

# Chapter 2:

# Configure a Network Operating System

Introduction to Networks v5.1



# Chapter Outline

2.0 Introduction

2.1 IOS Bootcamp

2.2 Basic Device Configuration

2.3 Address Schemes

2.4 Summary

# Section 2.1:

## IOS Bootcamp

Upon completion of this section, you should be able to:

- Explain the purpose of Cisco IOS.
- Explain how to access a Cisco IOS device for configuration purposes.
- Explain how to navigate Cisco IOS to configure network devices.
- Describe the command structure of Cisco IOS software.

## Topic 2.1.1: Cisco IOS



# Operating Systems



Shell: The user interface that allows users to request specific tasks from the computer.

These requests can be made either through the CLI or GUI interfaces.

Kernel: Communicates between the hardware and software of a computer and manages how hardware resources are used to meet software requirements.

Hardware: The physical part of a computer including underlying electronics.

# Purpose of OS

- PC operating systems enable a user to:
  - Use a mouse to make selections and run programs.
  - Enter text and text-based commands.
  - View output on a monitor.
- Cisco IOS enables a network technician to:
  - Use a keyboard to run CLI-based network programs.
  - Use a keyboard to enter text and text-based commands.
  - View output on a monitor.
- All networking devices come with a default IOS.
- It is possible to upgrade the IOS version or feature set.

## Topic 2.1.2: Cisco IOS Access



# Access Methods

## Console

The advantage of using a console port is that the device is accessible even if no networking services have been configured, such as when performing an initial configuration of the networking device. When performing an initial configuration, a computer running terminal emulation software is connected to the console port of the device using a special cable. Configuration commands for setting up the switch or router can be entered on the connected computer.

## Telnet

Best practice dictates to use SSH instead of Telnet for remote management CLI connections. Cisco IOS includes a Telnet server and a Telnet client that can be used to establish Telnet sessions with other devices.

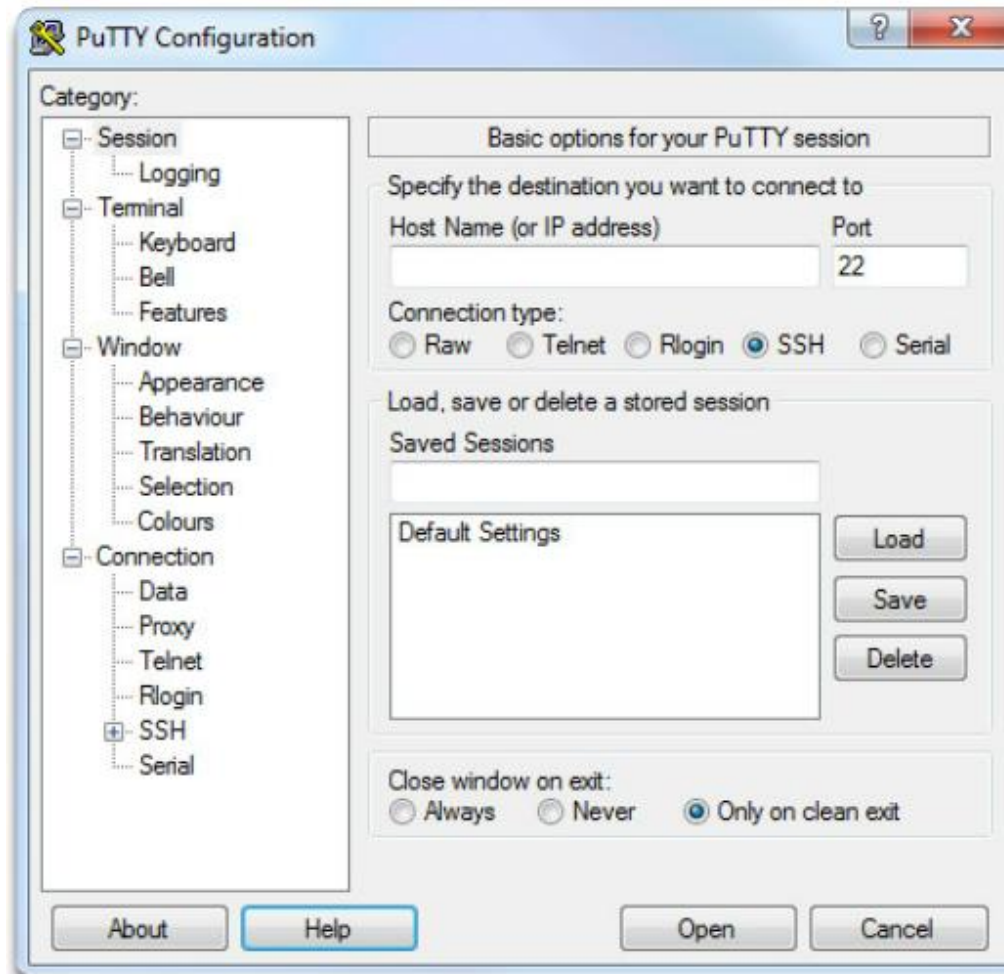
## SSH

SSH is the recommended method for remote management because it provides a secure connection. SSH provides encrypted password authentication and transport of session data. This keeps the user ID, password, and the details of the management session private. Most versions of Cisco IOS include an SSH server and an SSH client that can be used to establish SSH sessions with other devices.



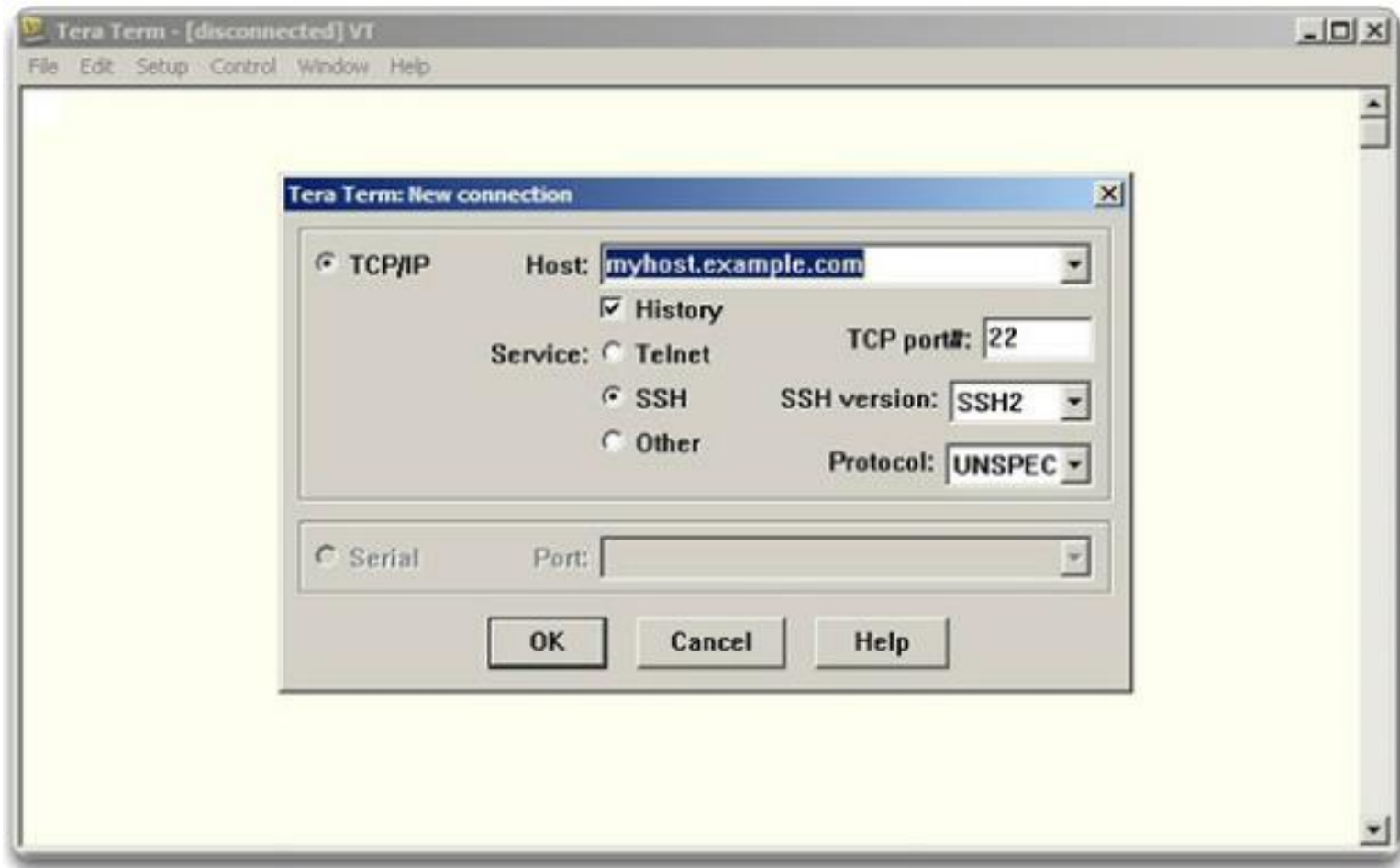
# Terminal Emulation Programs

## PuTTY



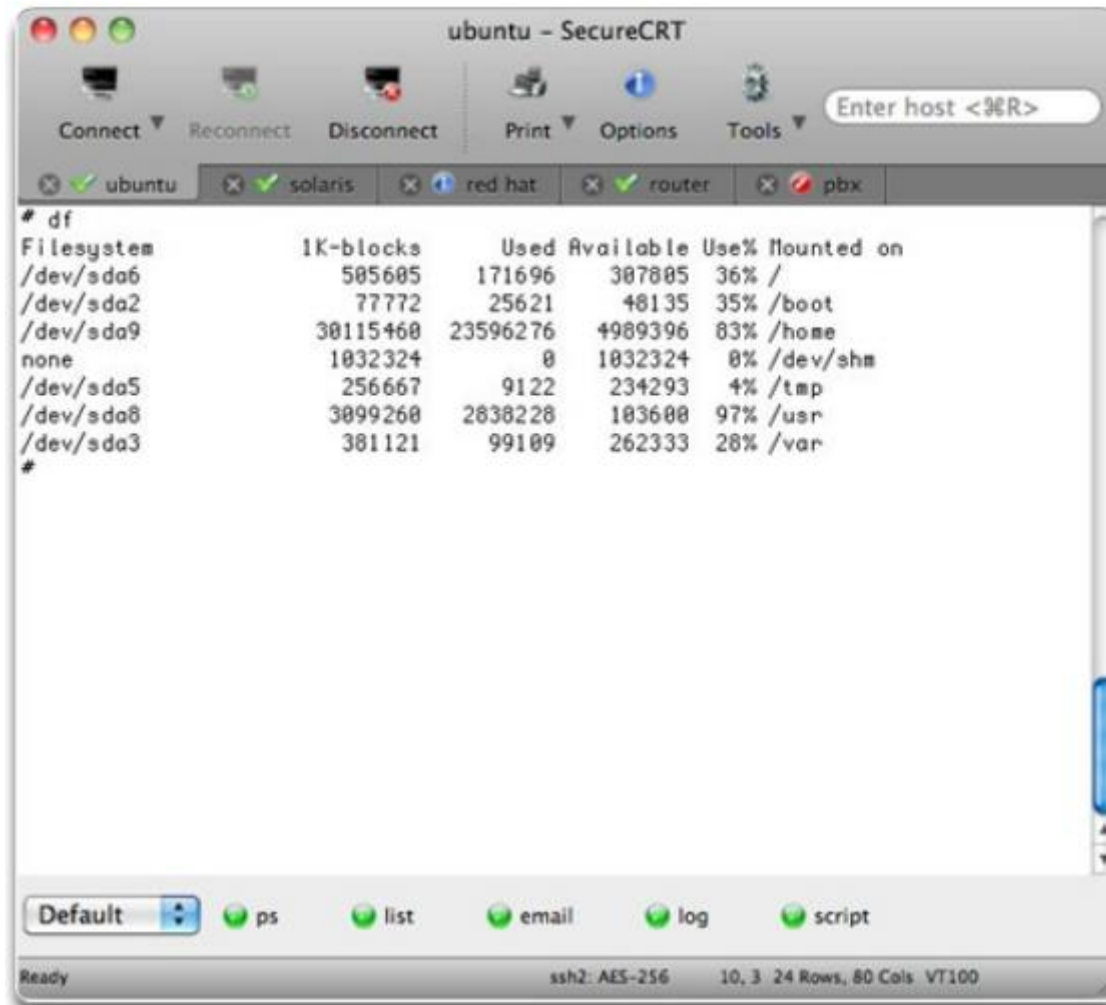
# Terminal Emulation Programs (cont.)

## Tera Term



# Terminal Emulation Programs (cont.)

## SecureCRT



The screenshot shows the SecureCRT application window titled "ubuntu - SecureCRT". The window has a menu bar with "Connect", "Reconnect", "Disconnect", "Print", "Options", and "Tools". Below the menu bar is a tab bar with tabs for "ubuntu", "solaris", "red hat", "router", and "pbx". The "ubuntu" tab is selected. The terminal window displays the output of the "df" command, which shows disk space usage for various filesystems. The output is as follows:

```
# df
Filesystem            1K-blocks    Used Available Use% Mounted on
/dev/sda6              505605    171696   307805   36% /
/dev/sda2              77772     25621   48135   35% /boot
/dev/sda9             30115460 23596276  4989396   83% /home
none                  1032324         0   1032324    0% /dev/shm
/dev/sda5              256667      9122   234293    4% /tmp
/dev/sda8             3099260 2838228  103600   97% /usr
/dev/sda3              381121     99109   262333   28% /var
#
```

At the bottom of the window, there is a status bar with a "Default" dropdown menu, several icons (ps, list, email, log, script), and the text "Ready", "ssh2: AES-256", "10, 3", "24 Rows, 80 Cols", and "VT100".

## Topic 2.1.3: Navigate the IOS



# Cisco IOS Modes of Operation

- A console connection must be established before initial configuration of a Cisco device.
- After being consoled in, the network technician will have to navigate through various command modes of the IOS CLI.
- The Cisco IOS modes use a hierarchical structure and are quite similar for both switches and routers.
- **Video Available**



# Primary Command 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.

# Configuration Command Modes

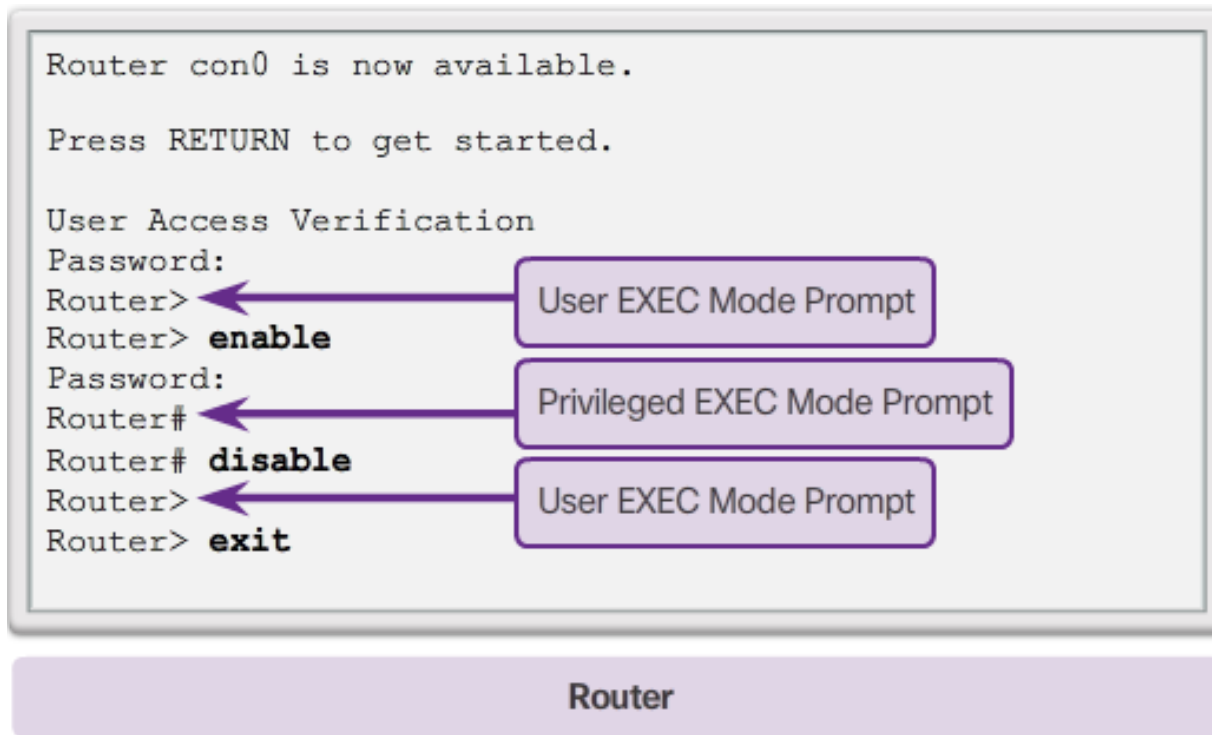
## Global Configuration Mode

- To configure the device must enter this mode with **configure terminal** command
- Example: **Switch(config)#**
- CLI configuration changes are made that affect the operation of the device as a whole
- From this mode, the user can enter different sub-configuration modes

Two common sub-configuration modes include:

- **Line Configuration Mode** - Used to configure console, SSH, Telnet, or AUX access. Example: **Switch(config-line)#**
- **Interface Configuration Mode** - Used to configure a switch port or router network interface. Example: **Switch(config-if)#**
- **Video Available**

# Navigate Between IOS Modes



Switch

Router



# Navigate 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#
```

**Exit**  
**End or Ctrl+Z**  
**Video Available**

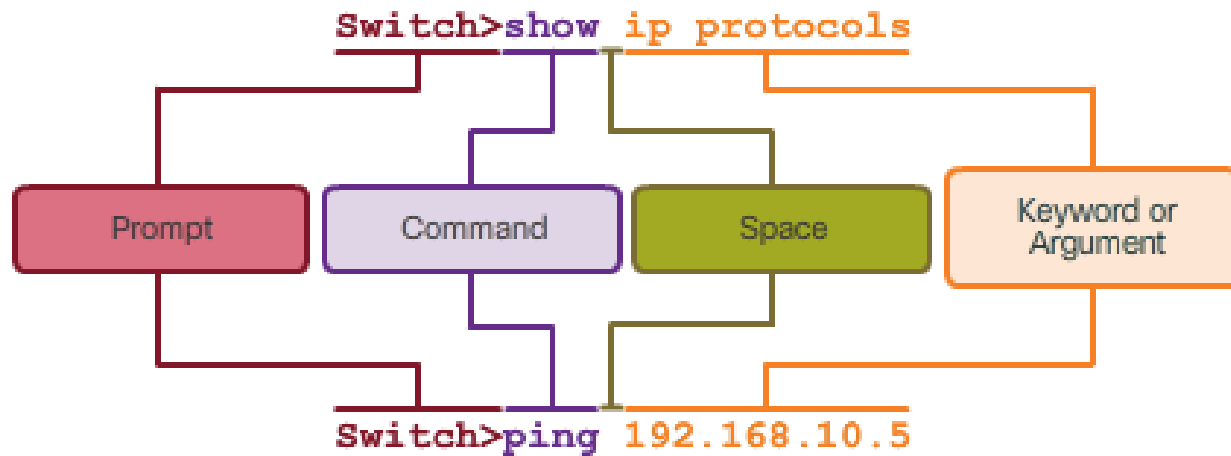
```
Switch# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Switch(config)# vlan 1
Switch(config-vlan)# end
Switch#
```

```
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#
```

## Topic 2.1.4: The Command Structure



# Basic IOS Command Structure



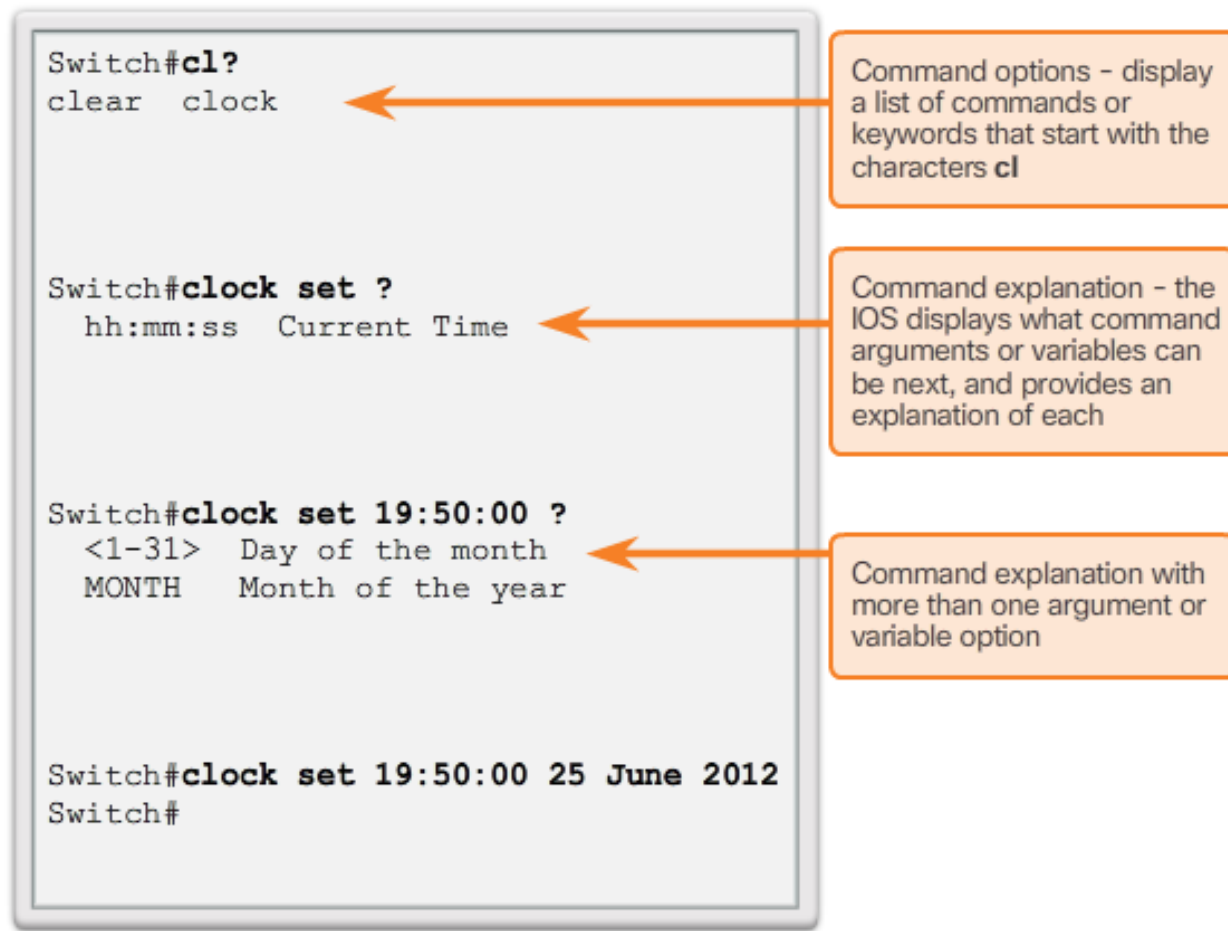
# IOS Command Syntax

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

Convention	Description
<b>boldface</b>	Boldface text indicates commands and keywords that you enter literally as shown.
<i>italics</i>	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.

# IOS Help Features

## Context-Sensitive Help



Video Available

# IOS Help Features (cont.)

```
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.

Video Available

```
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.

# Hotkeys and Shortcuts

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

# Section 2.2:

## Basic Device Configuration

Upon completion of this section, you should be able to:

- Configure hostnames on a Cisco IOS device using the CLI.
- Use Cisco IOS commands to limit access to device configurations.
- Use IOS commands to save the running configuration.



## Topic 2.2.1: Hostnames



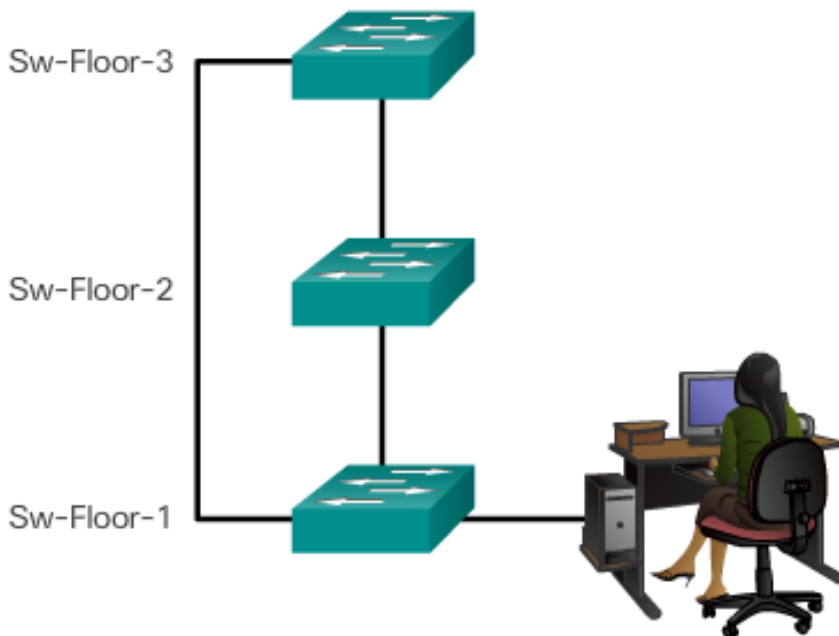
# Device Names

## Guidelines to Choose a Hostname

Hostnames should:

- Start with a letter
- Contain no spaces
- End with a letter or digit
- Use only letters, digits, and dashes
- Be less than 64 characters in length

## Configuring Device Names



Hostnames allow devices to be identified by network administrators over a network or the Internet.

# Configure Hostnames

```
Switch# configure terminal
Switch(config)# hostname SW-Floor-1
Sw-Floor-1(config)#
```

Syntax Checker Available

## Topic 2.2.2: Limit Access to Device Configurations



# Secure Device Access

## Securing Administrative Access

- Secure privileged EXEC access with a password
- Secure user EXEC access with a password
- Secure remote Telnet access with a password

## Other tasks

- Encrypt all passwords
- Provide legal notification

## When Choosing Passwords:

- Use passwords that are more than 8 characters in length.
- Use a combination of upper and lowercase letters, numbers, special characters, and/or numeric sequences.
- Avoid using the same password for all devices.
- Don't use common words because these are easily guessed.

# Configure Passwords

```
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#
```

## Privileged EXEC Password Example

Class

```
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)#
```

## User EXEC Password Example

```
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)#
```

## VTY Line Password Example

# Configure Passwords (cont.)

```
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#
```

- Use the **enable secret** command, not the older **enable password** command.
- The **enable secret** command provides greater security because the password is encrypted.

# Configure Passwords (cont.)

```
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)#
```

Console port must be secured.

- Reduces the chance of unauthorized personnel physically plugging a cable into the device and gaining device access.

VTY lines allow access to a Cisco device via Telnet.

- The number of VTY lines supported varies with the type of device and the IOS version.



# Encrypt Passwords

## service password-encryption

- Prevents passwords from showing up as plain text when viewing the configuration.
- Purpose of this command is to keep unauthorized individuals from viewing passwords in the configuration file.
- After this command is applied, removing the encryption service does not reverse the 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#
You successfully encrypted the plain text passwords.
```

Reset

Show Me

# Banner Messages

- These are an important part of the legal process in the event that someone is prosecuted for breaking into a device.
- Wording that implies that a login is "welcome" or "invited" is not appropriate.
- Often used for legal notification because it is displayed to all connected terminals.
- **Video Available**

## Limiting Device Access - MOTD Banner

```
Sw1-Floor-1(config)#banner motd # This is a secure system. Authorized Access ONLY!!! #
```

This configuration results in this message of the day banner.

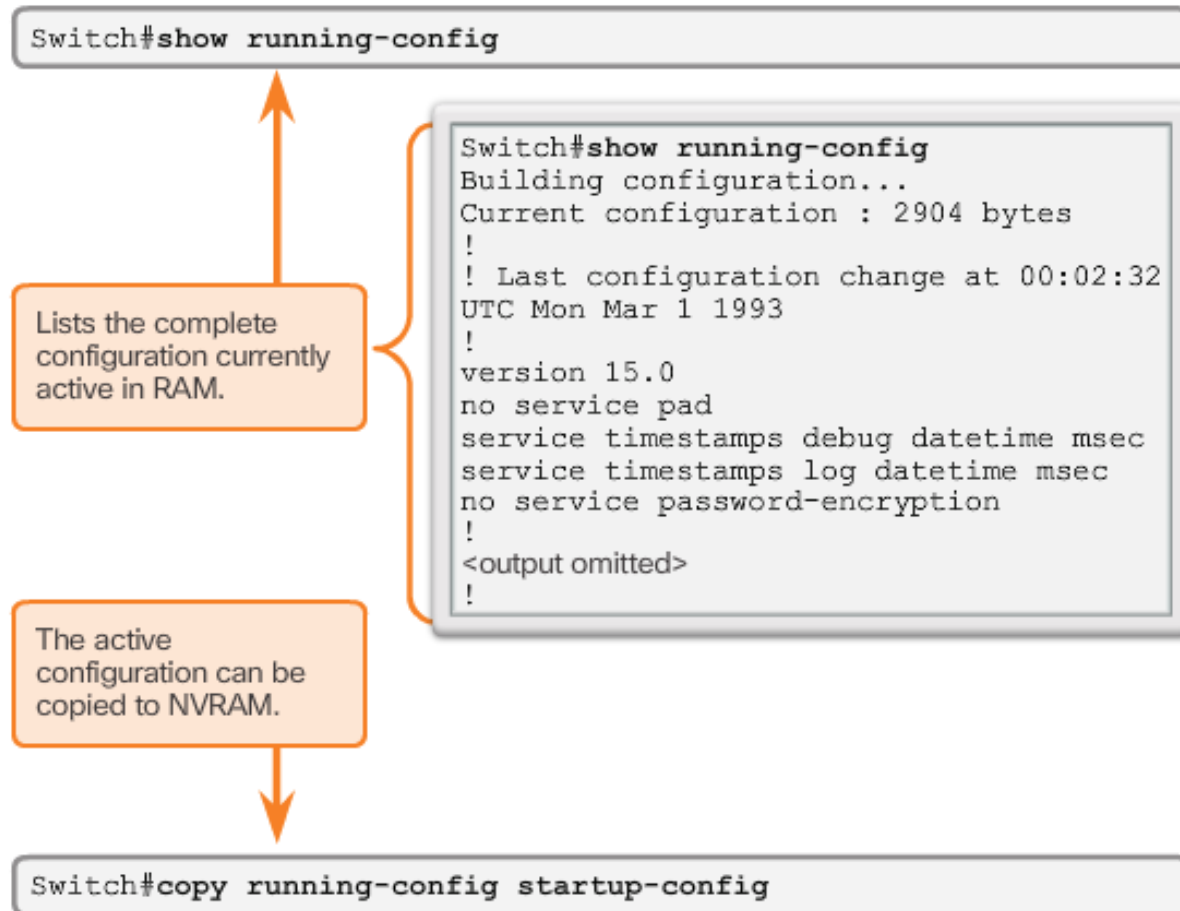
Delimiting characters are not included in the message.

```
Sw1-Floor-1 con0 is now available
Press RETURN to get started.
This is a secure system. Authorized
Access ONLY!!!
User Access Verification
password:
Sw1-Floor-1>enable
Password:
Sw1-Floor-1#
```

## Topic 2.2.3: Save Configurations



# Save the Running Configuration File



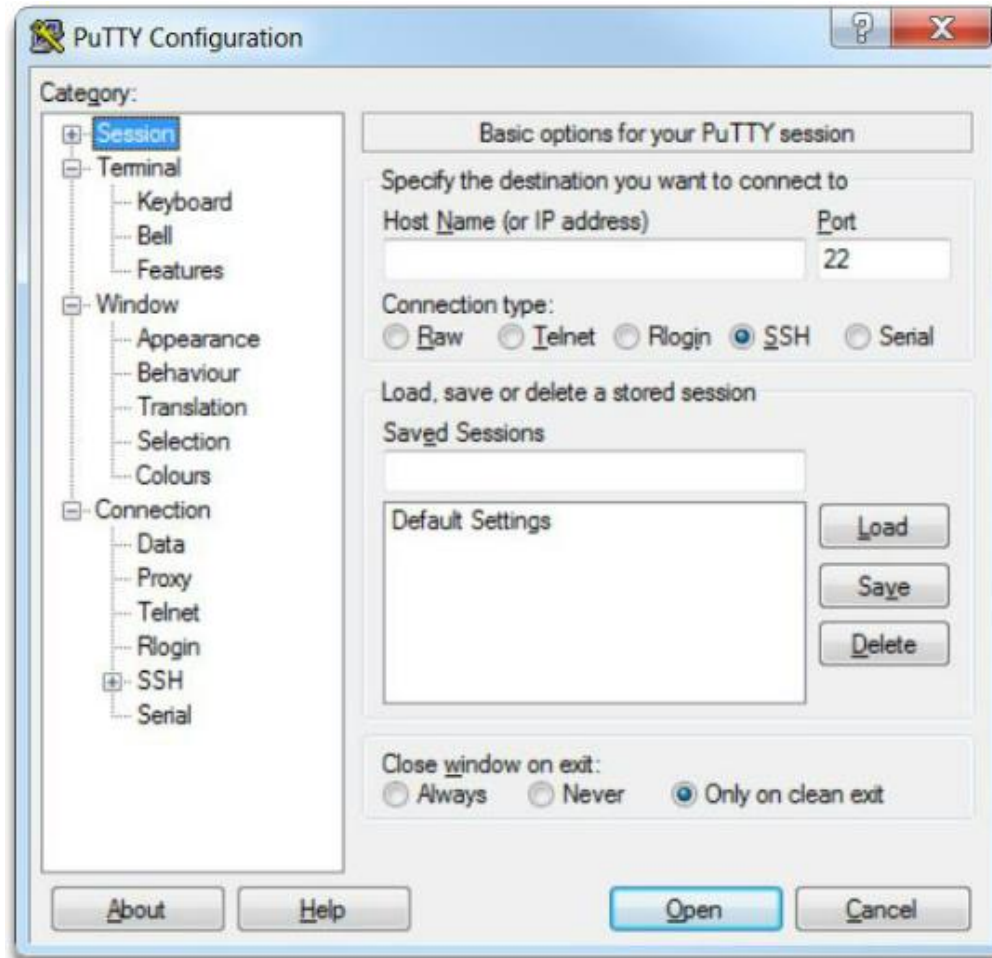
- **Startup configuration** – File stored in NVRAM that contains all of the commands that will be used upon startup or reboot. NVRAM does not lose its contents when the device is powered off.
- **Running configuration** – File stored in RAM that reflects the current configuration, modifying affects the operation of a Cisco device immediately. RAM loses all of its content when the device is powered off or restarted.

# Alter the Running Configuration

- Restore the device to its previous configuration by removing the changed commands individually.
- Copy the startup configuration file to the running configuration with the **copy startup-config running-config** privileged EXEC mode command.
- Reload the device with the **reload** command from privileged EXEC mode.
- Switch# **reload**  
System configuration has been modified. Save? [yes/no]: **n**  
Proceed with reload? [confirm]
- **Video Available**

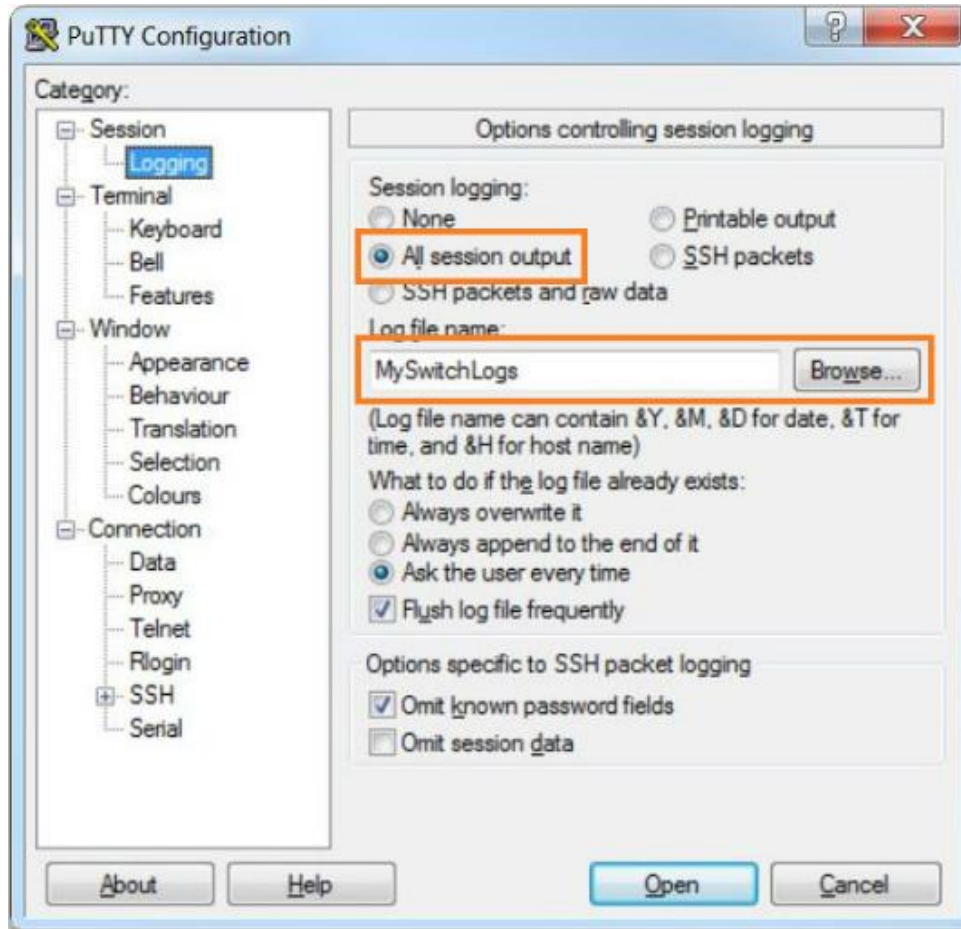
# Capture Configuration to a Text File

## Using PuTTY to Capture Console Session



# Capture Configuration to a Text File (cont.)

## Enabling Session Logging in PuTTY

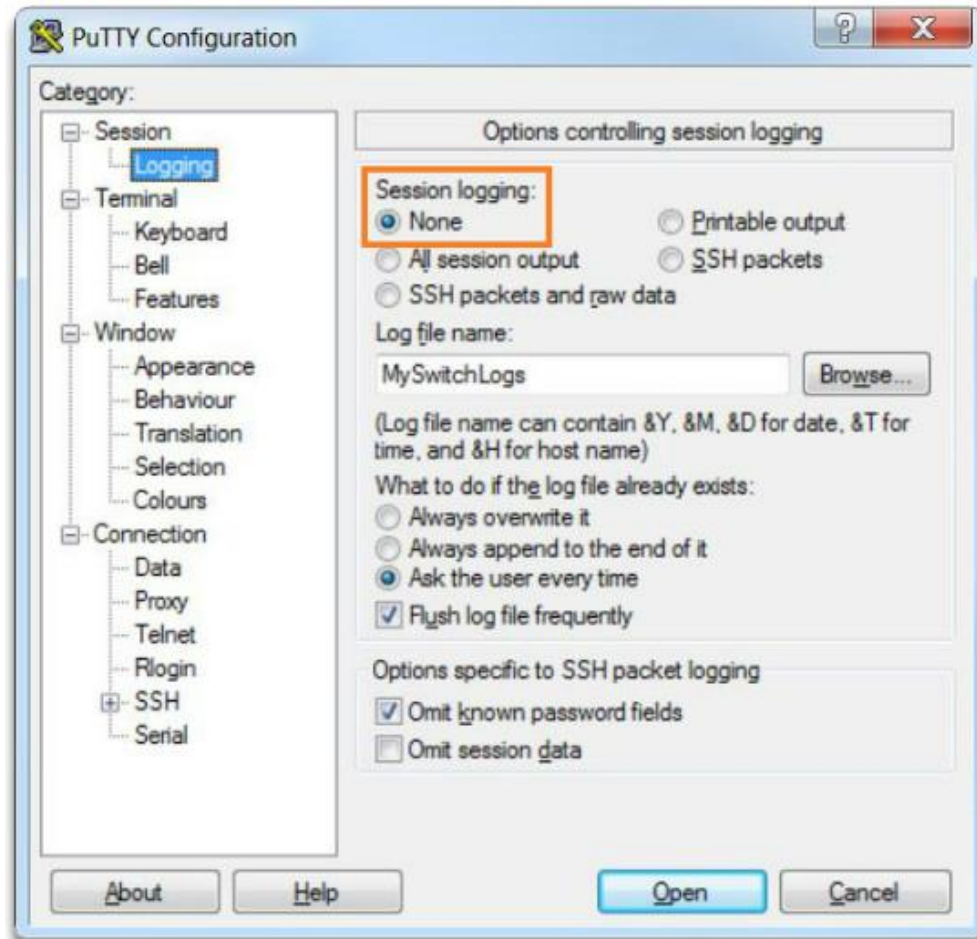


- All session output will be captured to the file specified, MySwitchLogs.
- Execute the show running-config or show startup-config command at the privileged EXEC prompt. Text displayed in the terminal window will be placed into the chosen file.



# Capture Configuration to a Text File (cont.)

## Disabling Session Logging in PuTTY





# Section 2.3: Address Schemes

## Chapter Objectives:

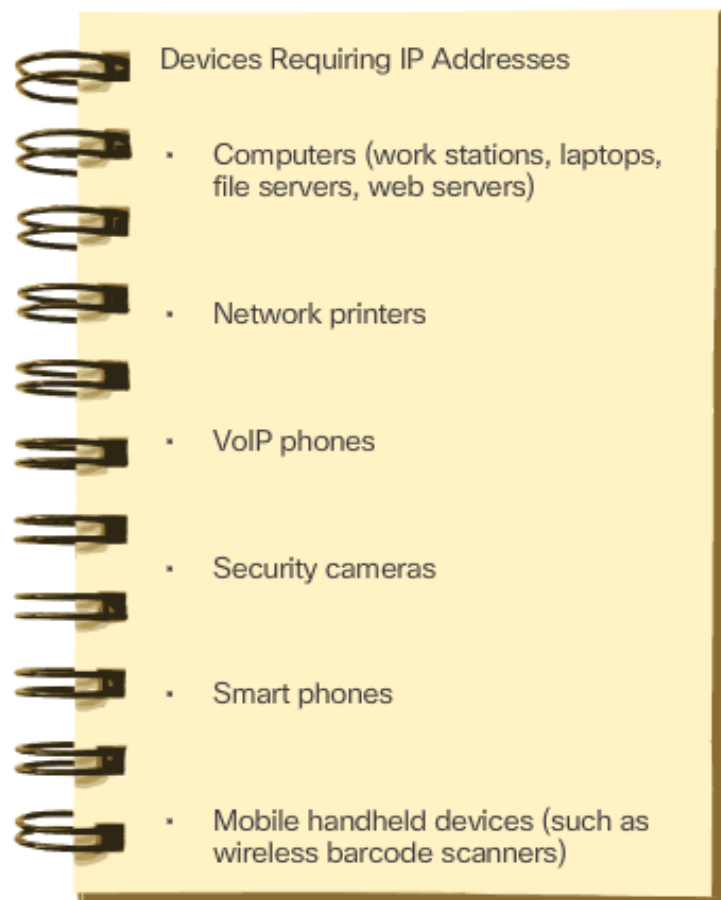
- Explain how devices communicate across network media.
- Configure a host device with an IP address.
- Verify connectivity between two end devices.

## Topic 2.3.1: Ports and Addresses

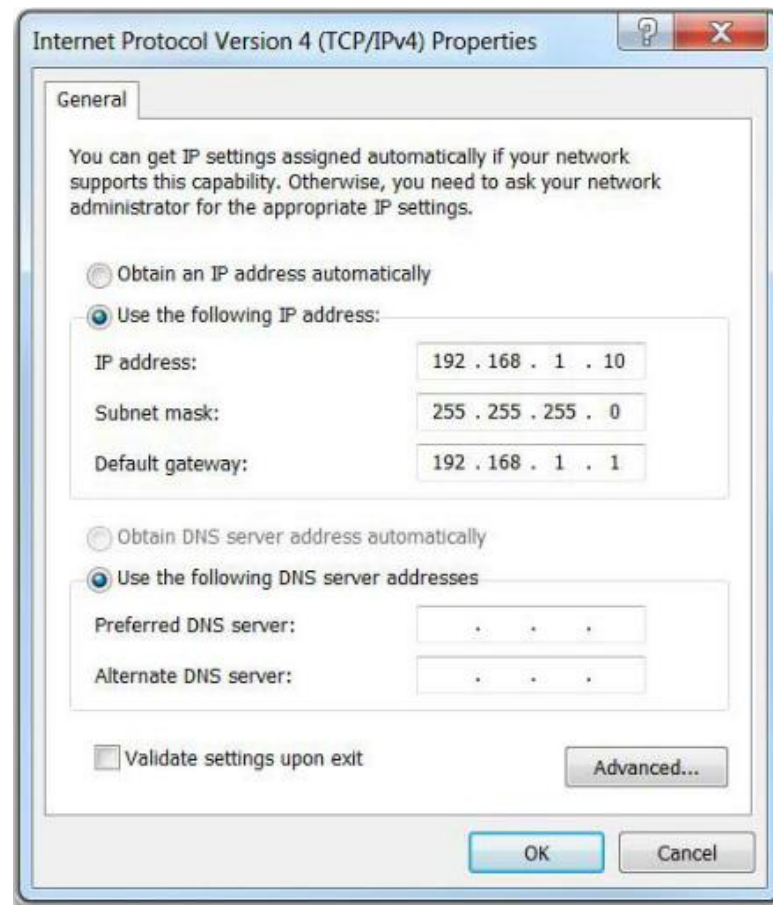


# IP Addresses

## Connecting End Devices



## Configuring a Static IP Address on a Host



# Interfaces and Ports

- Network communications depend on end user device interfaces, networking device interfaces, and the cables that connect them.
- Types of network media include twisted-pair copper cables, fiber-optic cables, coaxial cables, or wireless.
- Different types of network media have different features and benefits.
- Ethernet is the most common local area network (LAN) technology.
- Ethernet ports are found on end user devices, switch devices, and other networking devices.
- Cisco IOS switches have physical ports for devices to connect to, but they also have one or more switch virtual interfaces (SVIs). No physical hardware on the device is associated with it. It is created in software.
- SVI provides a means to remotely manage a switch over a network.

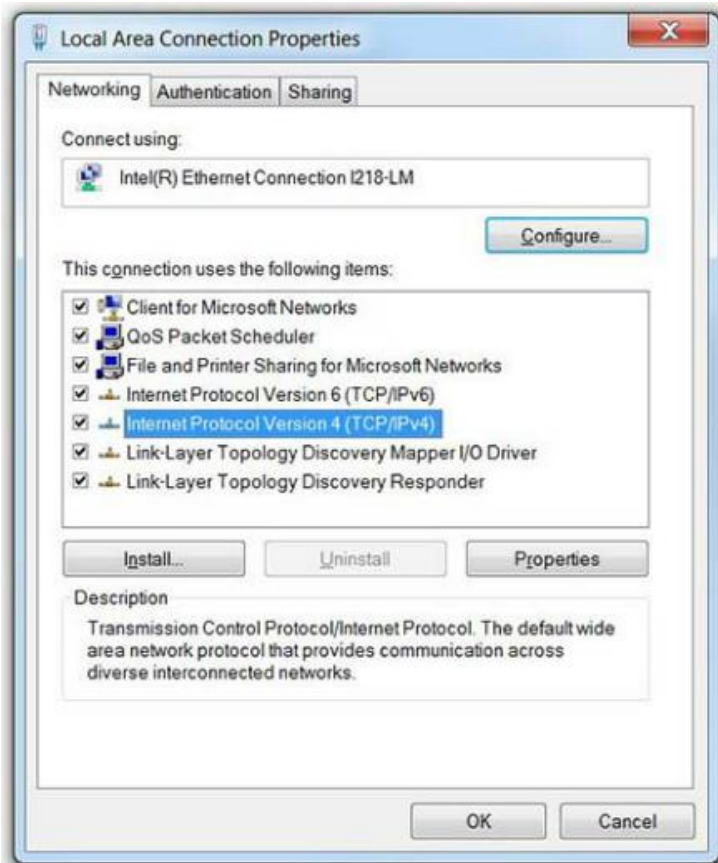


## Topic 2.3.2: Configure IP Addressing

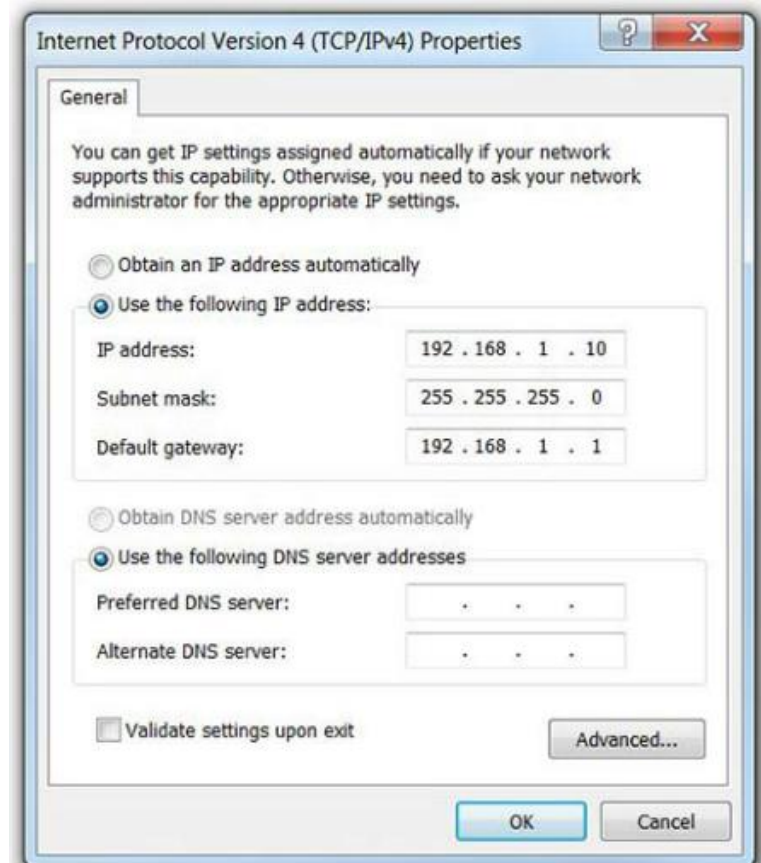


# Manual IP Address Configuration for End Devices

## Ethernet Adapter Properties

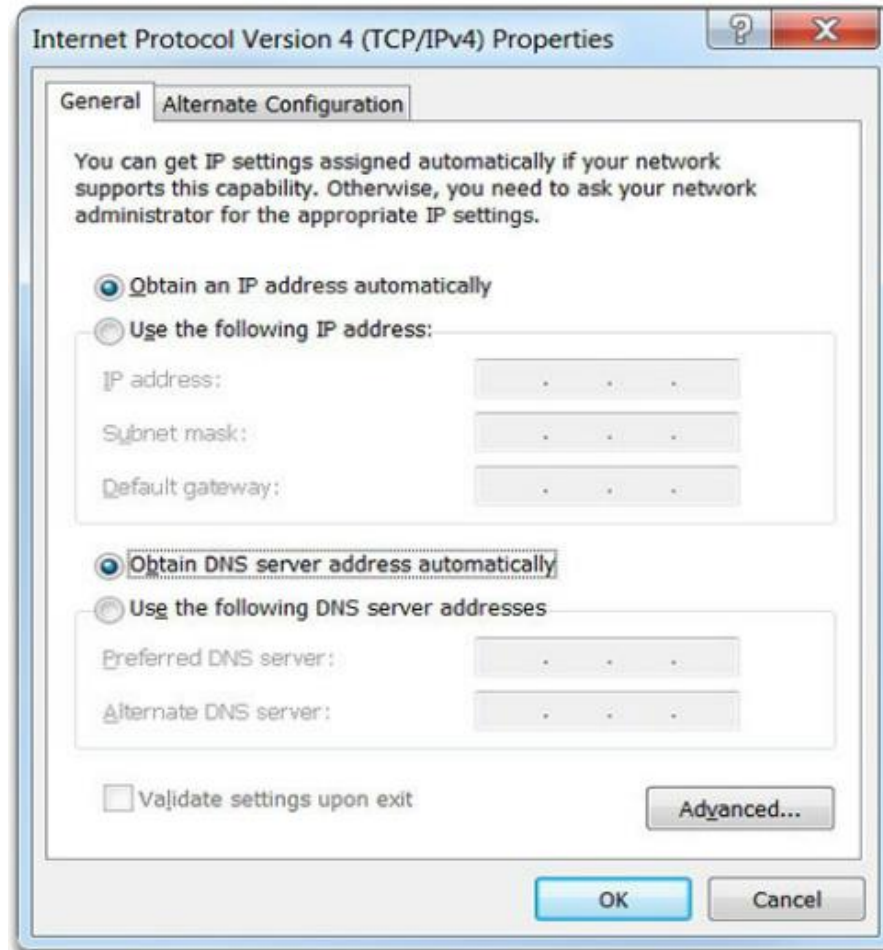


## Manually Assigning IPv4 Address Information



# Automatic IP Address Configuration for End Devices

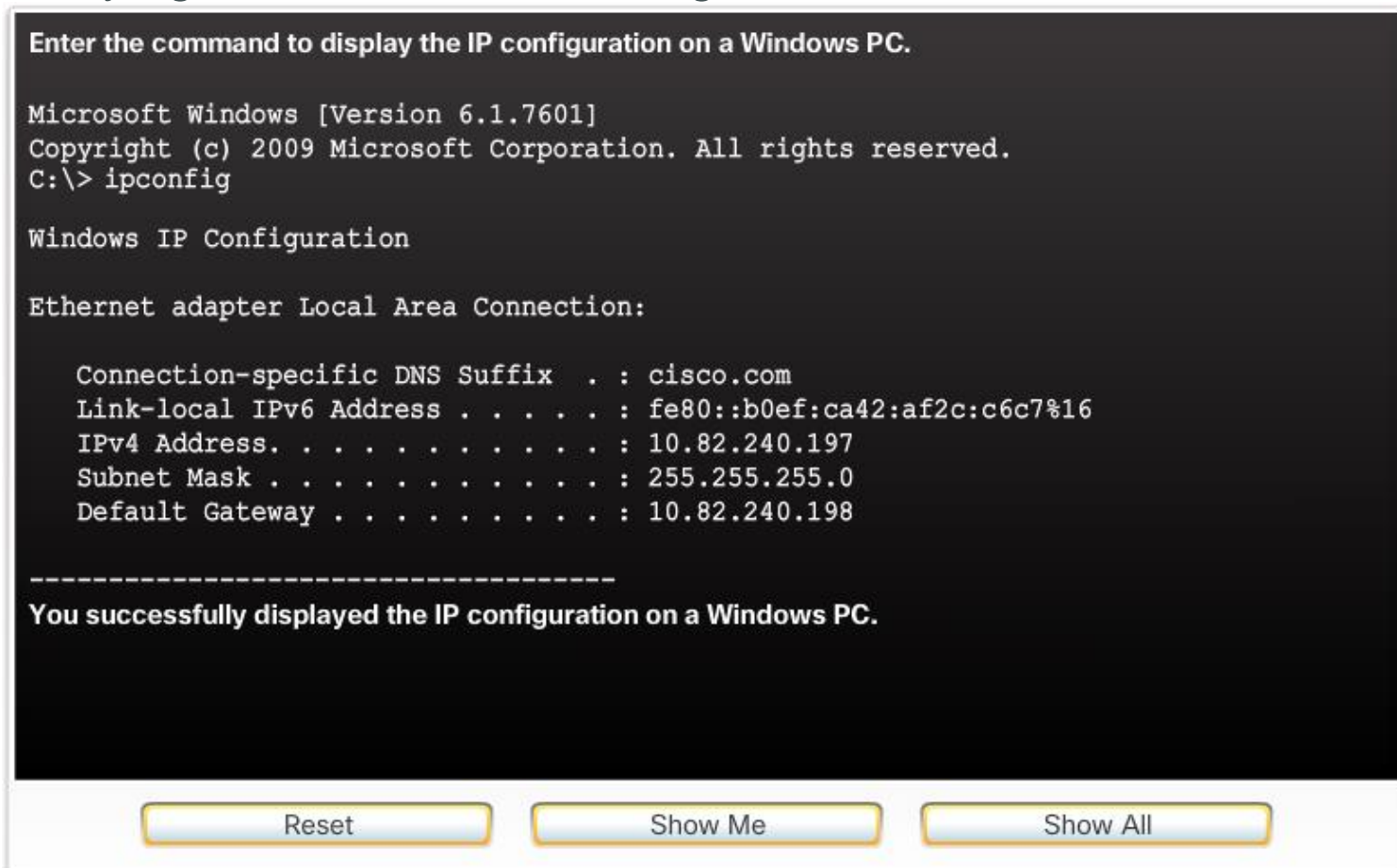
## Assigning Dynamic Addresses





# Automatic IP Address Configuration for End Devices (cont.)

## 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.
```

Reset Show Me Show All



# Switch Virtual Interface Configuration

```
Switch#configure terminal  
Enter configuration commands, one per line. End with  
CNTL/Z.  
Switch(config)#interface VLAN 1  
Switch(config-if)#ip address 192.168.10.2 255.255.255.0  
Switch(config-if)#no shutdown
```

Video  
Available

- **IP address** - Together with subnet mask, uniquely identifies end device on internetwork
- **Subnet mask** - Determines which part of a larger network is used by an IP address
- **interface VLAN 1** - Interface configuration mode
- **ip address 192.168.10.2 255.255.255.0** - Configures the IP address and subnet mask for the switch
- **no shutdown** - Administratively enables the interface
- Switch still needs to have physical ports configured and VTY lines to enable remote management

## Topic 2.3.3: Verifying Connectivity



# Interface Addressing Verification

Video  
Available

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

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

# End-to-End Connectivity Test

Video  
Available

```
C:\>ping 192.168.10.2

Pinging 192.168.10.2 with 32 bytes of data:
Reply from 192.168.10.2: bytes=32 time=838ms TTL=35
Reply from 192.168.10.2: bytes=32 time=820ms TTL=35
Reply from 192.168.10.2: bytes=32 time=883ms TTL=36
Reply from 192.168.10.2: bytes=32 time=828ms TTL=36

Ping statistics for 192.168.10.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 820ms, Maximum = 883ms, Average = 842ms

C:\>ping 192.168.10.11

Pinging 192.168.10.11 with 32 bytes of data:
Reply from 192.168.10.11: bytes=32 time=838ms TTL=35
Reply from 192.168.10.11: bytes=32 time=820ms TTL=35
Reply from 192.168.10.11: bytes=32 time=883ms TTL=36
Reply from 192.168.10.11: bytes=32 time=828ms TTL=36

Ping statistics for 192.168.10.11:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 820ms, Maximum = 883ms, Average = 842ms

C:\>
```

# Section 2.4: Summary

## Chapter Objectives:

- Explain the features and functions of Cisco IOS Software.
- Configure initial settings on a network device using the Cisco IOS software.
- Given an IP addressing scheme, configure IP address parameters on end devices to provide end-to-end connectivity in a small to medium-sized business network.

## Topic 2.4.1: Conclusion



Thank you.



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