



# Instructor Materials

## Chapter 2: Configure a Network Operating System



## CCNA Routing and Switching

### Introduction to Networks v6.0

Cisco | Networking Academy®  
Mind Wide Open™



## Chapter 2: Configure a Network Operating System



### Introduction to Networks v6.0

Cisco | Networking Academy®  
Mind Wide Open™



# Chapter 2 - Sections & Objectives

- 2.1 IOS Bootcamp
  - 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.
- 2.2 Basic Device Configuration
  - 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.
- 2.3 Address Schemes
  - Explain how devices communicate across network media.
  - Configure a host device with an IP address.
  - Verify connectivity between two end devices.



## 2.1 IOS Bootcamp



Cisco | Networking Academy®  
Mind Wide Open™

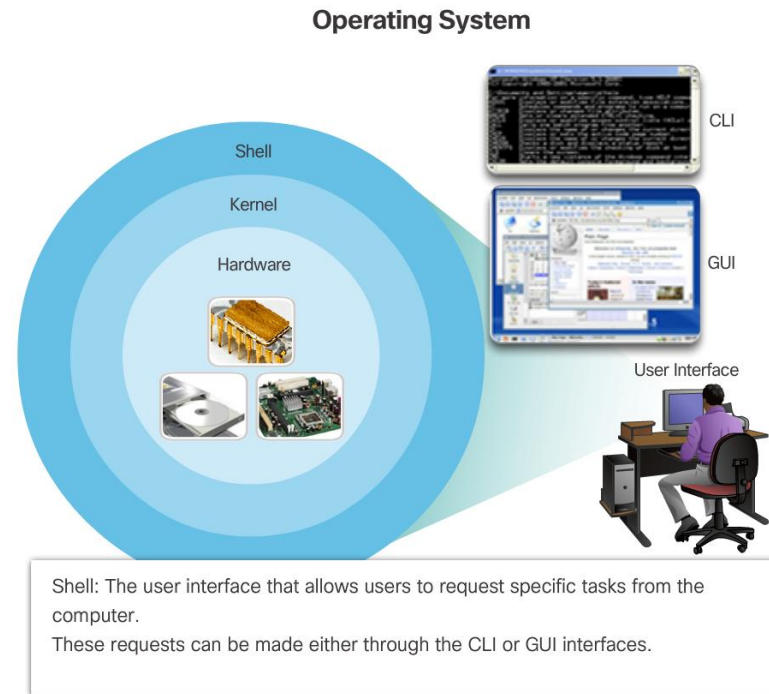


# IOS Bootcamp

## Cisco IOS

### ■ Operating Systems

- Every computer requires an operating system to function, including computer-based network devices such as switches, routers, access points, and firewalls. These network devices use an operating system called a network operating system.
- An operating system has two basic parts. **Shell** and **Kernel**
- A **shell** provides user interface.
- A **kernel** interacts with hardware.



# IOS Bootcamp

## Cisco IOS

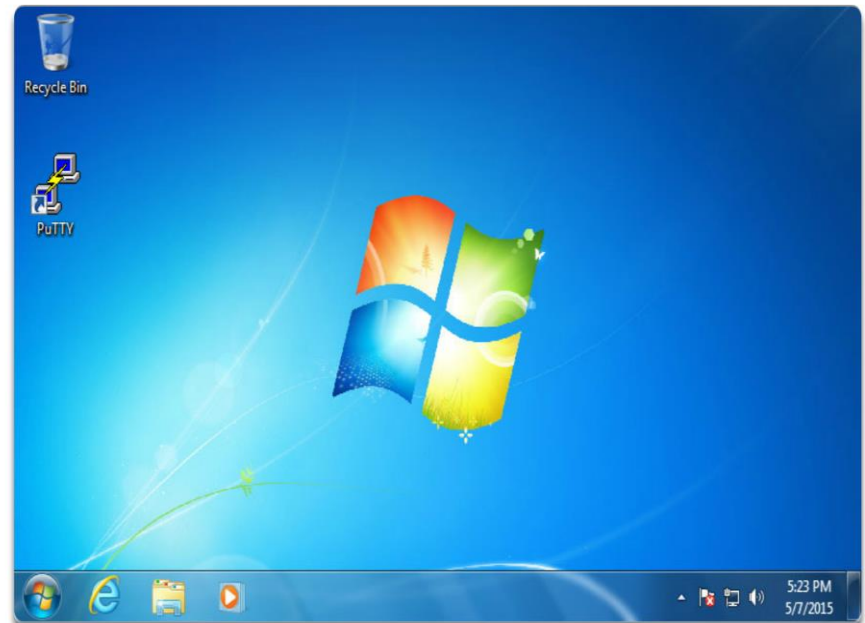
### ■ Operating Systems

- Operating System interface could either be Command-Line-Interface (**CLI**) or Graphical-User-Interface (**GUI**)

Command-Line Interface

```
[root@danscentos-s5 /]# ls
bin  dev  home  lib64  media  opt  root  selinux  sys  usr
boot  etc  lib  lost+found  mnt  proc  sbin  srv  tmp  var
[root@danscentos-s5 /]# _
```

Graphical User Interface



# IOS Bootcamp

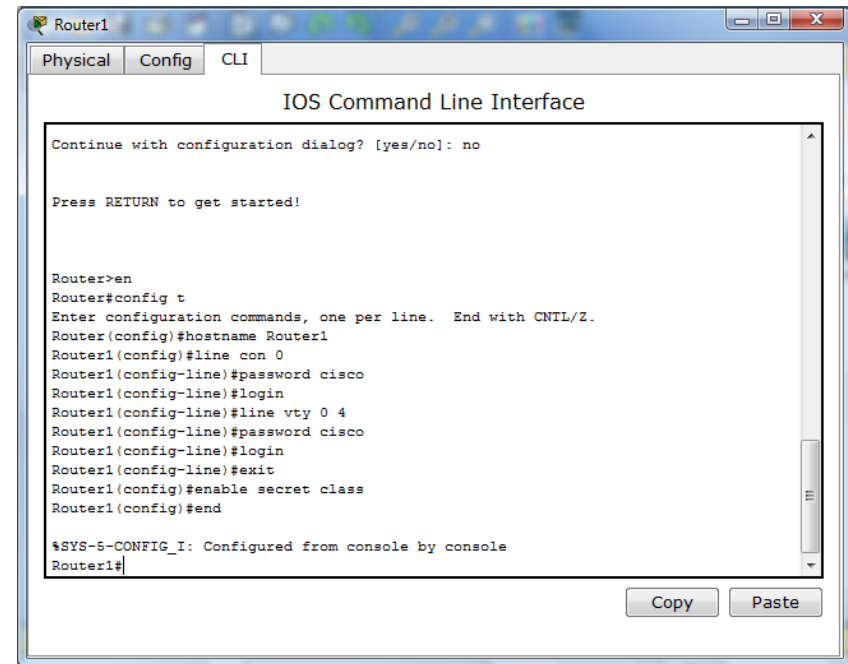
## Cisco IOS

### ■ Operating Systems

- A Network Operating System (**NOS**) enables device hardware to function and provides an interface for users to interact.
- Cisco devices like switch, routers etc has its own operating system known as Cisco Internetwork Operating System (**Cisco IOS**).
- Cisco IOS allows users to interact with Cisco devices. It also allow users to configure or troubleshoot Cisco network devices.

### ■ Cisco IOS enables a 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.





# IOS Bootcamp

## Cisco IOS Access

- Three Access Methods to access CLI (Command Line Interface) and configure Cisco devices (e.g. switch, router)
  - **Console** - This is a physical management port that provides out-of-band access to a Cisco device.
  - **Auxiliary** – is a legacy (i.e. old) auxiliary port that was used to establish a CLI session remotely using a modem. Similar to a console connection, the AUX port is out-of-band and does not require networking service
  - **Virtual Terminal (Telnet / SSH)**

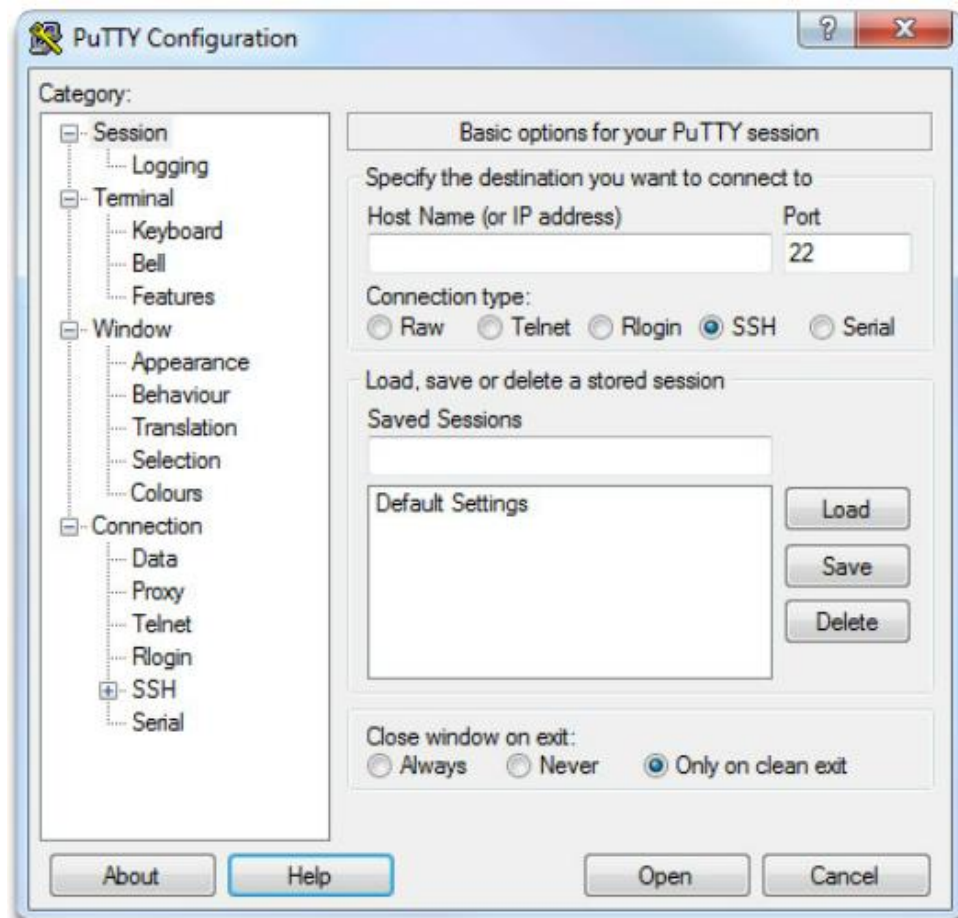
**SSH** is a method for remotely establishing a secure CLI connection through a virtual interface, over a network. Unlike a console connection, SSH connections require active networking services on the device including an active interface configured with an address.

**Telnet** is an insecure method of remotely establishing a CLI session through a virtual interface, over a network. Unlike SSH, Telnet does not provide a securely encrypted connection. User authentication, passwords, and commands are sent over the network in plaintext.

# IOS Bootcamp

## Cisco IOS Access

- Terminal Emulation Programs - allows you to connect to a networking device either by a serial connection over a console port or by a SSH/Telnet connection. Some of these include:
  - PuTTY
  - Tera Term
  - SecureCRT





# IOS Bootcamp

## Navigate the IOS

### ■ Cisco IOS Modes of Operation

- Initial configuration must be done via console connection
- Configuration is then done via various CLI command modes.

### ■ Primary Command Modes

- **User EXEC Mode** - This mode has limited capabilities but is useful for basic operations. It allows only a limited number of basic monitoring commands but does not allow the execution of any commands that might change the configuration of the device. The user exec mode is identified with the prompt >.

Switch>

Router>

- **Privileged EXEC Mode** - To execute configuration commands, a network administrator must access privileged EXEC mode. Higher configuration modes, like global configuration mode, can only be reached from privileged EXEC mode. The privileged EXEC mode can be identified by the prompt ending with the # symbol.

Switch#

Router#



# IOS Bootcamp

## Navigate the IOS

### ■ Configuration Command Modes

- The **Configure Terminal** command enters the Global Configuration Mode.

switch# **configure terminal**

switch(config)# **[This is in global configuration mode]**

- Sub-configuration modes are accessible from the Privileged EXEC Mode.

switch# **line console 0**

switch(config-line)# **[This is in line console sub-configuration]**

switch# **interface vlan 1**

switch(config-if)# **[This is in interface sub-configuration]**

### ■ Navigate Between IOS Modes

- Navigation between modes is also done via commands.
- The **enable** command enters the Privileged EXEC Mode from User EXEC Mode.
- The **exit** commands exits from sub-configuration to the parent command mode.
- The **end** command or **Ctrl+Z** exits from sub-configuration to User EXEC Mode.

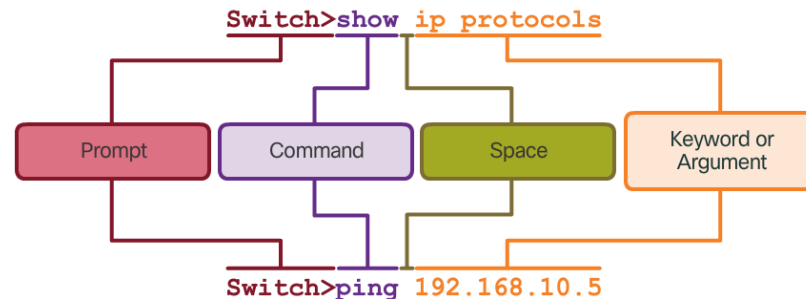


## IOS Bootcamp

# The Command Structure

### ■ Basic IOS Command Structure

- The general syntax for a command is the command followed by any appropriate keywords and arguments.
- Keyword - a specific parameter defined in the operating system
- Argument - not predefined; a value or variable defined by the user



### ■ IOS Command Syntax

- Provides the pattern or format that must be used when entering a command.
- The [Cisco IOS Command Reference](#) is the ultimate source of information for a particular IOS command.



# IOS Bootcamp

## The Command Structure

### ■ IOS Help Feature

- The IOS has two forms of help available: Context-Sensitive Help and Command Syntax Check.

#### *Help using ? (Question Mark)*

- Router# ? **[Will display all the commands on that mode]**
- Router(config)# **zo?** **[Will display all commands that starts with zo]**
  - **zone zone-pair**

#### *Partial command using Tab key*

- Router(config)# **conf**<Tab>
- Router(config)# **configure** **[Will complete the whole word after Tab]**

### ■ Hotkeys and Shortcuts

- Commands and keywords can be shortened to the minimum number of characters that identify a unique selection.
  - Router> **en** **[Instead of enable command you could use en]**
  - Router# **conf t** **[Instead of configure terminal command you could use conf t]**



# IOS Bootcamp

## The Command Structure

### CLI Hot Keys and Shortcuts

#### CLI Line Editing

|                  |   |
|------------------|---|
| <b>Tab</b>       | Completes a partial command name entry.                               |
| <b>Backspace</b> | Erases the character to the left of the cursor.                       |
| <b>Ctrl-D</b>    | Erases the character at the cursor.                                   |
| <b>Ctrl-K</b>    | Erases all characters from the cursor to the end of the command line. |
| <b>Esc D</b>     | Erases all characters from the cursor to the end of the word.         |

(NOTE: "Delete", the key to erase to the right of the cursor, is not recognized by terminal emulation programs.)

#### At the "-----More-----" prompt

|                  |   |
|------------------|---|
| <b>Enter Key</b> | Displays the next line.                                     |
| <b>Space Bar</b> | Displays the next screen.                                   |
| <b>Any Key</b>   | Ends the display string, returning to privileged EXEC mode. |

#### Break Keys

|                     |   |
|---------------------|---|
| <b>Ctrl-C</b>       | When in any configuration mode, ends the configuration mode and returns to privileged EXEC mode. When in setup mode, aborts back to the command prompt. |
| <b>Ctrl-Z</b>       | When in any configuration mode, ends the configuration mode and returns to privileged EXEC mode.  |
| <b>Ctrl-Shift-6</b> | All-purpose break sequence. Use to abort DNS lookups, traceroutes, pings.   |

NOTE: **Control** keys – Press and hold the <Ctrl> key and then press the specified letter key.  
**Escape** sequences – Press and release the <Esc> key, and then press the letter key.



## 2.2 Basic Device Configuration



Cisco | Networking Academy®  
Mind Wide Open™



## Basic Device Configuration

# Hostnames

### ■ Device Names

- Hostnames allow devices to be identified by network administrators over a network or the Internet.
- Very important and should also be displayed in the topology.

### ■ Configure Hostnames

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

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



## Basic Device Configuration

# Limit Access to Device Configurations

### ■ Secure Device Access

- Secure privileged EXEC and user EXEC access with a password.

Privilege EXEC password setup:

**enable secret <password>**

**Router(config)# enable secret class**

User EXEC password setup:

**Router(config)# line console 0**

**Router(config-line)# password cisco**

**Router(config-line)# login**

- Secure virtual terminal lines with a password.

**Router(config)# line vty 0 15**

**Router(config-line)# password cisco**

**Router(config-line)# login**

### ■ Configure Passwords

- Use more than 8 characters (above is for example only).
- Use a combination of uppercase, lowercase, numbers and special characters.
- Avoid re-using passwords



## Basic Device Configuration

# Limit Access to Device Configurations

### ■ Encrypt Passwords

- Cisco IOS displays passwords in plain text by default.
- Passwords should be encrypted.

**Router(config)# service password-encryption**

### ■ Banner Messages

- 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.

**Router(config)# banner motd #No unauthorized access  
allowed violators will be prosecuted to the full extent of the  
law#**



# Basic Device Configuration

## Configuration Files

### ■ Start-up Configuration File

- **startup-config** - 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.

### ■ Start-up Configuration File

- **running-config** - The file stored in Random Access Memory (RAM) that reflects the current configuration. Modifying a running configuration affects the operation of a Cisco device immediately. RAM is volatile memory. It loses all of its content when the device is powered off or restarted.

### ■ Showing running configuration

- **Router# show running-config**

```
Switch#show running-config
Building configuration...
Current configuration : 2904 bytes
!
! Last configuration change at 00:02:32
UTC Mon Mar 1 1993
!
version 15.0
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
<output omitted>
!
```

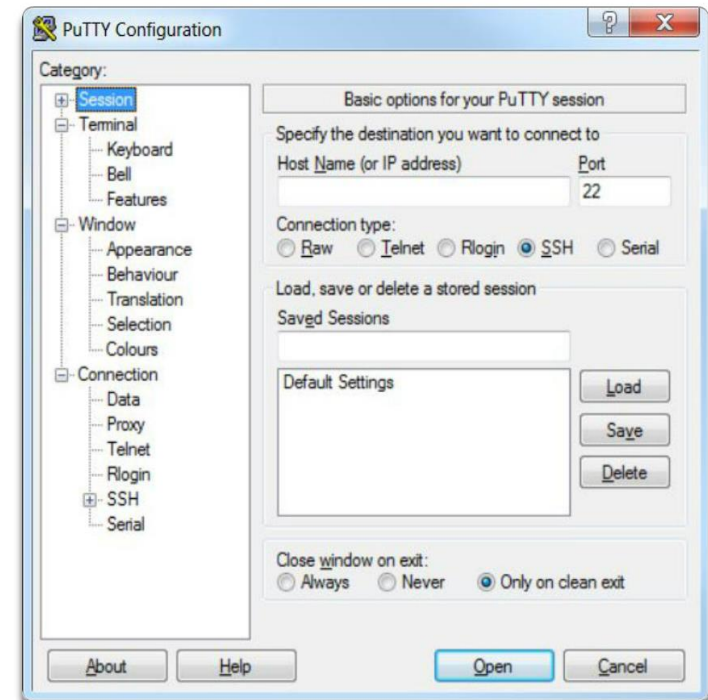
## Basic Device Configuration

# Save Configurations

- Save Configuration files
  - Router# copy running-config startup-config
- Capture Configuration to a Text File
  - Configuration files can also be saved and archived to a text document.
  - The configuration can then be edited with any text editor and placed back in the device.



## Using PuTTY to Capture Console Session



**Open a terminal emulation software such as PuTTY or Tera Term connected to a switch.**

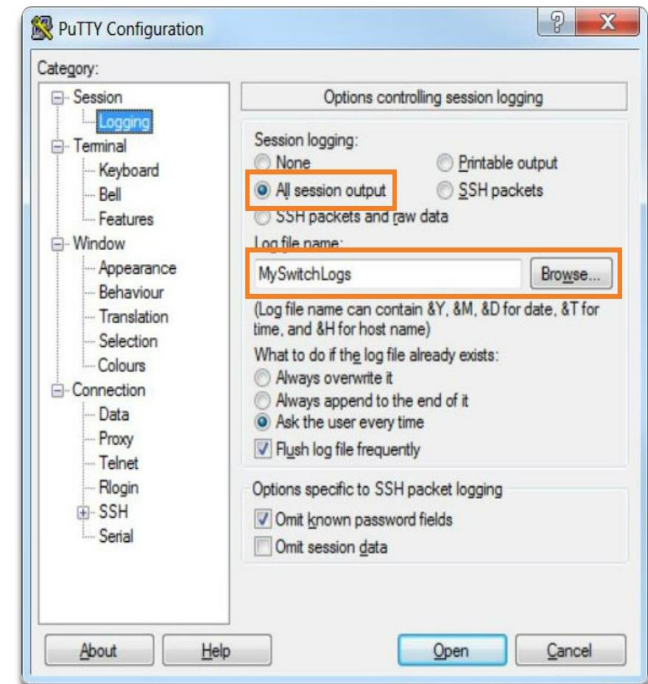
## Basic Device Configuration

# Save Configurations

Enable logging in the terminal software, such as PuTTY or Tera Term, and assign a name and file location to save the log file. As shown on the right figure, that **All session output** will be captured to the file specified (i.e., 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.

2

Enabling Session Logging in PuTTY





# Basic Device Configuration

## Save Configurations

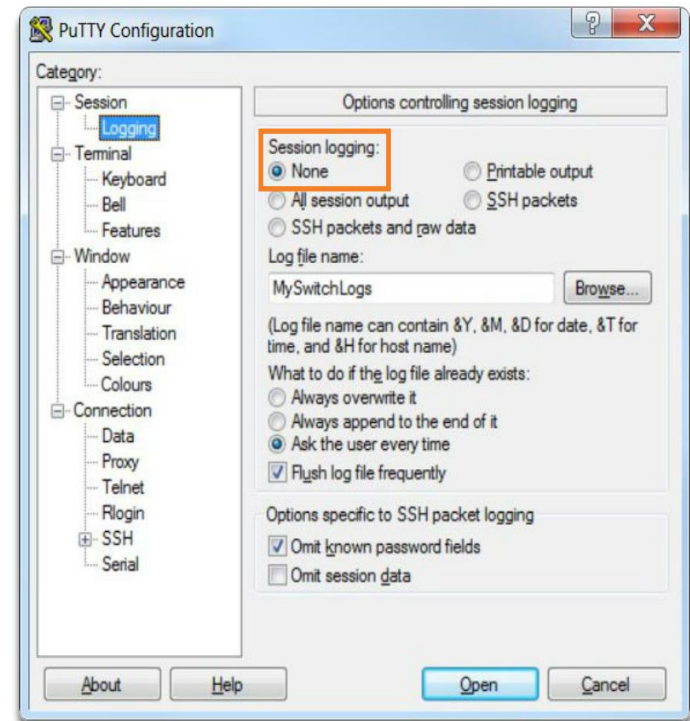


### Disabling Session Logging in PuTTY

Disable logging in the terminal software. Figure 3 shows how to disable logging by choosing the **None** session logging option.

To restore a configuration file to a device:

Enter global configuration mode on the device. Copy and paste the text file into the terminal window connected to the switch.





## 2.3 Address Schemes



Cisco | Networking Academy®  
Mind Wide Open™



## Address Schemes

# Ports and Addresses

### ■ IP Addresses

- Each end device on a network must be configured with an IP address.
- Enable devices to establish end-to-end communication on the Internet.
- The structure of an IPv4 address is called dotted decimal notation and is represented by four decimal numbers between 0 and 255. Example : **192.168.10.10**
- IPv4 is 32 bits or 4 octets (8 bits).
- IPv6 is the most recent version of IP and the replacement for the more common IPv4. IPv6 is 128 bits and uses hexadecimal values instead of decimal numbers.
- Example:  
`2001:0DB8:0000:1133:0000:0000:0000:0200`

|          |   |          |   |          |   |          |
|----------|---|----------|---|----------|---|----------|
| 192      | . | 168      | . | 10       | . | 10       |
| 11000000 |   | 10101000 |   | 00001010 |   | 00001010 |

192.168.10.10 is an IP address that is assigned to a computer.



## Address Schemes

# Ports and Addresses

### ■ Interface and Ports

- Network communications depend on interfaces and the cables that connect them.
- Different types of network media (e.g. twisted-pair copper cables, fiber-optic cables, coaxial cables, or wireless) have different features and benefits.
- **Ethernet** is the most common local area network (LAN) technology.
- Cisco IOS Layer 2 switches have physical ports for devices to connect. These ports do not support Layer 3 IP addresses. Therefore, switches 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.
- **SVI** provides a means to remotely manage a switch over a network.

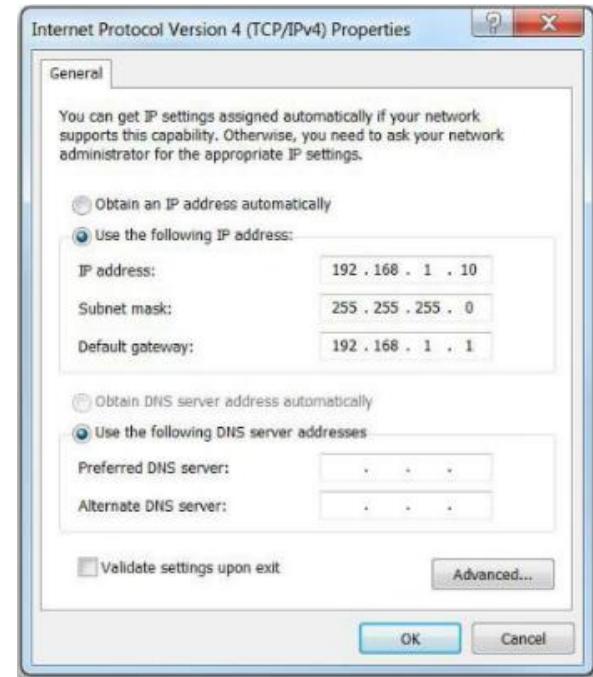




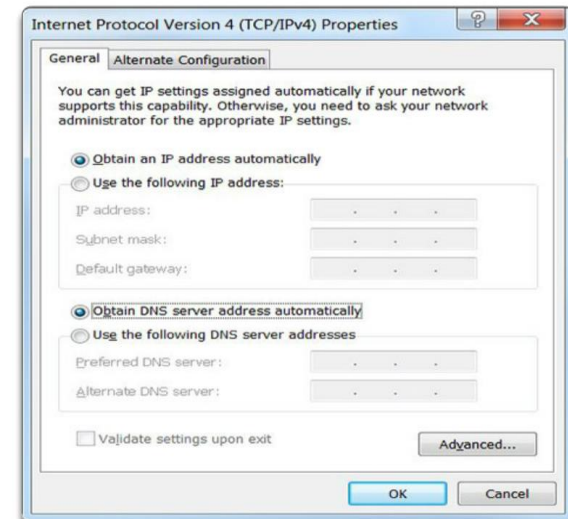
## Address Schemes

# Configure IP Addressing

- Manual IP Address Configuration for End Devices
  - To manually configure an IPv4 address on a Windows host, open the Control Panel > Network Sharing Center > Change adapter settings and choose the adapter.
  - Next right-click and select Properties to display the Local Area Connection Properties shown in Figure 1.
  
- Automatic IP Address Configuration for End Devices
  - DHCP enables automatic IPv4 address configuration for every end device that has DHCP enabled. No extra configuration is needed.
  
- Switch Virtual Interface Configuration
  - To configure an SVI on a switch, use the interface vlan 1 global configuration command. Vlan 1 is not an actual physical interface but a virtual one.



Assigning Dynamic Addresses





## Address Schemes

# Configure IP Addressing

### ■ Switch Virtual Interface Configuration

- To configure an SVI on a switch, use the interface vlan 1 global configuration command. Vlan 1 is not an actual physical interface but a virtual one.

**Router(config)# interface vlan 1**

**[Assign IP address and subnet mask]**

**Router(config-if)# ip address 192.168.1.10 255.255.255.0**

**[Activate interface]**

**Router(config-if)# no shutdown**



## Address Schemes

# Verifying Connectivity

### ■ Interface Addressing Verification

- Cisco IOS supports commands to allow IP configuration verification.

### ■ End-To-End Connectivity Test

- The ping command can be used to test connectivity to another device on the network or a website on the Internet.

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 |
|-------|--------------|-----|--------|----|----|

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:\>



## 2.4 Chapter Summary



Cisco | Networking Academy®  
Mind Wide Open™



## Chapter Summary

# Summary

- 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.



