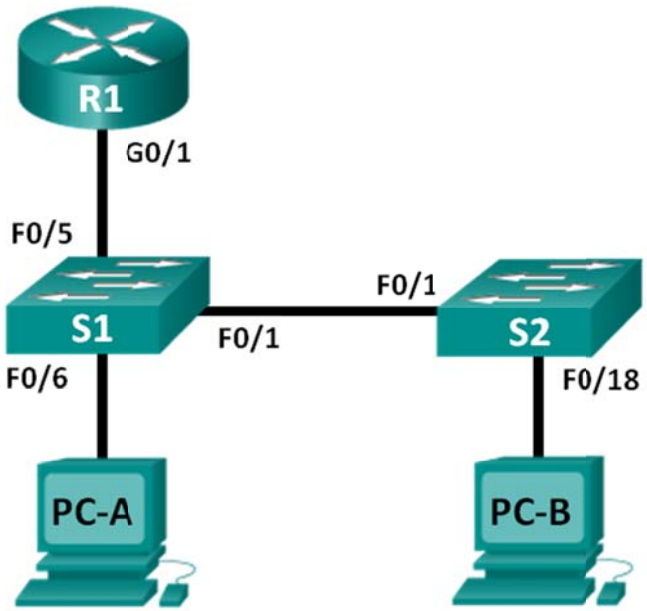
Lab - Using IOS CLI with Switch MAC Address Tables (Instructor Version)

Instructor Note: Red font color or Gray highlights indicate text that appears in the instructor copy only.

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/1	192.168.1.1	255.255.255.0	N/A
S1	VLAN 1	192.168.1.11	255.255.255.0	192.168.1.1
S2	VLAN 1	192.168.1.12	255.255.255.0	192.168.1.1
PC-A	NIC	192.168.1.3	255.255.255.0	192.168.1.1
PC-B	NIC	192.168.1.2	255.255.255.0	192.168.1.1

Objectives

Part 1: Build and Configure the Network

- Cable the network according to the topology diagram.
- Configure the network devices according to the Addressing Table.

Part 2: Examine the Switch MAC Address Table

- Use **show** commands to observe the process of building the switch MAC address table.

Background / Scenario

The purpose of a Layer 2 LAN switch is to deliver Ethernet frames to host devices on the local network. The switch records host MAC addresses that are visible on the network, and maps those MAC addresses to its own Ethernet switch ports. This process is called building the MAC address table. When a switch receives a frame from a PC, it examines the frame's source and destination MAC addresses. The source MAC address is recorded and mapped to the switch port from which it arrived. Then the destination MAC address is looked up in the MAC address table. If the destination MAC address is a known address, then the frame is forwarded out of the corresponding switch port of the MAC address. If the MAC address is unknown, then the frame is broadcast out of all switch ports, except the one from which it came. It is important to observe and understand the function of a switch and how it delivers data on the network. The way a switch operates has implications for network administrators whose job it is to ensure secure and consistent network communication.

Switches are used to interconnect and deliver information to computers on local area networks. Switches deliver Ethernet frames to host devices identified by network interface card MAC addresses.

In Part 1, you will build a multi-switch and router topology with a trunk linking the two switches. In Part 2, you will ping various devices and observe how the two switches build their MAC address tables.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other routers, switches and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Make sure that the routers and switches have been erased and have no startup configurations. If you are unsure contact your instructor.

Instructor Note: Refer to the Instructor Lab Manual for the procedures to initialize and reload devices.

Instructor Note: The Wireshark program will need to be downloaded and installed on PC-B prior to the start of the lab. Wireshark can be downloaded from http://www.wireshark.org/.

Required Resources

- 1 Router (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet cables as shown in the topology

Note: The Fast Ethernet interfaces on Cisco 2960 switches are autosensing and an Ethernet straight-through cable may be used between switches S1 and S2. If using another model Cisco switch, it may be necessary to use an Ethernet crossover cable.

Part 1: Build and Configure the Network

Step 1: Cable the network according to the topology.

Step 2: Configure PC hosts.

Step 3: Initialize and reload the routers and switches as necessary.

Step 4: Configure basic settings for each switch.

a. Configure device name as shown in the topology.

b. Configure IP address and default gateway as listed in Addressing Table.

c. Assign **cisco** as the console and vty passwords.

d. Assign **class** as the privileged EXEC password.

Step 5: Configure basic settings for the router.

a. Disable DNS lookup.

b. Configure IP address for the router as listed in Addressing Table.

c. Configure device name as shown in the topology.

d. Assign **cisco** as the console and vty passwords.

e. Assign **class** as the privileged EXEC password.

Part 2: Examine the Switch MAC Address Table

A switch learns MAC addresses and builds the MAC address table, as network devices initiate communication on the network.

Step 1: Record network device MAC addresses.

a. Open a command prompt on PC-A and PC-B and type **ipconfig /all**. What are the Ethernet adapter physical addresses?

PC-A MAC Address: _____

PC-B MAC Address: _____

Answers will vary.

b. Console into router R1 and type the **show interface G0/1** command. What is the hardware address?

R1 Gigabit Ethernet 0/1 MAC Address: _____

Answers will vary but from the example output below, the G0/1 MAC address is 30f7.0da3.17c1.

```
R1# show interface G0/1
GigabitEthernet0/1 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is 30f7.0da3.17c1 (bia 30f7.0da3.17c1)
  Internet address is 192.168.1.1/24
<output omitted>
R1#
```

c. Console into switch S1 and S2 and type the **show interface F0/1** command on each switch. On the second line of command output, what is the hardware addresses (or burned-in address [bia])?

S1 Fast Ethernet 0/1 MAC Address: _____

S2 Fast Ethernet 0/1 MAC Address: _____

Answers will vary but from the example output below the S1 F0/1 MAC address is 0cd9.96d2.3d81 and the S1 F0/1 MAC address is 0cd9.96d2.4581.

```
S1# show interface f0/1
FastEthernet0/1 is up, line protocol is up (connected)
 Hardware is Fast Ethernet, address is 0cd9.96d2.3d81 (bia 0cd9.96d2.3d81)
 MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
<output omitted>
S1#

S2# show interface f0/1
FastEthernet0/1 is up, line protocol is up (connected)
 Hardware is Fast Ethernet, address is 0cd9.96d2.4581 (bia 0cd9.96d2.4581)
 MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
<output omitted>
S2#
```

Step 2: Display the switch MAC address table.

Console into switch S2 and view the MAC address table, both before and after running network communication tests with ping.

a. Establish a console connection to S2 and enter privileged EXEC mode.

b. In privileged EXEC mode, type the **show mac address-table** command and press Enter.

S2# **show mac address-table**

Even though there has been no network communication initiated across the network (i.e., no use of ping), it is possible that the switch has learned MAC addresses from its connection to the PC and the other switch.

Are there any MAC addresses recorded in the MAC address table?

_____

The switch may have one or more MAC addresses in its table, based on whether or not the students entered a ping command when configuring the network. The switch will most likely have learned MAC addresses through S1's F0/1 switch port. The switch will record multiple MAC addresses of hosts learned through the connection to the other switch on F0/1.

```
S2# show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 All    0100.0ccc.cccc    STATIC      CPU
 All    0100.0ccc.cccd    STATIC      CPU
 All    0180.c200.0000    STATIC      CPU
 All    0180.c200.0001    STATIC      CPU
 All    0180.c200.0002    STATIC      CPU
 All    0180.c200.0003    STATIC      CPU
 All    0180.c200.0004    STATIC      CPU
```

```
 All    0180.c200.0005    STATIC      CPU
 All    0180.c200.0006    STATIC      CPU
 All    0180.c200.0007    STATIC      CPU
 All    0180.c200.0008    STATIC      CPU
 All    0180.c200.0009    STATIC      CPU
 All    0180.c200.000a    STATIC      CPU
 All    0180.c200.000b    STATIC      CPU
 All    0180.c200.000c    STATIC      CPU
 All    0180.c200.000d    STATIC      CPU
 All    0180.c200.000e    STATIC      CPU
 All    0180.c200.000f    STATIC      CPU
 All    0180.c200.0010    STATIC      CPU
 All    ffff.ffff.ffff    STATIC      CPU
   1    0cd9.96d2.3d81    DYNAMIC     Fa0/1
   1    1cc1.de91.c35d    DYNAMIC     Fa0/1
Total Mac Addresses for this criterion: 22
S2#
```

What MAC addresses are recorded in the table? To which switch ports are they mapped and to which devices do they belong? Ignore MAC addresses that are mapped to the CPU.

_____

_____

_____

There may be multiple MAC addresses recorded in the MAC address table, especially MAC addresses learned through S1's F0/1 switch port. In the example output above, the S1 F0/1 MAC address and PC-A MAC address are mapped to S2 F0/1.

If you had not previously recorded MAC addresses of network devices in Step 1, how could you tell which devices the MAC addresses belong to, using only the output from the **show mac address-table** command? Does it work in all scenarios?

_____

_____

_____

_____

The output of the **show mac address-table** command shows the port that the MAC address was learned on. In most cases this would identify which network device the MAC address belongs to, except in the case of multiple MAC addresses associated to the same port. This happens when switches are connected to other switches and record all of the MAC addresses for devices connected to the other switch.

Step 3: Clear the S2 MAC address table and display the MAC address table again.

a. In privileged EXEC mode, type the **clear mac address-table dynamic** command and press Enter.

```
S2# clear mac address-table dynamic
```

b. Quickly type the **show mac address-table** command again. Does the MAC address table have any addresses in it for VLAN 1? Are there other MAC addresses listed?

_____

No. The student will most likely discover that the MAC address for the other switch's F0/1 switch port has been quickly reinserted in the MAC address table.

```
S2# show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 All    0100.0ccc.cccc    STATIC      CPU
 All    0100.0ccc.cccd    STATIC      CPU
 All    0180.c200.0000    STATIC      CPU
 All    0180.c200.0001    STATIC      CPU
 All    0180.c200.0002    STATIC      CPU
 All    0180.c200.0003    STATIC      CPU
 All    0180.c200.0004    STATIC      CPU
 All    0180.c200.0005    STATIC      CPU
 All    0180.c200.0006    STATIC      CPU
 All    0180.c200.0007    STATIC      CPU
 All    0180.c200.0008    STATIC      CPU
 All    0180.c200.0009    STATIC      CPU
 All    0180.c200.000a    STATIC      CPU
 All    0180.c200.000b    STATIC      CPU
 All    0180.c200.000c    STATIC      CPU
 All    0180.c200.000d    STATIC      CPU
 All    0180.c200.000e    STATIC      CPU
 All    0180.c200.000f    STATIC      CPU
 All    0180.c200.0010    STATIC      CPU
 All    ffff.ffff.ffff    STATIC      CPU
   1    0cd9.96d2.3d81    DYNAMIC     Fa0/1
Total Mac Addresses for this criterion: 21
S2#
```

Wait 10 seconds, type the **show mac address-table** command, and press Enter. Are there new addresses in the MAC address table? _____ Answers will vary. There may be.

Step 4: From PC-B, ping the devices on the network and observe the switch MAC address table.

a. From PC-B, open a command prompt and type **arp -a**. Not including multicast or broadcast addresses, how many device IP-to-MAC address pairs have been learned by ARP?

_____

Answers will vary. The ARP cache may have no entries in it, or it may have the gateway IP address to MAC address mapping.

```
C:\Users\PC-B> arp -a
Interface: 192.168.1.2 --- 0xb
  Internet Address      Physical Address      Type
  192.168.1.1           30-f7-0d-a3-17-c1     dynamic
C:\Users\PC-B>
```

b. From the PC-B command prompt, ping the router/gateway R1, PC-A, S1, and S2. Did all devices have successful replies? If not, check your cabling and IP configurations.

_____

_____

If the network was cabled and configured correctly the answer should be yes.

c. From a console connection to S2, enter the **show mac address-table** command. Has the switch added additional MAC addresses to the MAC address table? If so, which addresses and devices?

_____

_____

There may only be one additional MAC address mapping added to the table, most likely the MAC address of PC-A.

```
S2# show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 All    0100.0ccc.cccc    STATIC      CPU
 All    0100.0ccc.cccd    STATIC      CPU
 All    0180.c200.0000    STATIC      CPU
 All    0180.c200.0001    STATIC      CPU
 All    0180.c200.0002    STATIC      CPU
 All    0180.c200.0003    STATIC      CPU
 All    0180.c200.0004    STATIC      CPU
 All    0180.c200.0005    STATIC      CPU
 All    0180.c200.0006    STATIC      CPU
 All    0180.c200.0007    STATIC      CPU
 All    0180.c200.0008    STATIC      CPU
 All    0180.c200.0009    STATIC      CPU
 All    0180.c200.000a    STATIC      CPU
 All    0180.c200.000b    STATIC      CPU
 All    0180.c200.000c    STATIC      CPU
 All    0180.c200.000d    STATIC      CPU
 All    0180.c200.000e    STATIC      CPU
 All    0180.c200.000f    STATIC      CPU
 All    0180.c200.0010    STATIC      CPU
 All    ffff.ffff.ffff    STATIC      CPU
   1    0021.700c.050c    DYNAMIC     Fa0/18
   1    0cd9.96d2.3d81    DYNAMIC     Fa0/1
   1    0cd9.96d2.3dc0    DYNAMIC     Fa0/1
   1    1cc1.de91.c35d    DYNAMIC     Fa0/1
   1    30f7.0da3.17c1    DYNAMIC     Fa0/1
Total Mac Addresses for this criterion: 25
S2#
```

From PC-B, open a command prompt and retype **arp -a**. Does the PC-B ARP cache have additional entries for all network devices that were sent pings?

Answers may vary, but the ARP cache on PC-B should have more entries.

```
C:\Users\PC-B> arp -a
Interface: 192.168.1.2 --- 0xb
  Internet Address      Physical Address      Type
  192.168.1.1           30-f7-0d-a3-17-c1     dynamic
  192.168.1.3           1c-c1-de-91-c3-5d     dynamic
  192.168.1.11          0c-d9-96-d2-3d-c0     dynamic
  192.168.1.12          0c-d9-96-d2-45-c0     dynamic
C:\Users\PC-B>
```

Reflection

On Ethernet networks, data is delivered to devices by their MAC addresses. For this to happen, switches and PCs dynamically build ARP caches and MAC address tables. With only a few computers on the network this process seems fairly easy. What might be some of the challenges on larger networks?

ARP broadcasts could cause broadcast storms. Because ARP and switch MAC tables do not authenticate or validate the IP addresses to MAC addresses it would be easy to spoof a device on the network.

Router Interface Summary Table

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
1800	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
1900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2801	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)
2811	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)

Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.

Device Configs

Router R1

```
R1#show running-config
Building configuration...
```

```
Current configuration : 1128 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
!
no aaa new-model
!
no ipv6 cef
!
!
!
!
!
ip cef
multilink bundle-name authenticated
!
!
!
!
!
!
!
!
!
!
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
```

```
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 no ip address
 shutdown
 clock rate 2000000
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Switch S1

```
S1#show running-config
Building configuration...

Current configuration : 1355 bytes
!
version 12.2
no service pad
```

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S1
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
!
!
no aaa new-model
system mtu routing 1500
!
!
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
!
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
```

```
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface GigabitEthernet0/1
!
interface GigabitEthernet0/2
!
interface Vlan1
 ip address 192.168.1.11 255.255.255.0
!
ip default-gateway 192.168.1.1
ip http server
ip http secure-server
!
line con 0
line vty 0 4
 password cisco
 login
line vty 5 15
 login
!
end
```

Switch S2

```
S2#show running-config
Building configuration...

Current configuration : 1355 bytes
!
version 12.2
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S2
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
!
!
no aaa new-model
system mtu routing 1500
!
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
!
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
```

```
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface GigabitEthernet0/1
!
interface GigabitEthernet0/2
!
interface Vlan1
 ip address 192.168.1.12 255.255.255.0
!
ip default-gateway 192.168.1.1
ip http server
ip http secure-server
!
line con 0
line vty 0 4
```

```
 password cisco
 login
line vty 5 15
 login
!
end
```