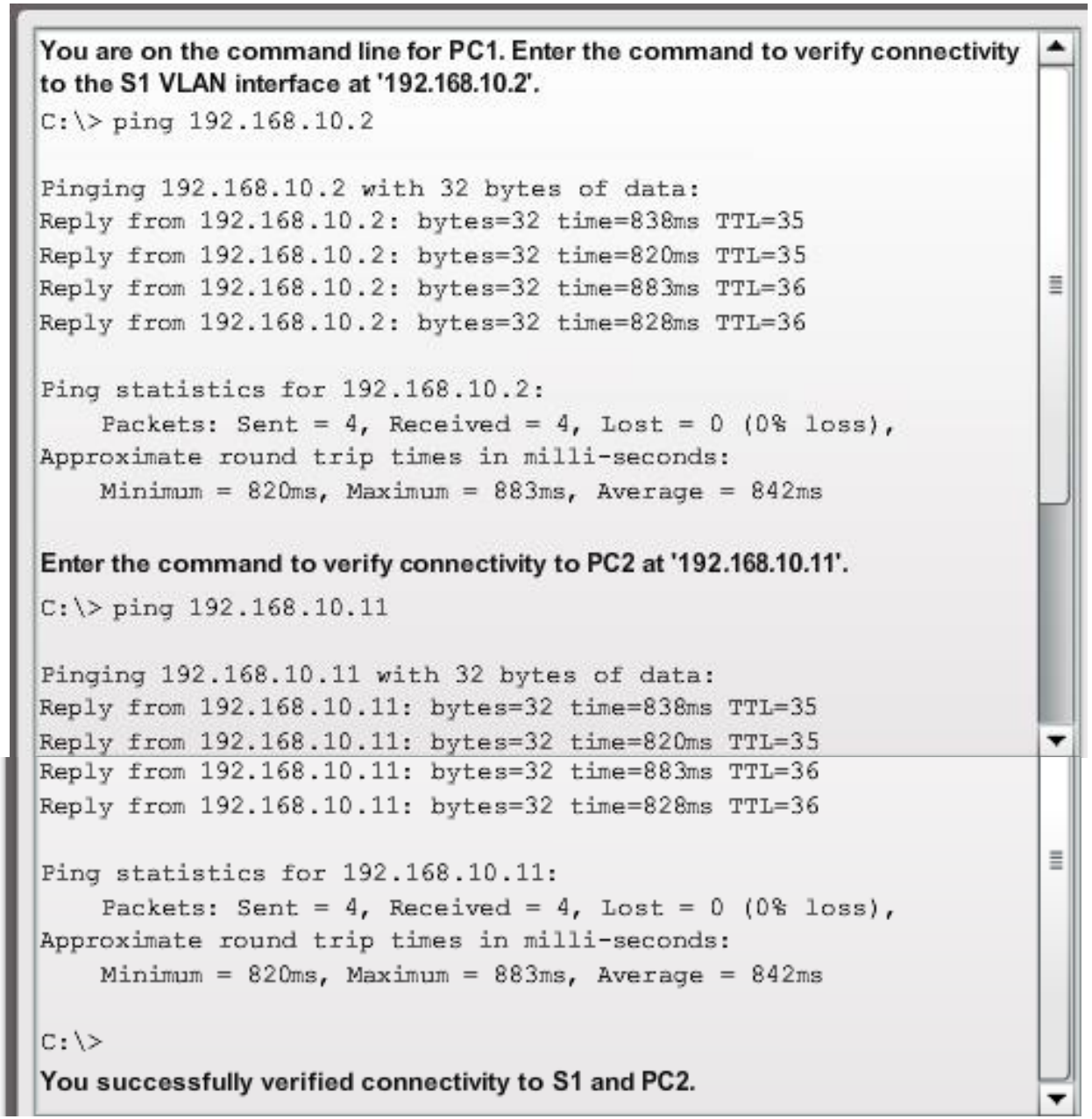
```
S1# show ip interface brief
Interface      IP-Address      OK?  Method  Status      Protocol
FastEthernet0/1   unassigned      YES  manual  up          up
FastEthernet0/2   unassigned      YES  manual  up          up
<output omitted>
Vlan1             192.168.10.2    YES  manual  up          up
```

You are now on S2. Enter the command to verify the interface configuration on S2.

```
S2# show ip interface brief
Interface      IP-Address      OK?  Method  Status      Protocol
FastEthernet0/1   unassigned      YES  manual  up          up
FastEthernet0/2   unassigned      YES  manual  up          up
<output omitted>
Vlan1             192.168.10.3    YES  manual  up          up
```

You successfully verified the interface assignment on S1 and S2.

2.3.3.3 Testing End-to-End Connectivity



- The ping command can be used on a PC, just as on a Cisco IOS device. The figure shows that a ping from PC1 to the IP address of the S1 VLAN 1 interface, 192.168.10.2, should be successful.
- Testing End-to-End Connectivity
- The IP address of PC1 is 192.168.10.10, with subnet mask 255.255.255.0, and default gateway 192.168.10.1.
- The IP address of PC2 is 192.168.10.11, with subnet mask 255.255.255.0, and default gateway 192.168.10.1.
- A ping from PC1 to PC2 should also be successful. A successful ping from PC1 to PC2 verifies end-to-end connectivity in the network!

2.3.3.4 Lab - Building a Simple Network

2.3.3.5 Lab - Configuring a Switch Management Address

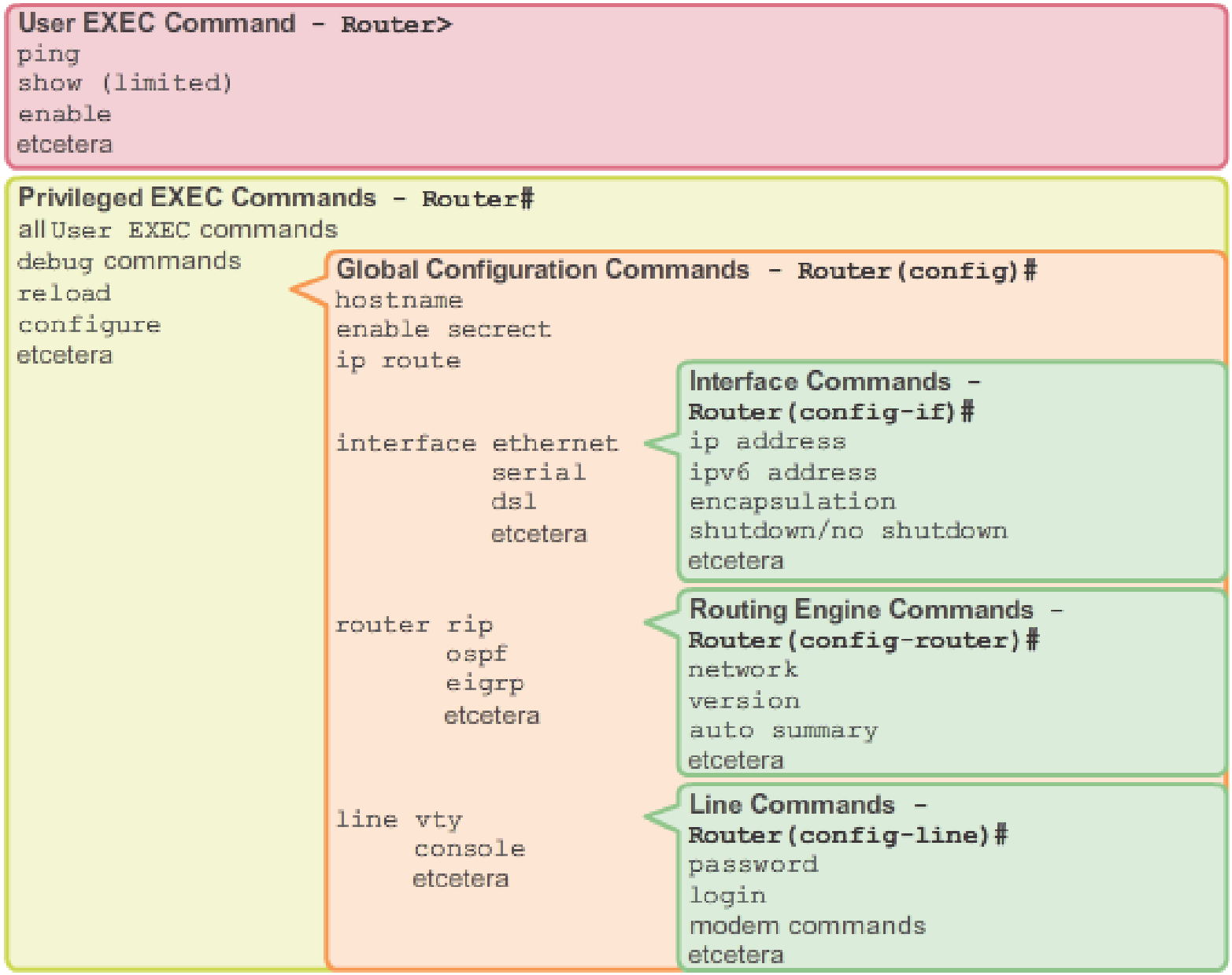
2.4.1.1 Class Activity - Tutor Me

The CLI commands the Cisco IOS!

2.4.1.2 Packet Tracer - Skills Integration Challenge

As a recently hired LAN technician, your network manager has asked you to demonstrate your ability to configure a small LAN. Your tasks include configuring initial settings on two switches using the Cisco IOS and configuring IP address parameters on host devices to provide end-to-end connectivity. You are to use two switches and two hosts/PCs on a cabled and powered network.

2.4.1.3 Summary



Cisco IOS is a term that encompasses a number of different operating systems, which runs on various networking devices. The technician can enter commands to configure, or program, the device to perform various networking functions. Cisco IOS routers and switches perform functions that network professionals depend upon to make their networks operate as expected

Thanks!!!

Thank you for your attention!