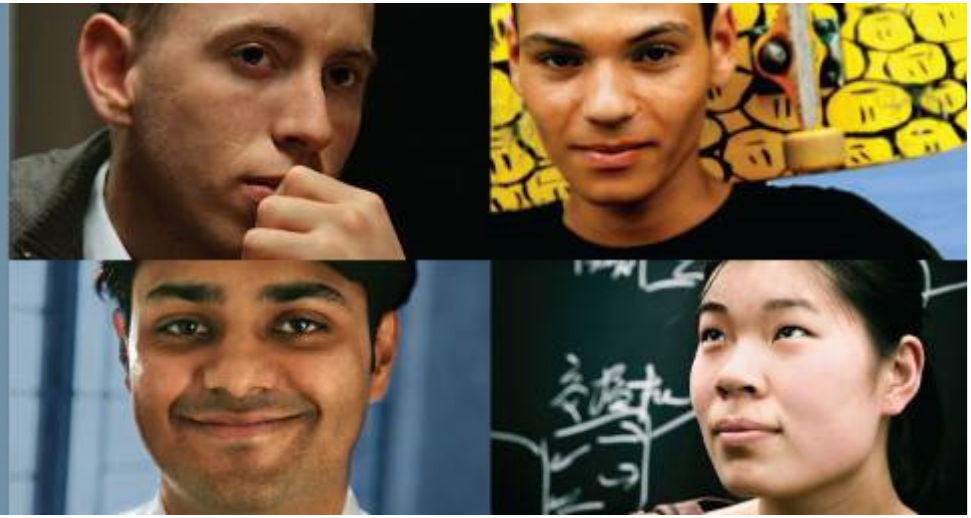
Chapter 5: Switch Configuration



Routing and Switching Essentials v6.0

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Chapter 5 - Sections & Objectives

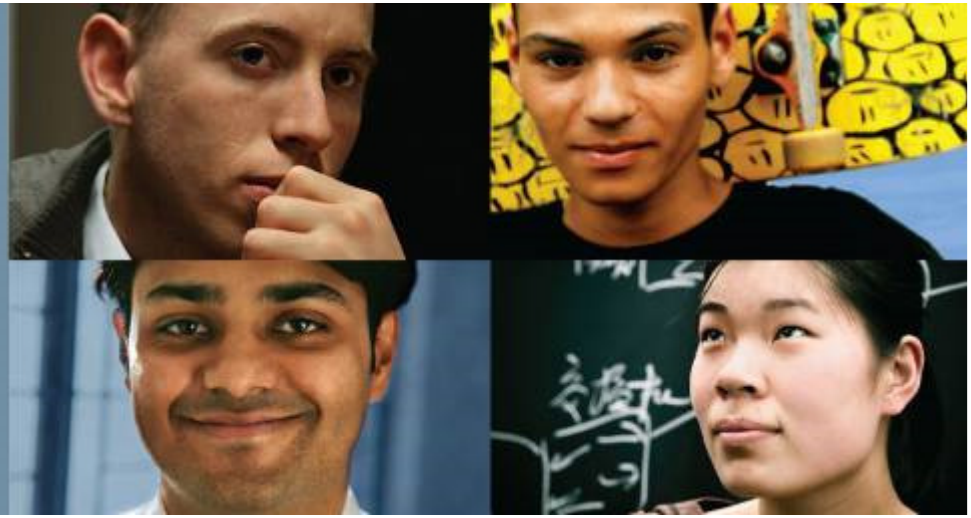
5.1 Basic Switch Configuration

- Configure initial settings on a Cisco switch.
- Configure switch ports to meet network requirements.

5.2 Switch Security: Management and Implementation

- Configure the management virtual interface on a switch.
- Configure the port security feature to restrict network access.

5.1 Basic Switch Configuration



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Switch Boot Sequence

1. Power-on self test (POST).
2. Run boot loader software.
3. Boot loader performs low-level CPU initialization.
4. Boot loader initializes the flash file system.
5. Boot loader locates and loads a default IOS operating system software image into memory and passes control of the switch over to the IOS.

Switch Boot Sequence (cont.)

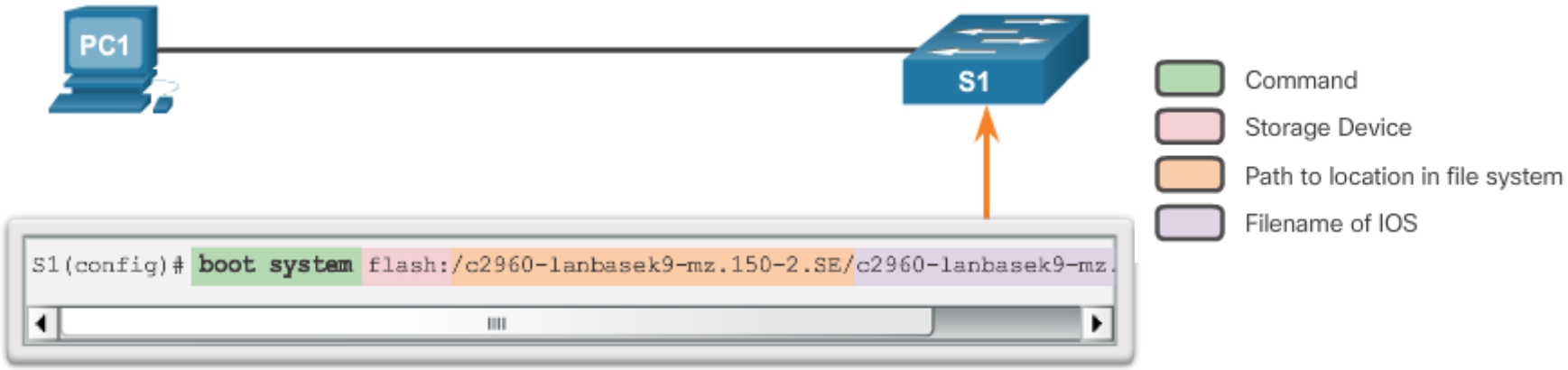
To find a suitable Cisco IOS image, the switch goes through the following steps:

Step 1. It attempts to automatically boot by using information in the BOOT environment variable.

Step 2. If this variable is not set, the switch performs a top-to-bottom search through the flash file system. It loads and executes the first executable file, if it can.

Step 3. The IOS software then initializes the interfaces using the Cisco IOS commands found in the configuration file and startup configuration, which is stored in NVRAM.

Note: The **boot system** command can be used to set the BOOT environment variable. Use the **show boot** command to see to what the current IOS boot file is set.

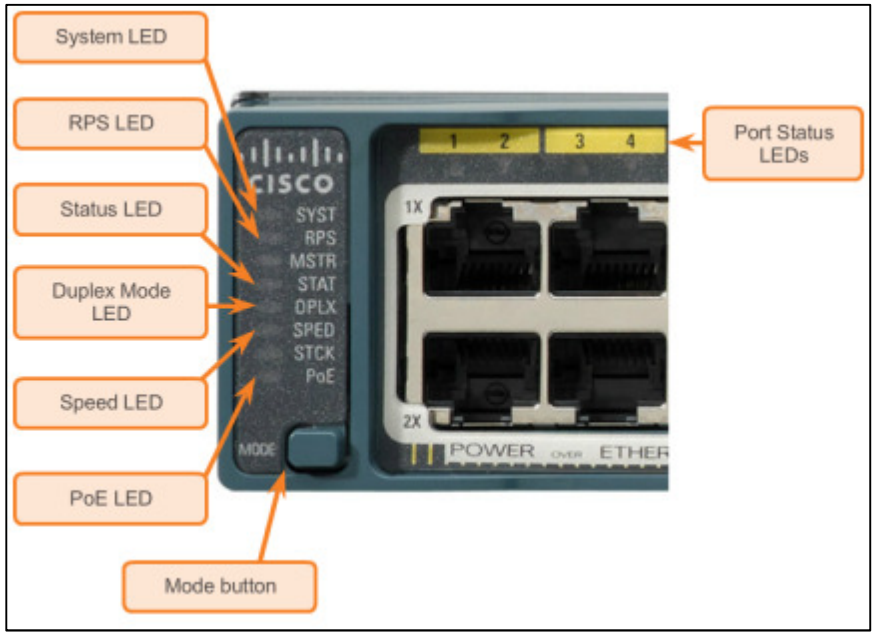


Recovering From a System Crash

- The boot loader can also be used to manage the switch if the IOS cannot be loaded.
- The boot loader can be accessed through a console connection by:
  1. Connecting a PC by console cable to the switch console port. Unplug the switch power cord.
  2. Reconnecting the power cord to the switch and press and hold the Mode button.
  3. The System LED turns briefly amber and then solid green. Release the Mode button.
- The boot loader **`switch:`** prompt appears in the terminal emulation software on the PC.

Switch LED Indicators

- Each port on Cisco Catalyst switches have status LED indicator lights.
- By default, these LED lights reflect port activity, but they can also provide other information about the switch through the Mode button.
- The following modes are available on Cisco Catalyst 2960 switches:
  - System LED
  - Redundant Power System (RPS) LED
  - Port Status LED
  - Port Duplex LED
  - Port Speed LED
  - Power over Ethernet (PoE) Mode LED



Preparing for Basic Switch Management

To remotely manage a Cisco switch, it must be configured to access the network.

- A console cable is used to connect a PC to the console port of a switch for configuration.
- The IP information (address, subnet mask, gateway) is to be assigned to a switch virtual interface (SVI).
- If managing the switch from a remote network, a default gateway must also be configured.
- Although these IP settings allow remote management and remote access to the switch, they do not allow the switch to route Layer 3 packets.

Configuring Switch Management Access

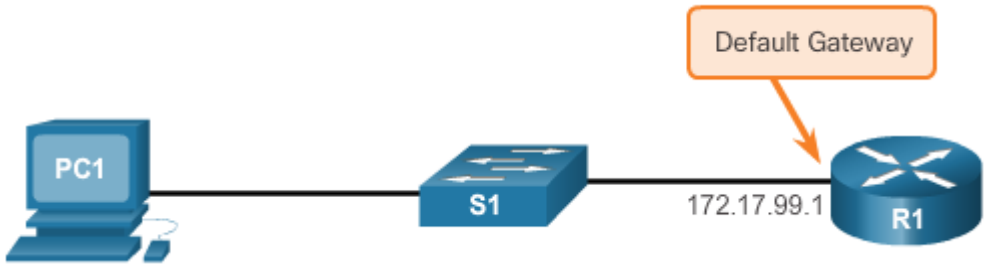
Configure Switch Management Interface

Cisco Switch IOS Commands	
Enter global configuration mode.	`S1# configure terminal`
Enter interface configuration mode for the SVI.	`S1(config)# interface vlan 99`
Configure the management interface IP address.	`S1(config-if)# ip address 172.17.99.11 255.255.255.0`
Enable the management interface.	`S1(config-if)# no shutdown`
Return to the privileged EXEC mode.	`S1(config-if)# end`
Save the running config to the startup config.	`S1# copy running-config startup-config`

Configuring Switch Management Access (cont.)

Configure Switch Default Gateway

Cisco Switch IOS Commands	
Enter global configuration mode.	`S1# configure terminal`
Configure the default gateway for the switch.	`S1(config)# ip default-gateway 172.17.99.1`
Return to the privileged EXEC mode.	`S1(config)# end`
Save the running config to the startup config.	`S1# copy running-config startup-config`



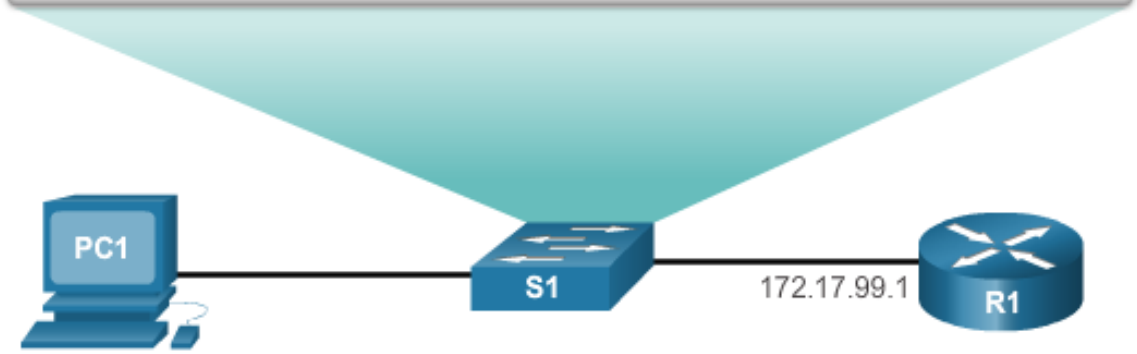
Configuring Switch Management Access (cont.)

Verify Switch Management Interface Configuration

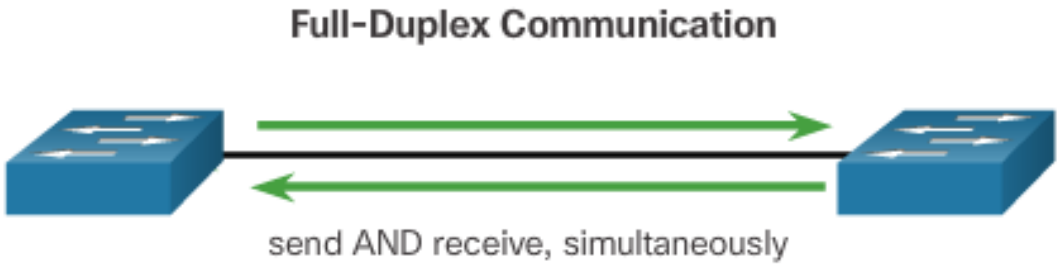
```
S1# show ip interface brief

Interface      IP-Address      OK? Method Status       Protocol
Vlan99         172.17.99.11    YES manual up           down

<output omitted>
```

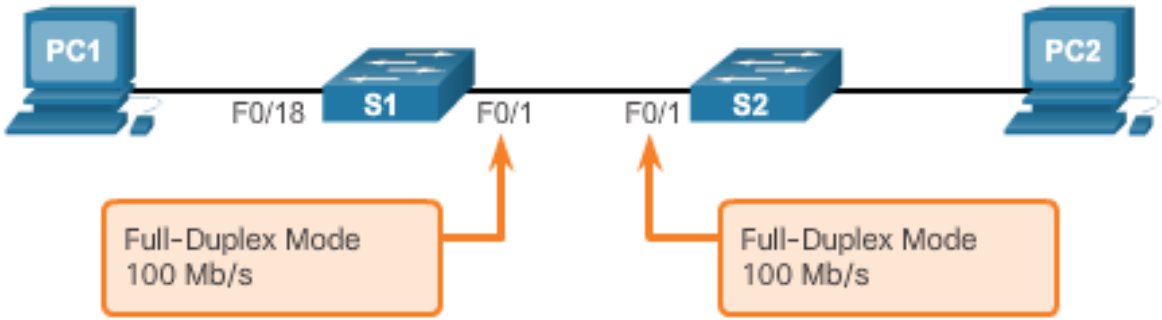


Duplex Communication



Configure Switch Ports at the Physical Layer

Configure Duplex and Speed



Cisco Switch IOS Commands	
Enter global configuration mode.	`S1# configure terminal`
Enter interface configuration mode.	`S1(config)# interface FastEthernet 0/1`
Configure the interface duplex.	`S1(config-if)# duplex full`
Configure the interface speed.	`S1(config-if)# speed 100`
Return to the privileged EXEC mode.	`S1(config-if)# end`
Save the running config to the startup config.	`S1# copy running-config startup-config`

Auto-MDIX

- Certain cable types (straight-through or crossover) were historically required when connecting devices.
- The automatic medium-dependent interface crossover (auto-MDIX) feature eliminates this problem.
- When auto-MDIX is enabled, the interface automatically detects and appropriately configures the connection.
- When using auto-MDIX on an interface, the interface speed and duplex must be set to auto.

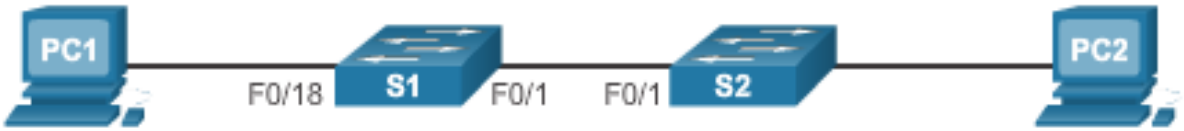
Auto-MDIX (cont.)

Configure auto-MDIX

Cisco Switch IOS Commands	
Enter global configuration mode.	`S1# configure terminal`
Enter interface configuration mode.	`S1(config)# interface fastethernet 0/1`
Configure the interface to autonegotiate duplex with the connected device.	`S1(config-if)# duplex auto`
Configure the interface to autonegotiate speed with the connected device.	`S1(config-if)# speed auto`
Enable auto-MDIX on the interface.	`S1(config-if)# mdix auto`
Return to the privileged EXEC mode.	`S1(config-if)# end`
Save the running config to the startup config.	`S1# copy running-config startup-config`

Auto-MDIX (cont.)

Verify auto-MDIX




```
S1# show controllers ethernet-controller fa 0/1 phy | include
Auto-MDIX
 Auto-MDIX      :  On    [AdminState=1    Flags=0x00056248]
S1#
```

Verifying Switch Port Configuration

Verification Commands

Cisco Switch IOS Commands	
Display interface status and configuration.	S1# **show interfaces** [*interface-id*]
Display current startup configuration.	S1# **show startup-config**
Display current operating config.	S1# **show running-config**
Display information about flash file system.	S1# **show flash**
Display system hardware and software status.	S1# **show version**
Display history of commands entered.	S1# **show history**
Display IP information about an interface.	S1# **show ip** [*interface-id*]
Display the MAC address table.	S1# **show mac-address-table** OR S1# **show mac address-table**

Network Access Layer Issue

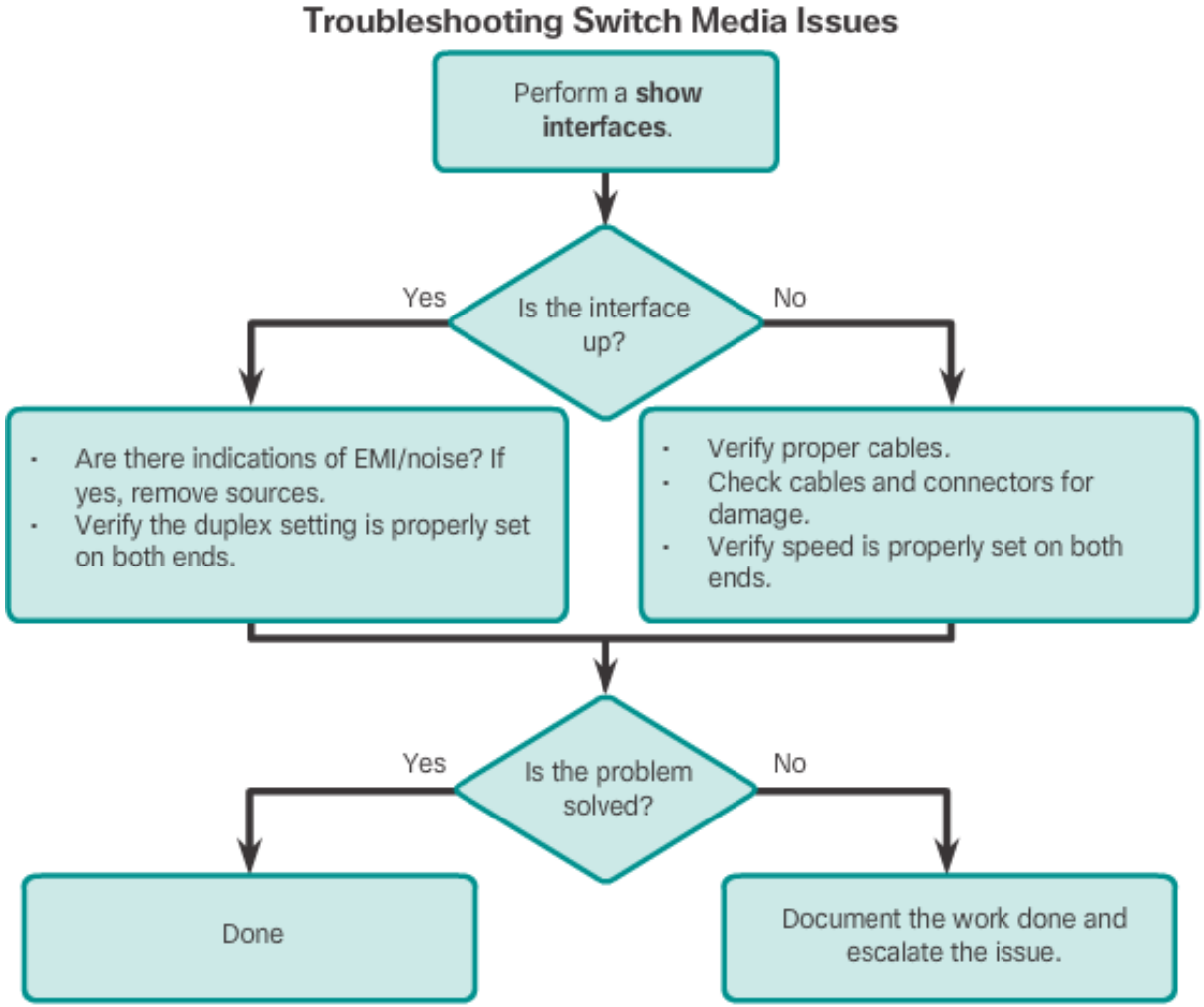
```
S1# show interfaces FastEthernet0/1
FastEthernet0/1 is up, line protocol is upHardware is Fast
Ethernet, address is 0022.91c4.0e01 (bia 0022.91c4.0e01)MTU
1500 bytes, BW 100000 Kbit, DLY 100 usec,
<output omitted>
  2295197 packets input, 305539992 bytes, 0 no buffer
  Received 1925500 broadcasts, 0 runts, 0 giants, 0
  throttles
  3 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored
  0 watchdog, 68 multicast, 0 pause input
  0 input packets with dribble condition detected
  3594664 packets output, 436549843 bytes, 0 underruns
  8 output errors, 1790 collisions, 10 interface resets
  0 unknown protocol drops
  0 babbles, 235 late collision, 0 deferred
<output omitted>
```

Network Access Layer Issue (cont.)

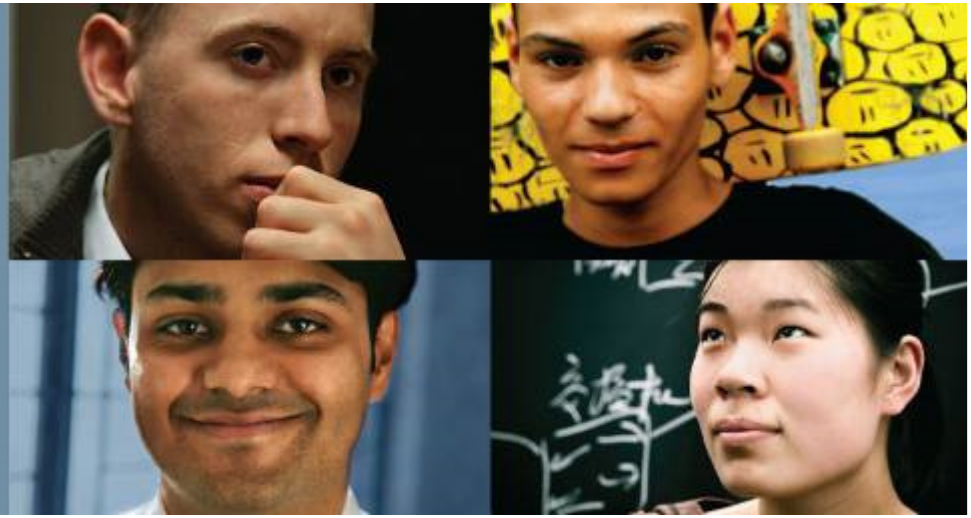
Network Access Layer Issues

Error Type	Description
Input Errors	Total number of errors. It includes runts, giants, no buffer, CRC, frame, overrun, and ignored counts.
Runts	Packets that are discarded because they are smaller than the minimum packet size for the medium. For instance, any Ethernet packet that is less than 64 bytes is considered a runt.
Giants	Packets that are discarded because they exceed the maximum packet size for the medium. For example, any Ethernet packet that is greater than 1,518 bytes is considered a giant.
CRC	CRC errors are generated when the calculated checksum is not the same as the checksum received.
Output Errors	Sum of all errors that prevented the final transmission of datagrams out of the interface that is being examined.
Collisions	Number of messages retransmitted because of an Ethernet collision.
Late Collisions	A collison that occurs after 512 bits of the frame have been transmitted.

Troubleshooting Network Access Layer Issues



5.2 Switch Security: Management and Implementation



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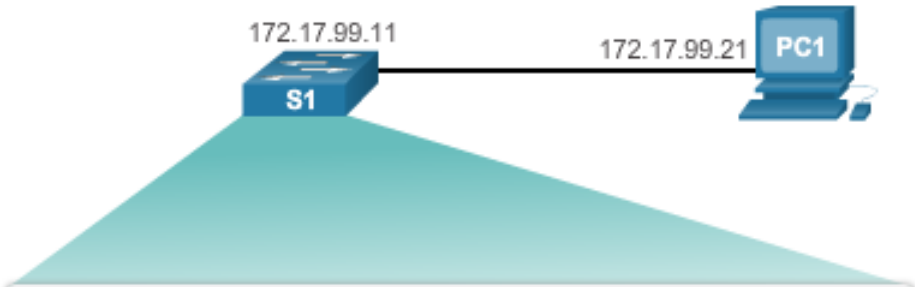
SSH Operation

- Secure Shell (SSH) is a protocol that provides a secure (encrypted), command-line based connection to a remote device.
- Because of strong encryption features, SSH should replace Telnet for management connections.
- SSH uses TCP port 22, by default.
- Telnet uses TCP port 23.
- A version of the IOS software, including cryptographic (encrypted) features and capabilities, is required to enable SSH on Catalyst 2960 switches.

Configuring SSH

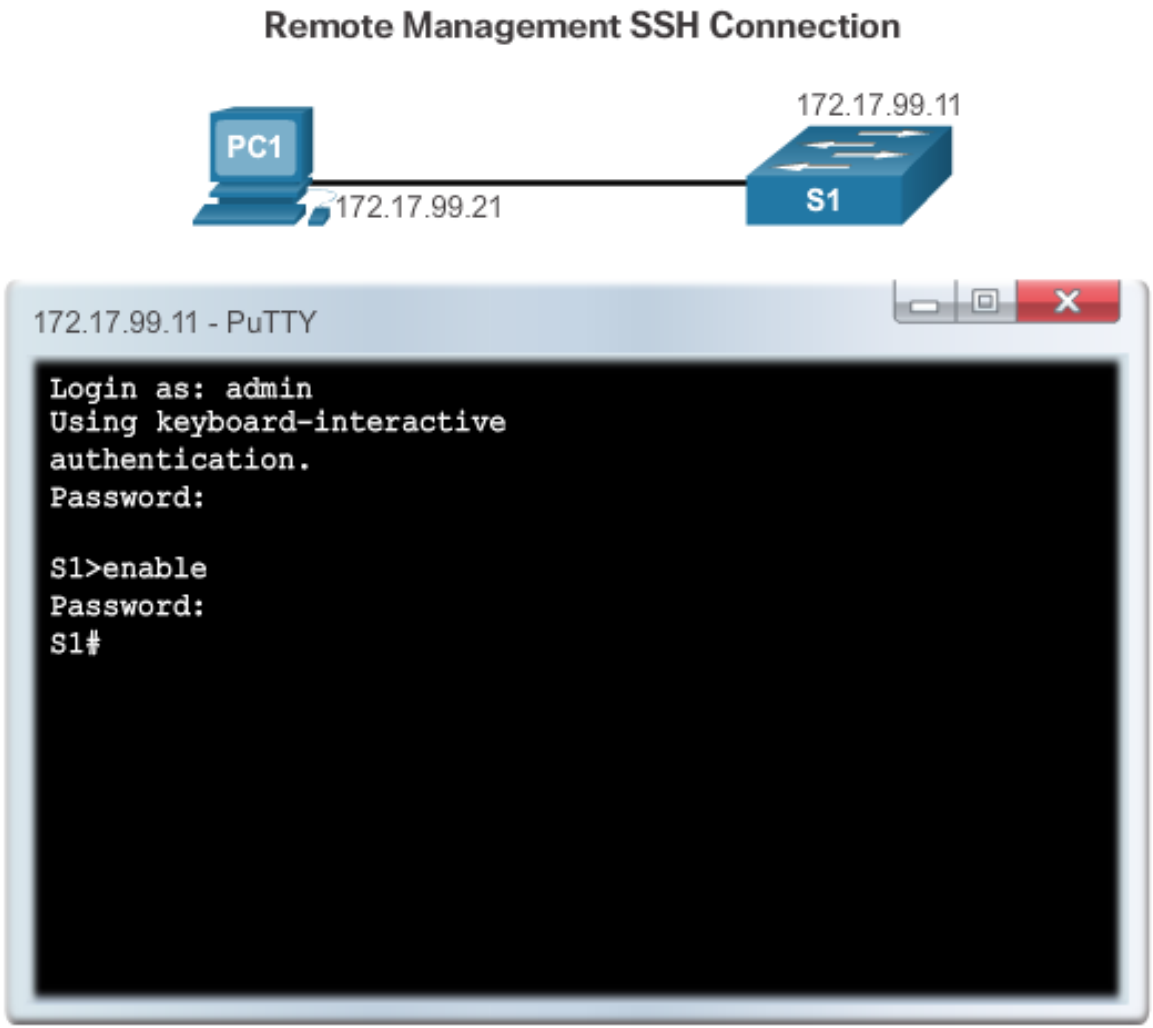
1. Verify SHH Support – `show ip ssh`
2. Configure the IP domain.
3. Generate RSA key pairs.
4. Configure user authentication.
5. Configure the vty lines.
6. Enable SSH version 2.

Configure SSH for Remote Management



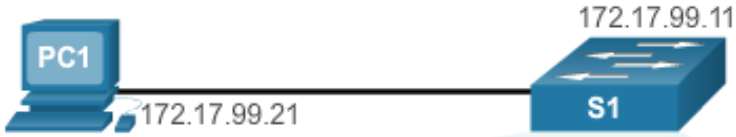

```
S1# configure terminal
S1(config)# ip domain-name cisco.com
S1(config)# crypto key generate rsa
The name for the keys will be: S1.cisco.com
...
How many bits in the modulus [512]: 1024
...
S1(config)# username admin secret ccna
S1(config-line)# line vty 0 15
S1(config-line)# transport input ssh
S1(config-line)# login local
S1(config-line)# exit
S1(config)# ip ssh version 2
S1(config)# exit
S1#
```

Verifying SSH



Verifying SSH (cont.)

Verify SSH Status and Settings



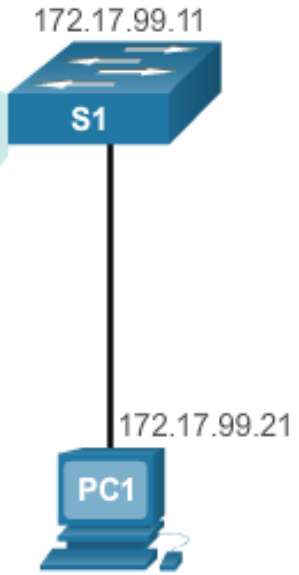

```
S1# show ip ssh
SSH Enabled - version 2.0
Authentication timeout: 90 secs; Authentication retries: 2
Minimum expected Diffie Hellman key size : 1024 bits
IOS Keys in SECSH format(ssh-rsa, base64 encoded):
ssh-rsa
AAAAB3NzaC1yc2EAAAADAQABAAAAgQCdLksVz2QlREsoZt2f2scJHbW3aMDM8
/8jg/srGFNL
i+f+qJWwxt26BWmy694+6ZIQ/j7wUfIVNlQhI8GUOVIuKNqVMOMtLg8Ud4qAiLbGJfAa
P3fyrKmViPpO
eOZof6tnKgKKvJz18Mz22XAf2u/7Jq2JnEFXycGMO88OUJQL3Q==

S1# show ssh
Connection Version Mode Encryption  Hmac       State         Username
0          2.0     IN   aes256-cbc  hmac-sha1 Session started admin
0          2.0     OUT  aes256-cbc  hmac-sha1 Session started admin
%No SSHv1 server connections running.
S1#
```

Secure Unused Ports

Disable Unused Ports

Disable unused ports using the **shutdown** command.

```
S1# show run
Building configuration...
…
version 15.0
hostname S1
…
interface FastEthernet0/4
 shutdown
!
interface FastEthernet0/5
 shutdown
!
interface FastEthernet0/6
description web server
!
interface FastEthernet0/7
 shutdown
!
…
```



Port Security: Operation

- The MAC addresses of legitimate devices are allowed access, while other MAC addresses are denied.
- Any additional attempts to connect by unknown MAC addresses generate a security violation.
- Secure MAC addresses can be configured in a number of ways:
  - Static secure MAC addresses – manually configured and added to running configuration - **switchport port-security mac-address** *mac-address*
  - Dynamic secure MAC addresses – removed when switch restarts
  - Sticky secure MAC addresses – added to running configuration and learned dynamically – **switchport port-security mac-address sticky** interface configuration mode command

Port Security: Violation Modes

- IOS considers a security violation when:
  - The maximum number of secure MAC addresses for that interface have been added to the CAM, and a station whose MAC address is not in the address table attempts to access the interface.
- There are three possible actions to take when a violation is detected:
  - Protect – no notification received
  - Restrict – notification received of security violation
  - Shutdown
  - **`switchport port-security violation {protect | restrict | shutdown}`** interface configuration mode command

Port Security: Violation Modes (cont.)

Security violation modes include: Protect, Restrict, and Shutdown.

Security Violation Modes

Violation Mode	Forwards Traffic	Sends Syslog Message	Displays Error Message	Increases Violation Counter	Shuts Down Port
Protect	No	No	No	No	No
Restrict	No	Yes	No	Yes	No
Shutdown	No	No	No	Yes	Yes

Port Security: Configuring

Port Security Defaults

Feature	Default Setting
Port security	Disabled on a port
Maximum number of secure MAC addresses	1
Violation mode	Shutdown. The port shuts down when the maximum number of secure MAC addresses is exceeded.
Sticky address learning	Disabled

Configure Dynamic Port Security

Cisco IOS CLI Commands	
Specify the interface to be configured for port security.	`S1(config)# interface fastethernet 0/18`
Set the interface mode to access.	`S1(config-if)# switchport mode access`
Enable port security on the interface.	`S1(config-if)# switchport port-security`

Configure Sticky Port Security

Cisco IOS CLI Commands	
Specify the interface to be configured for port security.	`S1(config)# interface fastethernet 0/19`
Set the interface mode to access.	`S1(config-if)# switchport mode access`
Enable port security on the interface.	`S1(config-if)# switchport port-security`
Set the maximum number of secure addresses allowed on the port.	`S1(config-if)# switchport port-security maximum 10`
Enable sticky learning.	`S1(config-if)# switchport port-security mac-address sticky`

Port Security: Verifying

Verify MAC Address - Dynamic

```
S1# show port-security interface fastethernet 0/18
Port Security              : Enabled
Port Status                : Secure-up
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 1
Total MAC Addresses        : 1
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 0
Last Source Address:Vlan   : 0025.83e6.4b01:1
Security Violation Count   : 0
```

Verify MAC Address - Sticky

```
S1# show port-security interface fastethernet 0/19
Port Security              : Enabled
Port Status                : Secure-up
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 10
Total MAC Addresses        : 1
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 1
Last Source Address:Vlan   : 0025.83e6.4b02:1
Security Violation Count   : 0
```

Port Security: Verifying (cont.)

Verify Sticky MAC – Running Config

```
S1# show run | begin FastEthernet 0/19
interface FastEthernet0/19
 switchport mode access
 switchport port-security maximum 10
 switchport port-security
 switchport port-security mac-address sticky
 switchport port-security mac-address sticky 0025.83e6.4b02
```

Verify Secure MAC Addresses

```
S1# show port-security address
Secure Mac Address Table
------------------------------------------------------------
Vlan    Mac Address       Type             Ports    Remaining Age
                                                     (mins)
----    -----------       ----             -----    -------------
1       0025.83e6.4b01    SecureDynamic    Fa0/18       -
1       0025.83e6.4b02    SecureSticky     Fa0/19       -
------------------------------------------------------------
```

Ports in Error Disabled State

- A port security violation can put a switch in error disabled state.
- A port in error disabled is effectively shutdown.
- The switch communicates these events through console messages.

```
Sep 20 06:44:54.966: %PM-4-ERR_DISABLE: psecure-violation
error detected on Fa0/18, putting Fa0/18 in err-disable state
Sep 20 06:44:54.966: %PORT_SECURITY-2-PSECURE_VIOLATION:
Security violation occurred, caused by MAC address
000c.292b.4c75 on port FastEthernet0/18.
Sep 20 06:44:55.973: %LINEPROTO-5-PPDOWN: Line protocol on
Interface
FastEthernet0/18, changed state to down
Sep 20 06:44:56.971: %LINK-3-UPDOWN: Interface
FastEthernet0/18, changed state to down
```

Ports in Error Disabled State (cont.)

Port Status

```
S1# show interface fa0/18 status
Port Name  Status        Vlan  Duplex  Speed   Type
Fa0/18     err-disabled  1     auto    auto    10/100BaseTX

S1# show port-security interface fastethernet 0/18
Port Security              : Enabled
Port Status                : Secure-shutdown
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 1
Total MAC Addresses        : 0
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 0
Last Source Address:Vlan   : 000c.292b.4c75:1
Security Violation Count   : 1
```

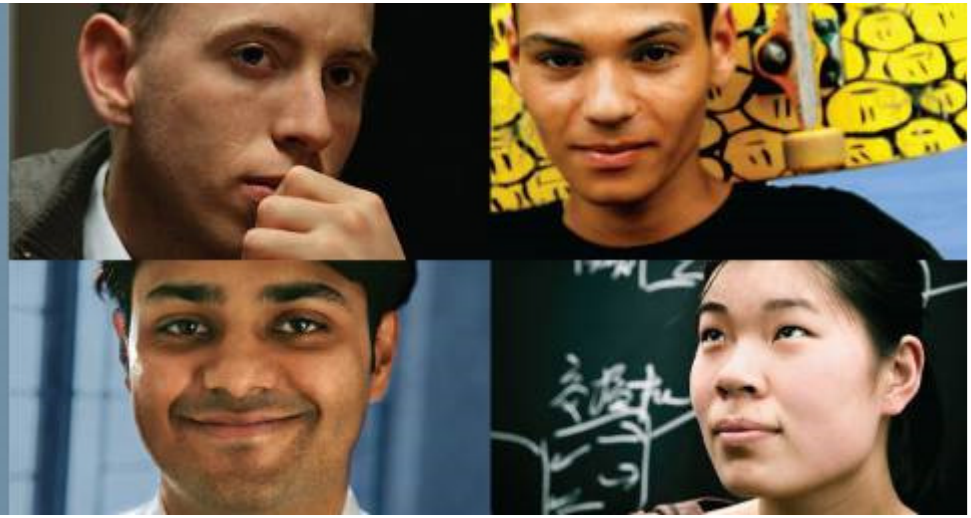
The **show interface** command also reveals a switch port on error disabled state.

A **shutdown** or **no shutdown** interface configuration mode command must be issued to re-enable the port.

Re-Enabling an Error Disabled Port

```
S1(config)# interface FastEthernet 0/18
S1(config-if)# shutdown
Sep 20 06:57:28.532: %LINK-5-CHANGED: Interface
FastEthernet0/18, changed state to administratively down
S1(config-if)# no shutdown
Sep 20 06:57:48.186: %LINK-3-UPDOWN: Interface
FastEthernet0/18, changed state to up
Sep 20 06:57:49.193: %LINEPROTO-5-UPDOWN: Line protocol on
Interface
FastEthernet0/18, changed state to up
```

5.3 Chapter Summary



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Chapter Summary

Summary

- Cisco LAN switch boot sequence.
- Cisco LAN switch LED modes.
- How to remotely access and manage a Cisco LAN switch through a secure connection.
- Cisco LAN switch port duplex modes.
- Cisco LAN switch port security, violation modes, and actions.
- Best practices for switched networks.

Summary

- When a Cisco LAN switch is first powered on it goes through the following boot sequence:
  1. First, the switch loads a power-on self-test (POST) program stored in ROM. POST checks the CPU subsystem. It tests the CPU, DRAM, and the portion of the flash device that makes up the flash file system.
  2. Next, the switch loads the boot loader software. The boot loader is a small program stored in ROM and is run immediately after POST successfully completes.
  3. The boot loader performs low-level CPU initialization. It initializes the CPU registers, which control where physical memory is mapped, the quantity of memory, and its speed.
  4. The boot loader initializes the flash file system on the system board.
  5. Finally, the boot loader locates and loads a default IOS operating system software image into memory and gives control of the switch over to the IOS.
- If the Cisco IOS files are missing or damaged, the boot loader program can be used to reload or recover from the problem.
- The operational status of the switch is displayed by a series of LEDs on the front panel. These LEDs display such things as port status, duplex, and speed.

Summary

- An IP address is configured on the SVI of the management VLAN to allow for remote configuration of the device. A default gateway belonging to the management VLAN must be configured on the switch using the **ip default-gateway** command. If the default gateway is not properly configured, remote management is not possible.
- It is recommended that Secure Shell (SSH) be used to provide a secure (encrypted) management connection to a remote device to prevent the sniffing of unencrypted user names and passwords, which is possible when using protocols such as Telnet.
- One of the advantages of a switch is that it allows full-duplex communication between devices, effectively doubling the communication rate. Although it is possible to specify the speed and duplex settings of a switch interface, it is recommended that the switch be allowed to set these parameters automatically to avoid errors.
- Port security is only one defense against network compromise.