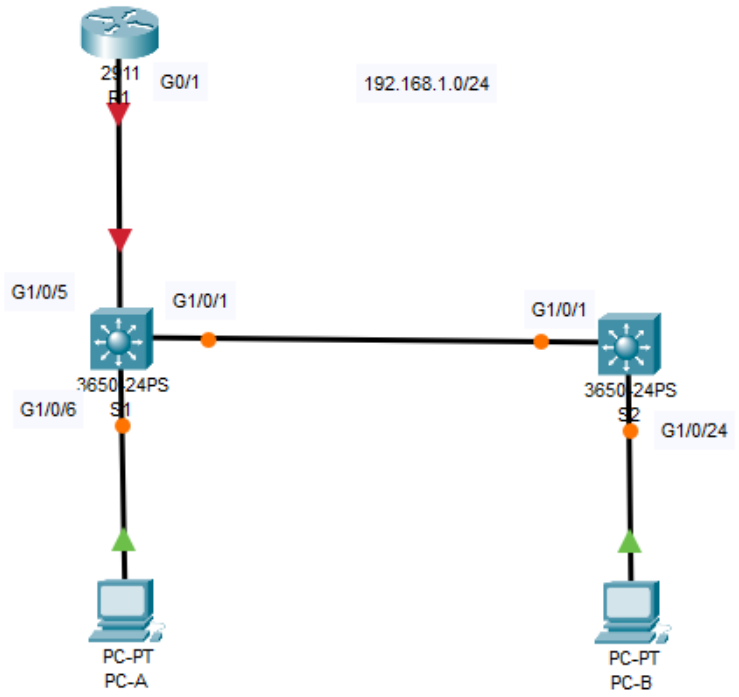
CCNA Security

Lab – PT Securing Layer 2 Switches

Topology



Note due to the IOS limitations of 2960 switch we are using the 3650 switch as a layer 2 Switch

IP Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway	Switch Port
R1	G0/1	192.168.1.1	255.255.255.0	N/A	S1 G1/0/5
S1	VLAN 1	192.168.1.2	255.255.255.0	N/A	N/A
S2	VLAN 1	192.168.1.3	255.255.255.0	N/A	N/A
PC-A	NIC	192.168.1.10	255.255.255.0	192.168.1.1	S1 G1/0/6
PC-B	NIC	192.168.1.11	255.255.255.0	192.168.1.1	S2 G1/0/24

Objectives

Part 1: Configure Basic Switch Settings

- Build the topology.
- Configure the hostname, IP address, and access passwords.

Part 2: Configure SSH Access to the Switches

- Configure SSH version 2 access on the switch.

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- Configure an SSH client to access the switch.
- Verify the configuration.

Part 3: Configure Secure Trunks and Access Ports

- Configure trunk port mode.
- Change the native VLAN for trunk ports.
- Verify trunk configuration.
- Configure access ports.
- Enable PortFast and BPDU guard.
- Verify BPDU guard.
- Enable root guard.
- Configure and verify port security.
- Disable unused ports.
- Move ports from default VLAN 1 to alternate VLAN.
- Configure the PVLAN Edge feature on a port.

Part 4: Configure IP DHCP Snooping

- Configure DHCP on R1.
- Configure Inter-VLAN communication on R1.
- Configure S1 interface F0/5 as a trunk.
- Verify DHCP operation on PC- A and B.
- Enable DHCP Snooping.
- Verify DHCP Snooping.

Background / Scenario

The Layer 2 infrastructure consists mainly of interconnected Ethernet switches. Most end-user devices, such as computers, printers, IP phones, and other hosts, connect to the network via Layer 2 access switches. As a result, switches can present a network security risk. Similar to routers, switches are subject to attack from malicious internal users. The switch Cisco IOS software provides many security features that are specific to switch functions and protocols.

In this lab, you will configure SSH access and Layer 2 security for S1 and S2. You will also configure various switch protection measures, including access port security and Spanning Tree Protocol (STP) features, such as BPDU guard and root guard.

Note: Make sure that the routers and switches have been erased and have no startup configurations.

Part 1: Configure Basic Switch Settings

In Part 1, you will set up the network topology and configure basic settings, such as the hostnames, IP addresses, and device access passwords.

Step 1: Cable the network as shown in the topology.

Attach the devices, as shown in the topology diagram, and cable as necessary.

Step 2: Configure basic settings for the router and each switch.

Perform all tasks on R1, S1, and S2. The procedure for S1 is shown here as an example.

a. Configure hostnames, as shown in the topology.

b. Configure interface IP addresses, as shown in the IP Addressing Table. The following configuration displays the VLAN 1 management interface on S1:

```
S1(config)# interface vlan 1
S1(config-if)# ip address 192.168.1.2 255.255.255.0
```

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```
S1(config-if)# no shutdown
```

c. Prevent the router or switch from attempting to translate incorrectly entered commands by disabling DNS lookup. S1 is shown here as an example.

```
S1(config)# no ip domain-lookup
```

d. Configure the enable secret password.

```
S1(config)# enable algorithm-type scrypt secret cisco12345
```

e. Configure console password.

```
S1(config)# line console 0
S1(config-line)# password ciscoconpass
S1(config-line)# exec-timeout 5 0
S1(config-line)# login
S1(config-line)# logging synchronous
```

Step 3: Configure PC host IP settings.

Configure a static IP address, subnet mask, and default gateway for PC-A and PC-B, as shown in the IP Addressing Table.

Step 4: Verify basic network connectivity.

a. Ping from PC-A and PC-B to the R1 F0/1 interface at IP address **192.168.1.1**.

If the pings are unsuccessful, troubleshoot the basic device configurations before continuing.

b. Ping from PC-A to PC-B.

If the pings are unsuccessful, troubleshoot the basic device configurations before continuing.

Step 5: Save the basic configurations for the router and both switches.

Save the running configuration to the startup configuration from the privileged EXEC mode prompt.

```
S1# copy running-config startup-config
```

Part 2: Configure SSH Access to the Switches

In Part 2, you will configure S1 and S2 to support SSH connections and install SSH client software on the PCs.

Note: A switch IOS image that supports encryption is required to configure SSH. If this version of image is not used you cannot specify SSH as an input protocol for the vty lines and the **crypto** commands are unavailable.

Task 1: Configure the SSH Server on S1 and S2 Using the CLI.

In this task, use the CLI to configure the switch to be managed securely using SSH instead of Telnet. SSH is a network protocol that establishes a secure terminal emulation connection to a switch or other networking device. SSH encrypts all information that passes over the network link and provides authentication of the remote computer. SSH is rapidly replacing Telnet as the preferred remote login tool for network professionals. It is strongly recommended that SSH be used in place of Telnet on production networks.

Note: A switch must be configured with local authentication or AAA in order to support SSH.

Step 1: Configure a domain name.

Enter global configuration mode and set the domain name.

```
S1# conf t
S1(config)# ip domain-name ccnasecurity.com
```

Step 2: Configure a privileged user for login from the SSH client.

Use the **username** command to create the user ID with the highest possible privilege level and a secret password.

```
S1(config)# username admin privilege 15 algorithm-type scrypt secret cisco12345
```

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Step 3: Generate the RSA encryption key pair for the router.

The switch uses the RSA key pair for authentication and encryption of transmitted SSH data.

Configure the RSA keys with **1024** modulus bits. The default number of modulus bits is 512, and the range is from 360 to 2,048.

```
S1(config)# crypto key generate rsa general-keys modulus 1024
 The name for the keys will be: S1.ccnasecurity.com

% The key modulus size is 1024 bits
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

S1(config)#
00:15:36: %SSH-5-ENABLED: SSH 1.99 has been enabled
```

Step 4: Configure SSH version 2

```
S1(config)# ip ssh version 2
```

Step 5: Verify the SSH configuration.

a. Use the **show ip ssh** command to see the current settings.

```
S1# show ip ssh
```

b. Fill in the following information based on the output of the **show ip ssh** command:

SSH version enabled: version 2.0

Authentication timeout: 120 secs

Authentication retries: 3

Step 6: Configure SSH timeouts and authentication parameters.

The default SSH timeouts and authentication parameters can be altered to be more restrictive using the following commands.

```
S1(config)# ip ssh time-out 90
S1(config)# ip ssh authentication-retries 2
```

Step 7: Configure the incoming vty lines.

a. Configure vty access on lines 0 to 4. Specify a privilege level of 15. This will ensure that a user with the highest privilege level (**15**) will default to privileged EXEC mode when accessing the vty lines. Other users will default to user EXEC mode. Specify the use of local user accounts for mandatory login and validation and accept only SSH connections.

```
S1(config)# line vty 0 4
S1(config-line)# privilege level 15
S1(config-line)# exec-timeout 5 0
S1(config-line)# login local
S1(config-line)# transport input ssh
S1(config-line)# exit
```

b. Disable login for switch vty lines 5 to 15 by allowing no transport input.

```
S1(config)# line vty 5 15
S1(config-line)# transport input none
```

Step 8: Save the running configuration to the startup configuration.

```
S1# copy running-config startup-config
```

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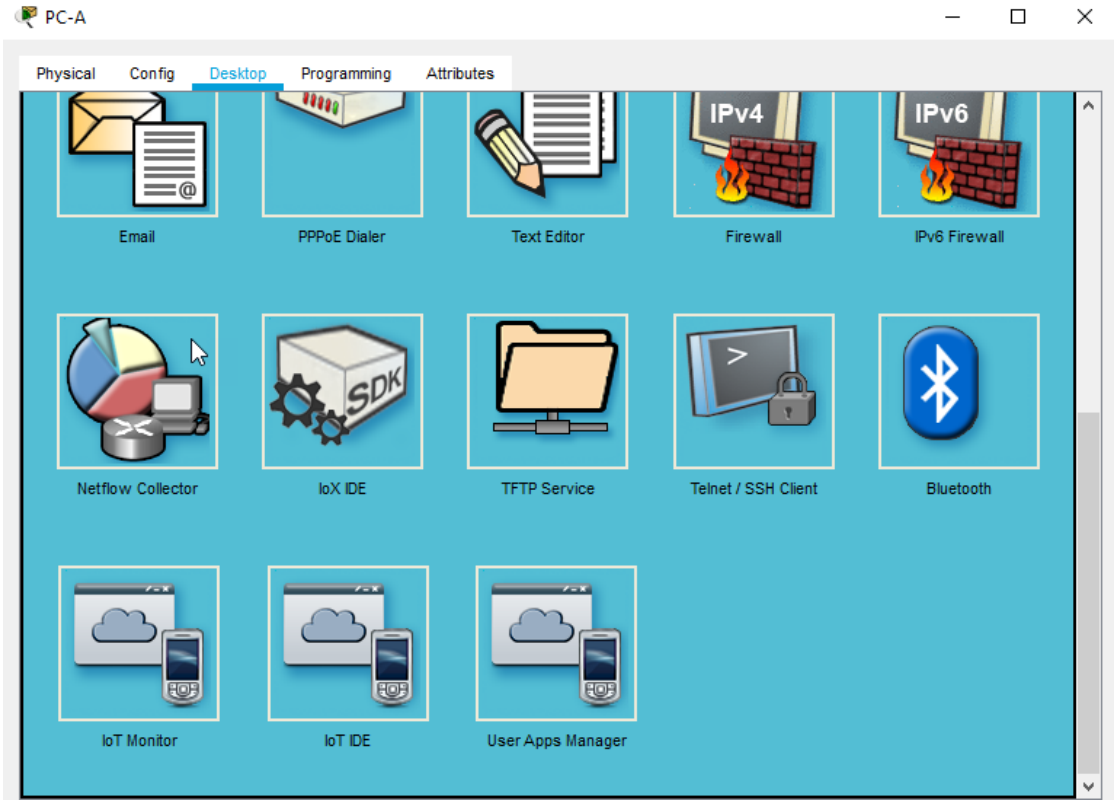
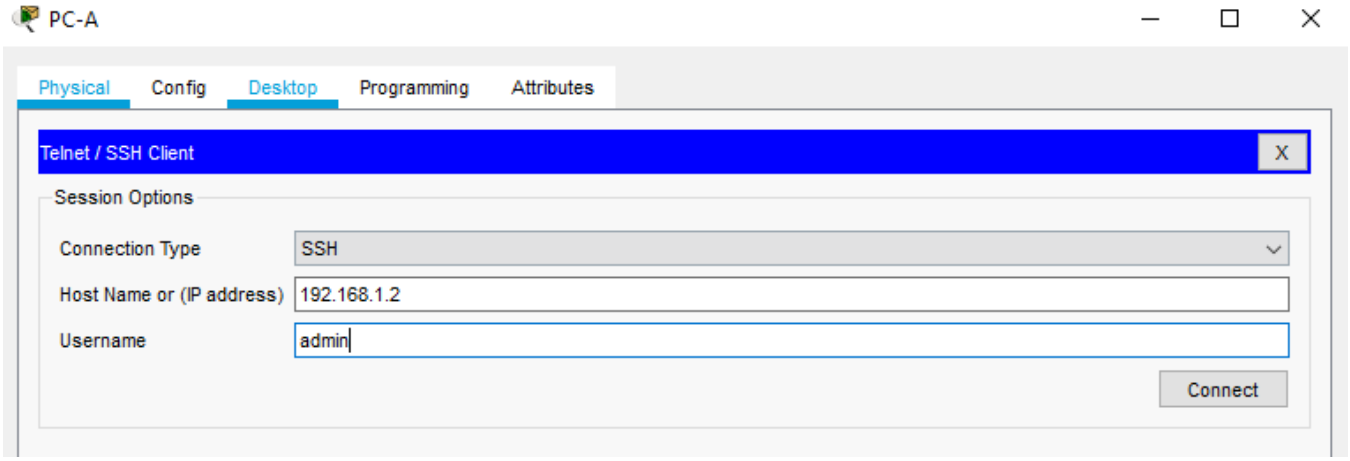
Task 2: Configure the SSH Client

Step 1: Open an SSH client on PC-A and PC-B.

Open the Telnet/SSH Client



Step 2: Verify SSH connectivity to S1 from PC-A.



a. Input the S1 IP address **192.168.1.2** in the **Host Name (or IP address)** field.

b. Verify that the **SSH** is selected

c. Enter the Username **admin**

d. Click **connect**

e. In the SSH client, enter **cisco12345** as the password.

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f. At the S1 privileged EXEC mode prompt, enter the **show users** command.

```
S1# show users
```

Which users are connected to S1 at this time?

There are two users connected one is the console connection and the other is the admin user who is logged in via SSH

g. Close the PuTTy SSH session window with the **exit** or **quit** command.

Try to open a Telnet session to S1 from PC-A. Were you able to open the Telnet session? Explain.

No, the Telnet session fails because only SSH is enabled as input for the vty lines.

Step 3: Save the configuration.

Save the running configuration to the startup configuration from the privileged EXEC mode prompt.

```
S1# copy running-config startup-config
```

Part 3: Configure Secure Trunks and Access Ports

In Part 3, you will configure trunk ports, change the native VLAN for trunk ports, and verify trunk configuration.

Securing trunk ports can help stop VLAN hopping attacks. The best way to prevent a basic VLAN hopping attack is to explicitly disable trunking on all ports except the ports that specifically require trunking. On the required trunking ports, disable DTP (auto trunking) negotiations and manually enable trunking. If no trunking is required on an interface, configure the port as an access port. This disables trunking on the interface.

Note: Tasks should be performed on S1 or S2, as indicated.

Task 1: Secure Trunk Ports

Step 1: Configure S1 as the root switch.

For the purposes of this lab, S2 is currently the root bridge. You will configure S1 as the root bridge by changing the bridge ID priority level.

a. From the console on S1, enter global configuration mode.

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b. The default priority for S1 and S2 is 32769 (32768 + 1 with System ID Extension). Set S1 priority to **0** so that it becomes the root switch.

```
S1(config)# spanning-tree vlan 1 priority 0
S1(config)# exit
```

Note: You can also use the **spanning-tree vlan 1 root primary** command to make S1 the root switch for VLAN 1.

c. Issue the **show spanning-tree** command to verify that S1 is the root bridge, to see the ports in use, and to see their status.

```
S1# show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    1
              Address     001d.4635.0c80
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    1      (priority 0 sys-id-ext 1)
              Address     001d.4635.0c80
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.1    P2p
Fa0/5            Desg FWD 19        128.5    P2p
Fa0/6            Desg FWD 19        128.6    P2p
```

d. What is the S1 priority?

1

Which ports are in use and what is their status?

Gi1/0/1, 5, 6 are in forwarding mode

Step 2: Configure trunk ports on S1 and S2.

a. Configure port F0/1 on S1 as a trunk port.

```
S1(config)# interface G1/0/1
S1(config-if)# switchport mode trunk
```

Note: If performing this lab with a 3560 switch, the user must first enter the **switchport trunk encapsulation dot1q** command.

b. Configure port F0/1 on S2 as a trunk port.

```
S2(config)# interface G1/0/1
S2(config-if)# switchport mode trunk
```

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c. Verify that S1 port G1/0/1 is in trunking mode with the **show interfaces trunk** command.

```
S1# show interfaces trunk

Port        Mode         Encapsulation  Status        Native vlan
Gi1/0/1       on           802.1q         trunking      1

Port        Vlans allowed on trunk
Gi1/0/1       1-4094

Port        Vlans allowed and active in management domain
Gi1/0/1       1

Port        Vlans in spanning tree forwarding state and not pruned
Gi1/0/1       1
```

Step 3: Change the native VLAN for the trunk ports on S1 and S2.

a. Changing the native VLAN for trunk ports to an unused VLAN helps prevent VLAN hopping attacks.

From the output of the **show interfaces trunk** command in the previous step, what is the current native VLAN for the S1 F0/1 trunk interface?

Vlan 1

b. Set the native VLAN on the S1 G1/0/1 trunk interface to an unused VLAN 99.

```
S1(config)# interface g1/0/1
S1(config-if)# switchport trunk native vlan 99
S1(config-if)# end
```

c. The following message should display after a brief period of time:

```
02:16:28: %CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/1 (99), with S2 GigabitEthernet1/0/1 (1).
```

What does the message mean?

The Native Vlan on the S1 Switch is different to S2 in order for trunkin to work both ends of the trunk link have to be on the same native vlan

d. Set the native VLAN on the S2 G1/0/1 trunk interface to VLAN 99.

```
S2(config)# interface g1/0/1
S2(config-if)# switchport trunk native vlan 99
S2(config-if)# end
```

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Step 4: Prevent the use of DTP on S1 and S2.

Setting the trunk port to **nonegotiate** also helps to mitigate VLAN hopping by turning off the generation of DTP frames.

```
S1(config)# interface g1/0/1
S1(config-if)# switchport nonegotiate

S2(config)# interface g1/0/1
S2(config-if)# switchport nonegotiate
```

Step 5: Verify the trunking configuration on port G1/0/1.

```
S1# show interfaces trunk

Port        Mode         Encapsulation  Status        Native vlan
Fa0/1       on           802.1q         trunking      99

Port        Vlans allowed on trunk
Fa0/1       1-4094

Port        Vlans allowed and active in management domain
Fa0/1       1

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/1       1

S1# show interfaces g1/0/1 switchport

Name: Fa0/1
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: Off
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 99 (Inactive)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk private VLANs: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL

Protected: false
Unknown unicast blocked: disabled
Unknown multicast blocked: disabled
Appliance trust: none
```

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Step 6: Verify the configuration with the show run command.

Use the **show run** command to display the running configuration, beginning with the first line that has the text string “0/1” in it.

```
S1# show run | begin 0/1
interface GigabitEthernet1/0/1
 switchport trunk native vlan 99
 switchport mode trunk
 switchport nonegotiate

<output omitted>
```

Task 2: Secure Access Ports

Network attackers hope to spoof their system, or a rogue switch that they add to the network, as the root bridge in the topology by manipulating the STP root bridge parameters.. If a port that is configured with PortFast receives a BPDU, STP can put the port into the blocking state by using a feature called BPDU guard.

Step 1: Disable trunking on S1 access ports.

a. On S1, configure G1/0/5, the port to which R1 is connected, as access mode only.

```
S1(config)# interface g1/0/5
S1(config-if)# switchport mode access
```

b. On S1, configure G1/0/6, the port to which PC-A is connected, as access mode only.

```
S1(config)# interface g1/0/6
S1(config-if)# switchport mode access
```

Step 2: Disable trunking on S2 access ports.

On S2, configure G1/0/24, the port to which PC-B is connected, as access mode only.

```
S2(config)# interface g1/0/24
S2(config-if)# switchport mode access
```

Task 3: Protect Against STP Attacks

The topology has only two switches and no redundant paths, but STP is still active. In this step, you will enable switch security features that can help reduce the possibility of an attacker manipulating switches via STP-related methods.

Step 1: Enable PortFast on S1 and S2 access ports.

PortFast is configured on access ports that connect to a single workstation or server, which enables them to become active more quickly.

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a. Enable PortFast on the S1 G1/0/5 access port.

```
S1(config)# interface g1/0/5
S1(config-if)# spanning-tree portfast
%Warning: portfast should only be enabled on ports connected to a single host. Connecting
hubs, concentrators, switches, bridges, etc... to this interface when portfast is enabled,
can cause temporary bridging loops. Use with CAUTION

%Portfast has been configured on FastEthernet0/5 but will only
 have effect when the interface is in a non-trunking mode.
```

b. Enable PortFast on the S1 G1/0/6 access port.

```
S1(config)# interface g1/0/6
S1(config-if)# spanning-tree portfast
```

c. Enable PortFast on the S2 G1/0/24 access ports.

```
S2(config)# interface g1/0/24
S2(config-if)# spanning-tree portfast
```

Step 2: Enable BPDU guard on the S1 and S2 access ports.

BPDU guard is a feature that can help prevent rogue switches and spoofing on access ports.

a. Enable BPDU guard on the switch port G1/0/6.

```
S1(config)# interface g1/0/6
S1(config-if)# spanning-tree bpduguard enable

S2(config)# interface g1/0/24
S2(config-if)# spanning-tree bpduguard enable
```

Note: PortFast and BPDU guard can also be enabled globally with the **spanning-tree portfast default** and **spanning-tree portfast bpduguard** commands in global configuration mode.

Note: BPDU guard can be enabled on all access ports that have PortFast enabled. These ports should never receive a BPDU. BPDU guard is best deployed on user-facing ports to prevent rogue switch network extensions by an attacker. If a port is enabled with BPDU guard and receives a BPDU, it is disabled and must be manually re-enabled. An **err-disable timeout** can be configured on the port so that it can recover automatically after a specified time period.

Step 3: Enable root guard.

Root guard is another option to help prevent rogue switches and spoofing. Root guard can be enabled on all ports on a switch that are not root ports. It is normally enabled only on ports connecting to edge switches where a superior BPDU should never be received. Each switch should have only one root port, which is the best path to the root switch.

a. The following command configures root guard on S1 interface Gi1/0/1.

```
S1(config)# interface G1/0/1
12(config-if)# spanning-tree guard root
```

b. Issue the **show run | begin Gig** command to verify that root guard is configured.

```
S1# show run | begin Gig
interface GigabitEthernet0/1
 spanning-tree guard root
```

Note: Root guard allows a connected switch to participate in STP as long as the device does not try to become the root. If root guard blocks the port, subsequent recovery is automatic. The port returns to the forwarding state if the superior BPDUs stop.

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Task 4: Configure Port Security and Disable Unused Ports

Switches can be subject to a CAM table, also known as a MAC address table, overflow, MAC spoofing attacks, and unauthorized connections to switch ports. In this task, you will configure port security to limit the number of MAC addresses that can be learned on a switch port and disable the port if that number is exceeded.

Step 1: Record the R1 G0/1 MAC address.

From the R1 CLI, use the **show interface** command and record the MAC address of the interface.

```
R1# show interfaces g0/1
GigabitEthernet0/1 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is fc99.4775.c3e1 (bia fc99.4775.c3e1)
  Internet address is 192.168.1.1/24
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 100Mbps, media type is RJ45
<Output Omitted>
```

What is the MAC address of the R1 G0/1 interface?

00e0.b0b3.5402

Step 2: Configure basic port security.

This procedure should be performed on all access ports that are in use. S1 port G1/0/5 is shown here as an example.

a. From the S1 CLI, enter interface configuration mode for the port that connects to the router (GigabitEthernet 1/0/5).

```
S1(config)# interface g1/0/5
```

b. Shut down the switch port.

```
S1(config-if)# shutdown
```

c. Enable port security on the port.

```
S1(config-if)# switchport port-security
```

Note: A switch port must be configured as an access port to enable port security.

Note: Entering just the **switchport port-security** command sets the maximum MAC addresses to **1** and the violation action to **shutdown**. The **switchport port-security maximum** and **switchport port-security violation** commands can be used to change the default behavior.

d. Configure a static entry for the MAC address of R1g0/1/ interface recorded in Step 1.

```
S1(config-if)# switchport port-security mac-address xxxx.xxxx.xxxx
```

Note: *xxxx.xxxx.xxxx* is the actual MAC address of the router g0/1 interface.

Note: You can also use the **switchport port-security mac-address sticky** command to add all the secure MAC addresses that are dynamically learned on a port (up to the maximum set) to the switch running configuration.

e. Enable the switch port.

```
S1(config-if)# no shutdown
```

Step 3: Verify port security on S1 G1/0/5.

a. On S1, issue the **show port-security** command to verify that port security has been configured on S1 g1/0/5.

```
S1# show port-security interface g1/0/5
Port Security              : Enabled
```

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```
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   : 1
Sticky MAC Addresses       : 0
Last Source Address:Vlan   : 0000.0000.0000:0
Security Violation Count   : 0
```

What is the Security Violation Count? 0

What is the status of the G1/0/5 port?

Secure - up

What is the Last Source Address and VLAN?

00E0.B0B3.5402:1

b. From the R1 CLI, ping PC-A to verify connectivity. This also ensures that the R1 G0/1 MAC address is learned by the switch.

```
R1# ping 192.168.1.10
```

c. Now, violate security by changing the MAC address on the router interface. Enter interface configuration mode for the Gigabit Ethernet 0/1. Configure a MAC address for the interface on the interface, using **aaaa.bbbb.cccc** as the address.

```
R1(config)# interface G0/1
R1(config-if)# mac-address aaaa.bbbb.cccc
R1(config-if)# end
```

Note: You can also change the PC MAC address attached to S1 g1/0/6 and achieve similar results to those shown here.

d. From the R1 CLI, ping PC-A. Was the ping successful? Explain.

No, the Fa0/5 port on S1 shut down because of the security violation.

e. On S1 console, observe the messages when port g1/0/5 detects the violating MAC address.

```
*Jan 14 01:34:39.750: %PM-4-ERR_DISABLE: psecure-violation error detected on Fa0/5,
putting Fa0/5 in err-disable state
*Jan 14 01:34:39.750: %PORT_SECURITY-2-PSECURE_VIOLATION: Security violation occurred,
caused by MAC address aaaa.bbbb.cccc on port FastEthernet0/5.
*Jan 14 01:34:40.756: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/5,
changed state to down
*Jan 14 01:34:41.755: %LINK-3-UPDOWN: Interface FastEthernet0/5, changed state to down
```

f. On the switch, use the **show port-security** commands to verify that port security has been violated.

```
S1# show port-security
Secure Port MaxSecureAddr CurrentAddr SecurityViolation Security Action
               (Count)       (Count)        (Count)
---------------------------------------------------------------------
      Fa0/5            1           1                1         Shutdown
---------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 8192
```

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```
S1# show port-security interface g1/0/5
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        : 1
Configured MAC Addresses   : 1
Sticky MAC Addresses       : 0
Last Source Address:Vlan   : aaaa.bbbb.cccc:1
Security Violation Count   : 1

S1# show port-security address
Secure Mac Address Table
-----------------------------------------------------------------------------
Vlan    Mac Address       Type                          Ports   Remaining Age
                                                                    (mins)
----    -----------       ----                          -----   -------------
   1    fc99.4775.c3e1    SecureConfigured              Fa0/5        -
-----------------------------------------------------------------------------
Total Addresses in System (excluding one mac per port)     : 0
Max Addresses limit in System (excluding one mac per port) : 8192
```

g. Remove the hard-coded MAC address from the router and re-enable the Gigabit Ethernet 0/1 interface.

```
R1(config)# interface g0/1
R1(config-if)# no mac-address aaaa.bbbb.cccc
```

Note: This will restore the original FastEthernet interface MAC address.

From R1, try to ping the PC-A again at 192.168.1.10. Was the ping successful? Why or why not?

No, the S1 F0/5 port is still in an err-disabled state.

Step 4: Clear the S1 G1/0/5 error disabled status.

a. From the S1 console, clear the error and re-enable the port using the commands shown in the example. This will change the port status from Secure-shutdown to Secure-up.

```
S1(config)# interface g1/0/5
S1(config-if)# shutdown
S1(config-if)# no shutdown
```

Note: This assumes the device/interface with the violating MAC address has been removed and replaced with the original device/interface configuration.

b. From R1, ping PC-A again. You should be successful this time.

```
R1# ping 192.168.1.10
```

Step 5: Remove basic port security on S1 G1/0/5.

From the S1 console, remove port security on Fa0/5. This procedure can also be used to re-enable the port, but **port security** commands must be reconfigured.

```
S1(config)# interface g1/0/5
S1(config-if)# no switchport port-security
S1(config-if)# no switchport port-security mac-address xxxx.xxxx.xxxx
```

You can also use the following commands to reset the interface to its default settings:

```
S1(config)# default interface g1/0/5
```

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```
S1(config)# interface g1/0/5
```

Note: This **default interface** command also requires that you reconfigure the port as an access port to re-enable the security commands.

Step 6: (Optional) Configure port security for VoIP.

This example shows a typical port security configuration for a voice port. Three MAC addresses are allowed and should be learned dynamically. One MAC address is for the IP phone, one is for the switch, and one is for the PC connected to the IP phone. Violations of this policy result in the port being shut down. The aging timeout for the learned MAC addresses is set to two hours.

The following example displays S2 port G1/0/24:

```
S2(config)# interface g1/0/24
S2(config-if)# switchport mode access
S2(config-if)# switchport port-security
S2(config-if)# switchport port-security maximum 3
S2(config-if)# switchport port-security violation shutdown
S2(config-if)# switchport port-security aging time 120
```

Step 7: Disable unused ports on S1 and S2.

As a further security measure, disable ports that are not being used on the switch.

a. Ports G1/0/1, G1/0/5, and g1/0/6 are used on S1. The remaining Fast Ethernet ports and the two Gigabit Ethernet ports will be shut down.

```
S1(config)# interface range g1/0/2 - 4
S1(config-if-range)# shutdown
S1(config-if-range)# interface range g1/0/7 - 24
S1(config-if-range)# shutdown
S1(config-if-range)# interface range g1/1/1 - 4
S1(config-if-range)# shutdown
```

b. Ports G1/0/1 and g1/0/24 are used on S2. The remaining Fast Ethernet ports and the Gigabit Ethernet ports will be shut down.

```
S2(config)# interface range g1/0/2 – 23,   G1/1/1 - 4
S2(config-if-range)# shutdown
```

Step 8: Move active ports to a VLAN other than the default VLAN 1.

As a further security measure, you can move all active end-user ports and router ports to a VLAN other than the default VLAN 1 on both switches.

a. Configure a new VLAN for users on each switch using the following commands:

```
S1(config)# vlan 20
S1(config-vlan)# name Users

S2(config)# vlan 20
S2(config-vlan)# name Users
```

b. Add the current active access (non-trunk) ports to the new VLAN.

```
S1(config)# interface g1/0/6
S1(config-if-range)# switchport access vlan 20

S2(config)# interface g1/0/24
S2(config-if)# switchport access vlan 20
```

Note: This will prevent communication between end-user hosts and the management VLAN IP address of the switch, which is currently VLAN 1. The switch can still be accessed and configured using the console connection.

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Note: To provide SSH access to the switch, a specific port can be designated as the management port and added to VLAN 1 with a specific management workstation attached. A more elaborate solution is to create a new VLAN for switch management (or use the existing native trunk VLAN 99), and configure a separate subnet for the management and user VLANs. In Part 4 you will enable trunking with subinterfaces on R1 to provide communication between the management and user VLAN subnets.

Step 9: Configure a port with the PVLAN Edge feature.

Some applications require that no traffic be forwarded at Layer 2 between ports on the same switch so that one neighbor does not see the traffic generated by another neighbor. In such an environment, the use of the Private VLAN (PVLAN) Edge feature, also known as protected ports, ensures that there is no exchange of unicast, broadcast, or multicast traffic between these ports on the switch. The PVLAN Edge feature can only be implemented for ports on the same switch and is locally significant.

For example, to prevent traffic between host PC-A on S1 (port Fa0/6) and a host on another S1 port (e.g. port Fa0/7, which was previously shut down), you could use the **switchport protected** command to activate the PVLAN Edge feature on these two ports. Use the **no switchport protected** interface configuration command to disable protected port.

a. Configure the PVLAN Edge feature in interface configuration mode using the following commands:

```
S1(config)# interface g1/0/6
S1(config-if)# switchport protected
S1(config-if)# interface g1/0/7
S1(config-if)# switchport protected
S1(config-if)# no shut
S1(config-if)# end
```

b. Verify that the PVLAN Edge Feature (protected port) is enabled on Fa0/6.

```
S1# show interfaces fa0/6 switchport
Name: Fa0/6
Switchport: Enabled
Administrative Mode: dynamic auto
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 20 (Users)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk private VLANs: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL

Protected: true      unfortunately PT does not display this
Unknown unicast blocked: disabled
Unknown multicast blocked: disabled
Appliance trust: none
```

c. Deactivate protected port on interfaces g1/0/6 and g1/0/7 using the following commands:

```
S1(config)# interface range g1/0/6 - 7
```

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```
S1(config-if-range)# no switchport protected
```

Part 4: Configure DHCP Snooping

DHCP snooping is a Cisco Catalyst feature that determines which switch ports can respond to DHCP requests. It enables only authorized DHCP servers to respond to DHCP requests and distribute network information to clients.

Task 1: Set Up DHCP

Step 1: Set up DHCP on R1 for VLAN 1.

```
R1(config)# ip dhcp pool CCNAS
R1(dhcp-config)# network 192.168.1.0 255.255.255.0
R1(dhcp-config)# default-router 192.168.1.1
R1(dhcp-config)# exit
R1(config)# ip dhcp excluded-address 192.168.1.1 192.168.1.4
```

Step 2: Set up DHCP on R1 for VLAN 20.

```
R1(config)# ip dhcp pool 20Users
R1(dhcp-config)# network 192.168.20.0 255.255.255.0
R1(dhcp-config)# default-router 192.168.20.1
R1(dhcp-config)# exit
R1(config)# ip dhcp excluded-address 192.168.20.1
```

Task 2: Configure Inter-VLAN Communication

Step 1: Configure subinterfaces on R1.

```
R1(config)# interface g0/1
R1(config-if)# shutdown
R1(config-if)# no ip address 192.168.1.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# int G0/1.1
R1(config-if)# encapsulation dot1q 1
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# int G0/1.20
R1(config-if)# encapsulation dot1q 20
R1(config-if)# ip address 192.168.20.1 255.255.255.0
R1(config-if)# int G0/1.99
R1(config-if)# encapsulation dot1q 99 native
R1(config-if)# ip address 192.168.99.1 255.255.255.0
```

Step 2: Configure S1 interface g1/0/5 as a trunk port.

```
S1(config)# int g1/0/5
S1(config-if)# switchport mode trunk
S1(config-if)# switchport trunk native vlan 99
```

Step 3: Configure PC-A and PC-B to obtain an IP Address using DHCP.

Change network settings on PC-A and PC-B to obtain an IP Address automatically.

Step 4: Verify DHCP operation.

Use desktop IP Configuration of PC-A and PC-B.

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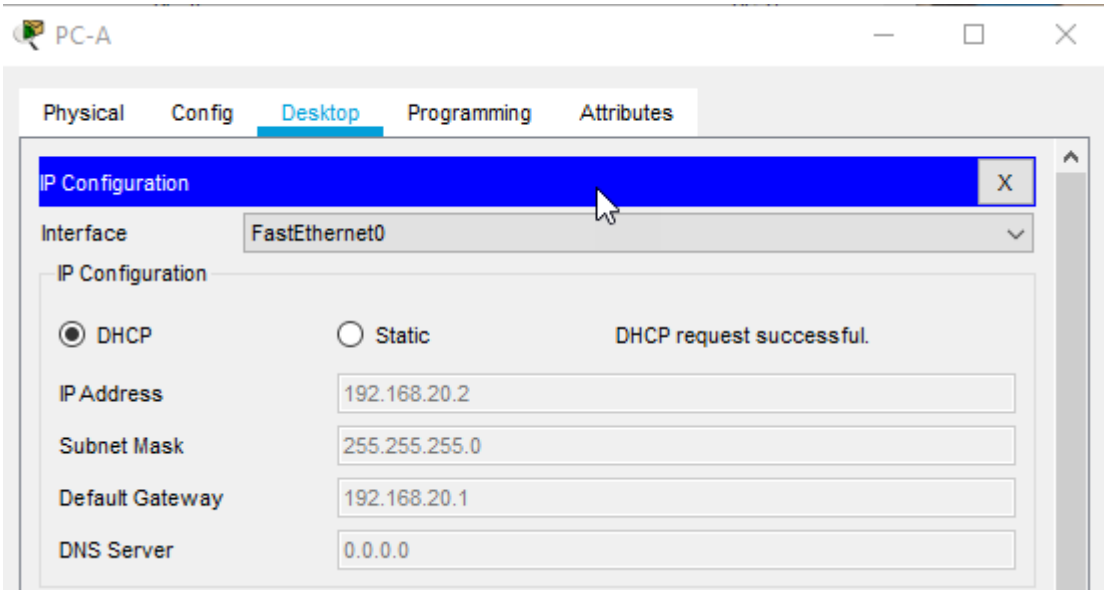

Task 3: Configure DHCP Snooping

Step 1: Enable DHCP snooping globally.

```
S1(config)# ip dhcp snooping
S1(config)# ip dhcp snooping information option
```

Step 2: Enable DHCP snooping for VLAN 1 and 20.

```
S1(config)# ip dhcp snooping vlan 1,20
```

Step 3: Limit the number of DHCP requests on an interface.

```
S1(config)# interface g1/0/6
S1(config-if)# ip dhcp snooping limit rate 10
S1(config-if)# exit
```

Step 4: Identify the trusted interface(s). DHCP responses are only permitted through trusted ports.

```
S1(config)# interface g1/0/5
S1(config-if)# description connects to DHCP server
S1(config-if)# ip dhcp snooping trust
```

Step 5: Verify DHCP snooping configuration.

```
S1# show ip dhcp snooping

DHCP snooping is configured on following VLANs:
1,20
DHCP snooping is operational on following VLANs:
1,20
DHCP snooping is configured on the following L3 Interfaces:
Insertion of option 82 is enabled
   circuit-id default format: vlan-mod-port
   remote-id: 0022.568a.3a80 (MAC)
Option 82 on untrusted port is not allowed
Verification of hwaddr field is enabled
Verification of giaddr field is enabled
DHCP snooping trust/rate is configured on the following Interfaces:
Interface                  Trusted    Allow option    Rate limit (pps)
-----------------------    -------    ------------    ----------------
```

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```
FastEthernet0/5             yes         yes               unlimited
FastEthernet0/6               no            no                10
```

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