

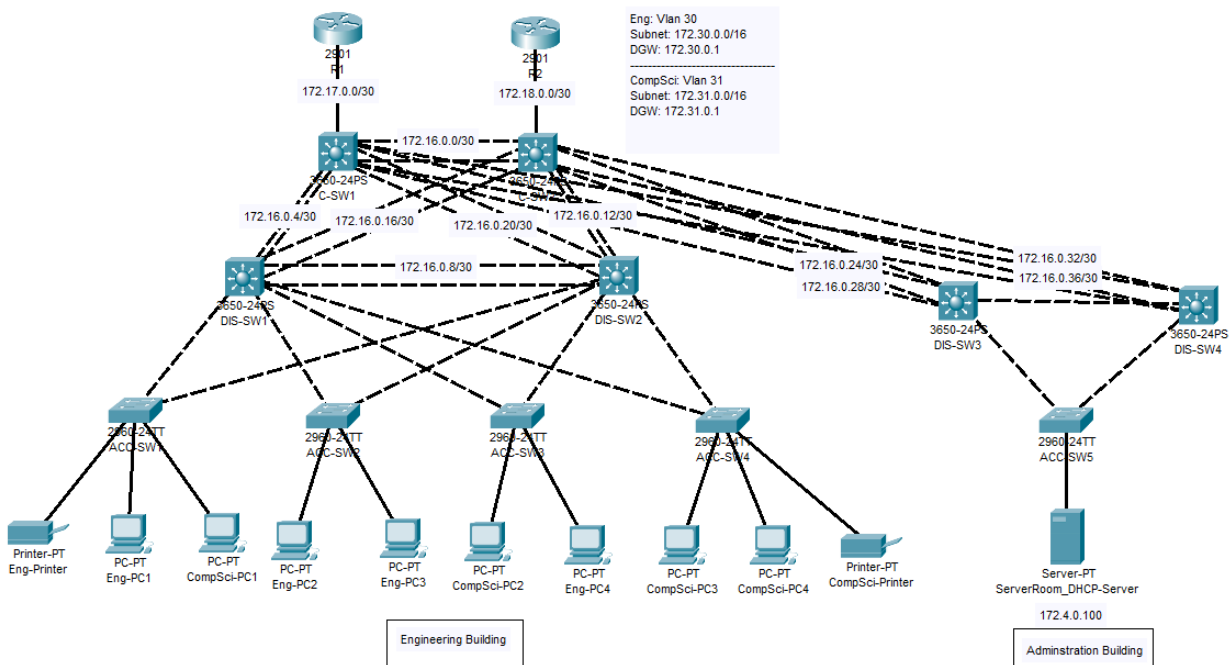
DHCP configuration in a 3-Tier Campus LAN Architecture

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Abstract



This packet Tracer project is an extension of a previous project titled as “[3-Tier Campus LAN Architecture with VLANs](#)”. In this project the goal was to allow automatic configuration of IP settings on the end hosts at the access layer instead of having to statically assign an IP address configuration on each end host added to the respective VLANs. The distribution switches in the Engineering building were successfully configured as DHCP relays for DHCP messages coming from the engineering and Computer Science VLANs. The distribution and access switches added in the administration building connected the DHCP standalone server to the rest of the network. DHCP messages from the server successfully reached the end hosts in the other building. Automatic IP configuration of all end hosts was achieved using DHCP.

Introduction

The aim is to implement Dynamic Host Configuration Protocol (DHCP) for end hosts in a 3-Tier campus LAN architecture, in Packet Tracer. The 3-Tier LAN contains 2 VLANs at the access layer. Port Security is already enabled at the access ports. This 3-Tier configuration was created in an initial project titled as [“3-Tier Campus LAN Architecture with VLANs”](#). Now the goal is to add an additional distribution and subsequent Access layer representing another part of the campus LAN network i.e., an additional geographical area/building hosting the standalone DHCP server. As part of this process, Hostnames will be configured on the new distribution and access layer network devices, new uplinks to the Core switches will be aggregated using the port aggregation protocol PAgP, IP subnets manually configured and routing will be implemented using OSPF, a DHCP relay will be configured, and finally ports will be secured using DHCP snooping and Dynamic ARP Inspection.

Method and Equipment

Hostname Configuration

DIS-SW3

```
Switch>en
```

```
Switch#config t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
Switch(config)#hostname DIS-SW3
```

```
DIS-SW3(config)#exit
```

```
DIS-SW3#copy run start
```

Destination filename [startup-config]?

Building configuration...

[OK]

```
DIS-SW3#
```

DIS-SW4

```
Switch>en
```

```
Switch#config t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
Switch(config)#hostname DIS-SW4
```

```
DIS-SW4(config)#exit
```

```
DIS-SW4#copy run start
```

Destination filename [startup-config]?

Building configuration...

[OK]

```
DIS-SW4#
```

ACC-SW5

Switch>en

Switch#config t

Enter configuration commands, one per line. End with CNTL/Z.

Switch(config)#hostname ACC-SW5

ACC-SW5(config)#exit

ACC-SW5#copy run start

Destination filename [startup-config]?

Building configuration...

[OK]

ACC-SW5#

EtherChannel & IP subnet Configuration

C-SW1

C-SW1#en

C-SW1#config t

Enter configuration commands, one per line. End with CNTL/Z.

C-SW1(config)#int range g1/0/8-11

C-SW1(config-if-range)#no shutdown

C-SW1(config-if-range)#exit

C-SW1(config)#int range g1/0/8-9

C-SW1(config-if-range)#channel-group 5 mode desirable

C-SW1(config-if-range)#exit

C-SW1(config)#int po5

C-SW1(config-if)#no switchport

C-SW1(config-if)#ip address 172.16.0.29 255.255.255.252

!

C-SW1(config)#int range g1/0/10-11

C-SW1(config-if-range)#channel-group 4 mode desirable

C-SW1(config-if-range)#exit

C-SW1(config)#int po4

C-SW1(config-if)#no switchport

C-SW1(config-if)#ip address 172.16.0.37 255.255.255.252

C-SW2

C-SW2#en

C-SW2#config t

Enter configuration commands, one per line. End with CNTL/Z.

C-SW2(config)#int range g1/0/8-11

C-SW2(config-if-range)#no shutdown

C-SW2(config-if-range)#exit

C-SW2(config)#int range g1/0/8-9

```

C-SW2(config-if-range)#channel-group 4 mode desirable
C-SW2(config-if-range)#exit
C-SW2(config)#int po4
C-SW2(config-if)#no switchport
C-SW2(config-if)#ip address 172.16.0.25 255.255.255.252
!
C-SW2(config)#int range g1/0/10-11
C-SW2(config-if-range)#channel-group 5 mode desirable
C-SW2(config-if-range)#exit
C-SW2(config)#int po5
C-SW2(config-if)#no switchport
C-SW2(config-if)#ip address 172.16.0.33 255.255.255.252
Creating a port-channel interface Port-channel 5

```

DIS-SW3

```

DIS-SW3#en
DIS-SW3#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW3(config)#int range g1/0/6-24
DIS-SW3(config-if-range)#shutdown
DIS-SW3(config-if-range)#exit
DIS-SW3(config)#int range g1/1/1-4
DIS-SW3(config-if-range)#shutdown
DIS-SW3(config-if-range)#exit
DIS-SW3(config)#int range g1/0/1-2
DIS-SW3(config-if-range)#channel-group 4 mode desirable
DIS-SW3(config-if-range)#exit
DIS-SW3(config)#int po4
DIS-SW3(config-if)#no switchport
DIS-SW3(config-if)#ip address 172.16.0.26 255.255.255.252
!
DIS-SW3(config)#int range g1/0/3-4
DIS-SW3(config-if-range)#channel-group 5 mode desirable
DIS-SW3(config-if-range)#exit
DIS-SW3(config)#int po5
DIS-SW3(config-if)#no switchport
DIS-SW3(config-if)#ip address 172.16.0.30 255.255.255.252

```

DIS-SW4

```

DIS-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW4(config)#int range g1/0/6-24
DIS-SW4(config-if-range)#shutdown
DIS-SW4(config-if-range)#exit

```

```
DIS-SW4(config)#int range g1/1/1-4
DIS-SW4(config-if-range)#shutdown
DIS-SW4#en
DIS-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW4(config)#int range g1/0/1-2
DIS-SW4(config-if-range)#channel-group 5 mode desirable
DIS-SW4(config-if-range)#exit
DIS-SW4(config)#int po5
DIS-SW4(config-if)#no switchport
DIS-SW4(config-if)#ip address 172.16.0.34 255.255.255.252
!
DIS-SW4(config)#int range g1/0/3-4
DIS-SW4(config-if-range)#channel-group 4 mode desirable
DIS-SW4(config-if-range)#exit
DIS-SW4(config)#int po4
DIS-SW4(config-if)#no switchport
DIS-SW4(config-if)#ip address 172.16.0.38 255.255.255.252
```

OSPF Configuration

```
DIS-SW3
DIS-SW3>en
DIS-SW3#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW3(config)#ip routing
DIS-SW3(config)#router ospf 1
DIS-SW3(config-router)#network 172.0.0.0 0.255.255.255 area 0
```

```
DIS-SW4
DIS-SW4>en
DIS-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW4(config)#ip routing
DIS-SW4(config)#router ospf 1
DIS-SW4(config-router)#network 172.0.0.0 0.255.255.255 area 0
```

VLAN, Trunk & STP Configuration

```
ACC-SW5
ACC-SW5#config t
Enter configuration commands, one per line. End with CNTL/Z.
```

```
ACC-SW5(config)#vlan 4
ACC-SW5(config-vlan)#name DHCP
ACC-SW5(config-if)#no shutdown
ACC-SW5(config-if)#exit
ACC-SW5(config-if)#int f0/1
ACC-SW5(config-if)#switchport mode access
ACC-SW5(config-if)#switchport access vlan 4
ACC-SW5(config)#int g0/1
ACC-SW5(config-if)#switchport mode trunk
ACC-SW5(config)#int g0/2
ACC-SW5(config-if)#switchport mode trunk
ACC-SW5(config-if)#exit
ACC-SW5(config)#int range f0/2-24
ACC-SW5(config-if-range)#shutdown
```

DIS-SW3

```
DIS-SW3#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW3(config)#vlan 4
DIS-SW3(config-vlan)#
%LINK-5-CHANGED: Interface Vlan4, changed state to up
DIS-SW3(config-vlan)#name DHCP
!
DIS-SW3(config)#int vlan 4
DIS-SW3(config-if)#ip address 172.4.0.8 255.255.0.0
DIS-SW3(config-if)#no shutdown
DIS-SW3(config-if)#int g1/0/5
DIS-SW3(config-if)#switchport mode trunk
DIS-SW3(config-if)#int g1/0/6
DIS-SW3(config-if)#switchport mode trunk
DIS-SW3(config-if)#no shutdown
DIS-SW3(config-if)#exit
DIS-SW3(config)#spanning-tree vlan 4 root primary
DIS-SW3(config)#spanning-tree vlan 1 root primary
```

DIS-SW4

```
DIS-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW4(config)#vlan 4
DIS-SW4(config-vlan)#name DHCP
!
DIS-SW4(config)#int vlan 4
DIS-SW4(config-if)#ip address 172.4.0.9 255.255.0.0
DIS-SW4(config-if)#no shutdown
DIS-SW4(config)#int g1/0/5
```



```
DIS-SW4(config-if)#switchport mode trunk
DIS-SW4(config-if)#int g1/0/6
DIS-SW4(config-if)#switchport mode trunk
DIS-SW4(config-if)#no shutdown
DIS-SW4(config-if)#exit
DIS-SW4(config)#spanning-tree vlan 4 root secondary
DIS-SW4(config)#spanning-tree vlan 1 root secondary
```

HSRP Configuration

```
DIS-SW3
DIS-SW3>en
DIS-SW3#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW3(config)#int vlan 4
DIS-SW3(config-if)#standby 4 ip 172.4.0.1
DIS-SW3(config-if)#standby 4 priority 110
DIS-SW3(config-if)#standby 4 preempt
```

```
DIS-SW4
DIS-SW4>en
DIS-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW4(config)#int vlan 4
DIS-SW4(config-if)#standby 4 ip 172.4.0.1
DIS-SW4(config-if)#standby 4 priority 90
```

DHCP Server Configuration

The screenshot displays the DHCP Server Configuration GUI. On the left is a sidebar with a tree view containing the following items: **GLOBAL** (selected), Settings, Algorithm Settings, **INTERFACE**, and FastEthernet0. The main panel is titled "Global Settings" and contains the following configuration fields:

- Display Name:** A text field containing "ServerRoom_DHCP-Server".
- Gateway/DNS IPv4:** A section containing:
 - Radio buttons for "DHCP" and "Static". The "Static" option is selected.
 - Default Gateway:** A text field containing "172.4.0.1".
 - DNS Server:** An empty text field.
- Gateway/DNS IPv6:** A section containing:
 - Radio buttons for "Automatic" and "Static". The "Static" option is selected.
 - Default Gateway:** An empty text field.
 - DNS Server:** An empty text field.

Figure 1-Global Setting DHCP Server GUI

GLOBAL Settings Algorithm Settings INTERFACE FastEthernet0	FastEthernet0	
	Port Status	<input checked="" type="checkbox"/> On
	Bandwidth	<input checked="" type="radio"/> 100 Mbps <input type="radio"/> 10 Mbps <input checked="" type="checkbox"/> Auto
	Duplex	<input type="radio"/> Half Duplex <input checked="" type="radio"/> Full Duplex <input checked="" type="checkbox"/> Auto
	MAC Address	0050.0F16.4918
	IP Configuration <input type="radio"/> DHCP <input checked="" type="radio"/> Static	
	IPv4 Address	172.4.0.100
	Subnet Mask	255.255.0.0
	IPv6 Configuration <input type="radio"/> Automatic <input checked="" type="radio"/> Static	
	IPv6 Address	
	Link Local Address:	FE80::250:FFF:FE16:4918

Figure 2-FastEthernet0 Interface settings on DHCP Server GUI

DHCP

Interface FastEthernet0 Service ☒ On ☐ Off

Pool Name CompSci

Default Gateway 172.31.0.1

DNS Server 172.4.0.100

Start IP Address : 172 31 0 11

Subnet Mask: 255 255 0 0

Maximum Number of Users : 512

TFTP Server: 0.0.0.0

WLC Address: 0.0.0.0

Add Save Remove

Figure 3- CompSci DHCP pool settings

DHCP

Interface FastEthernet0 Service ☒ On ☐ Off

Pool Name Eng

Default Gateway 172.30.0.1

DNS Server 172.4.0.100

Start IP Address : 172 30 0 11

Subnet Mask: 255 255 0 0

Maximum Number of Users : 512

TFTP Server: 0.0.0.0

WLC Address: 0.0.0.0

Add Save Remove

Figure 4-Eng DHCP pool settings

DHCP Relay Configuration

DIS-SW1

DIS-SW1>en

DIS-SW1#config t

Enter configuration commands, one per line. End with CNTL/Z.

DIS-SW1(config)#int vlan30

DIS-SW1(config-if)#ip helper-address 172.4.0.100

DIS-SW1(config-if)#int vlan31

DIS-SW1(config-if)#ip helper-address 172.4.0.100

DIS-SW2

DIS-SW2>en

DIS-SW2#config t

Enter configuration commands, one per line. End with CNTL/Z.

DIS-SW2(config)#int vlan30

DIS-SW2(config-if)#ip helper-address 172.4.0.100

DIS-SW2(config-if)#int vlan31

DIS-SW2(config-if)#ip helper-address 172.4.0.100

DHCP Snooping Configuration

ACC-SW5

ACC-SW5>en

ACC-SW5#config t

Enter configuration commands, one per line. End with CNTL/Z.

ACC-SW5(config)#ip dhcp snooping

ACC-SW5(config)#no ip dhcp snooping information option

ACC-SW5(config)#ip dhcp snooping vlan 4

ACC-SW5(config)#int f0/1

ACC-SW5(config-if)#ip dhcp snooping trust

ACC-SW5(config-if)#int range g0/1-2

ACC-SW5(config-if-range)#ip dhcp snooping trust

DIS-SW3

DIS-SW3>en

DIS-SW3#config t

Enter configuration commands, one per line. End with CNTL/Z.

DIS-SW3(config)#ip dhcp snooping

```
DIS-SW3(config)#no ip dhcp snooping information option
DIS-SW3(config)#ip dhcp snooping vlan 4
DIS-SW3(config)#int range g1/0/5-6
DIS-SW3(config-if-range)#ip dhcp snooping trust
```

DIS-SW4

```
DIS-SW4>en
DIS-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW4(config)#ip dhcp snooping
DIS-SW4(config)#no ip dhcp snooping information option
DIS-SW4(config)#ip dhcp snooping vlan 4
DIS-SW4(config)#int range g1/0/5-6
DIS-SW4(config-if-range)#ip dhcp snooping trust
```

ACC-SW1

```
ACC-SW1>en
ACC-SW1#config t
Enter configuration commands, one per line. End with CNTL/Z.
ACC-SW1(config)#ip dhcp snooping
ACC-SW1(config)#no ip dhcp snooping information option
ACC-SW1(config)#ip dhcp snooping vlan 30
ACC-SW1(config)#ip dhcp snooping vlan 31
ACC-SW1(config)#int range g0/1-2
ACC-SW1(config-if-range)#ip dhcp snooping trust
```

ACC-SW2

```
ACC-SW2>en
ACC-SW2#config t
Enter configuration commands, one per line. End with CNTL/Z.
ACC-SW2(config)#ip dhcp snooping
ACC-SW2(config)#no ip dhcp snooping information option
ACC-SW2(config)#ip dhcp snooping vlan 30
ACC-SW2(config)#ip dhcp snooping vlan 31
ACC-SW2(config)#int range g0/1-2
ACC-SW2(config-if-range)#ip dhcp snooping trust
```

ACC-SW3

```
ACC-SW3>en
ACC-SW3#config t
Enter configuration commands, one per line. End with CNTL/Z.
ACC-SW3(config)#ip dhcp snooping
ACC-SW3(config)#no ip dhcp snooping information option
ACC-SW3(config)#ip dhcp snooping vlan 30
ACC-SW3(config)#ip dhcp snooping vlan 31
```

```
ACC-SW3(config)#int range g0/1-2
ACC-SW3(config-if-range)#ip dhcp snooping trust
```

ACC-SW4

```
ACC-SW4>en
ACC-SW4#config t
Enter configuration commands, one per line. End with CNTL/Z.
ACC-SW4(config)#ip dhcp snooping
ACC-SW4(config)#no ip dhcp snooping information option
ACC-SW4(config)#ip dhcp snooping vlan 30
ACC-SW4(config)#ip dhcp snooping vlan 31
ACC-SW4(config)#int range g0/1-2
ACC-SW4(config-if-range)#ip dhcp snooping trust
```

DIS-SW1

```
DIS-SW1>en
DIS-SW1#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW1(config)#ip dhcp snooping
DIS-SW1(config)#ip dhcp snooping vlan 30
DIS-SW1(config)#ip dhcp snooping vlan 31
DIS-SW1(config)#int range g1/0/3-6
DIS-SW1(config-if-range)#ip dhcp snooping trust
```

DIS-SW2

```
DIS-SW2>en
DIS-SW2#config t
Enter configuration commands, one per line. End with CNTL/Z.
DIS-SW2(config)#ip dhcp snooping
DIS-SW2(config)#ip dhcp snooping vlan 30
DIS-SW2(config)#ip dhcp snooping vlan 31
DIS-SW2(config)#int range g1/0/3-6
DIS-SW2(config-if-range)#ip dhcp snooping trust
```

Dynamic ARP Inspection (DAI) Configuration

ACC-SW5

ACC-SW5>en

ACC-SW5#config t

Enter configuration commands, one per line. End with CNTL/Z.

ACC-SW5(config)#ip arp inspection vlan 4

ACC-SW5(config)#int f0/1

ACC-SW5(config-if)#ip arp inspection trust

ACC-SW5(config-if)#int range g0/1-2

ACC-SW5(config-if-range)#ip arp inspection trust

DIS-SW3

DIS-SW3>en

DIS-SW3#config t

Enter configuration commands, one per line. End with CNTL/Z.

DIS-SW3(config)#ip arp inspection vlan 4

DIS-SW3(config)#int range g1/0/5-6

DIS-SW3(config-if-range)#ip arp inspection trust

DIS-SW4

DIS-SW4>en

DIS-SW4#config t

Enter configuration commands, one per line. End with CNTL/Z.

DIS-SW4(config)#ip arp inspection vlan 4

DIS-SW4(config)#int range g1/0/5-6

DIS-SW4(config-if-range)#ip arp inspection trust

ACC-SW1

ACC-SW1>en

ACC-SW1#config t

Enter configuration commands, one per line. End with CNTL/Z.

ACC-SW1(config)#ip arp inspection vlan 30

ACC-SW1(config)#ip arp inspection vlan 31

ACC-SW1(config)#int range g0/1-2

ACC-SW1(config-if-range)#ip arp inspection trust

ACC-SW2

ACC-SW2>en

ACC-SW2#config t

Enter configuration commands, one per line. End with CNTL/Z.

```
ACC-SW2(config)#ip arp inspection vlan 30
```

```
ACC-SW2(config)#ip arp inspection vlan 31
```

```
ACC-SW2(config)#int range g0/1-2
```

```
ACC-SW2(config-if-range)#ip arp inspection trust
```

ACC-SW3

```
ACC-SW3>en
```

```
ACC-SW3#config t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
ACC-SW3(config)#ip arp inspection vlan 30
```

```
ACC-SW3(config)#ip arp inspection vlan 31
```

```
ACC-SW3(config)#int range g0/1-2
```

```
ACC-SW3(config-if-range)#ip arp inspection trust
```

ACC-SW4

```
ACC-SW4>en
```

```
ACC-SW4#config t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
ACC-SW4(config)#ip arp inspection vlan 30
```

```
ACC-SW4(config)#ip arp inspection vlan 31
```

```
ACC-SW4(config)#int range g0/1-2
```

```
ACC-SW4(config-if-range)#ip arp inspection trust
```

DIS-SW1

```
DIS-SW1>en
```

```
DIS-SW1#config t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
DIS-SW1(config)#ip arp inspection vlan 30
```

```
DIS-SW1(config)#ip arp inspection vlan 31
```

```
DIS-SW1(config)#int range g1/0/3-6
```

```
DIS-SW1(config-if-range)#ip arp inspection trust
```

DIS-SW2

```
DIS-SW2>en
```

```
DIS-SW2#config t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
DIS-SW2(config)#ip arp inspection vlan 30
```

```
DIS-SW2(config)#ip arp inspection vlan 31
```

```
DIS-SW2(config)#int range g1/0/3-6
```

```
DIS-SW2(config-if-range)#ip arp inspection trust
```

Verification & Discussion

A random switch and its corresponding end hosts were selected to demonstrate the functional configuration of DHCP on the 3-Tier LAN architecture. End Host CompSci-PC2 and Eng-PC4 seen in figure 5 and figure 4, respectively, are both connected to access switch, ACC-SW3. The end hosts can successfully release and automatically renew their IP configuration communicating with the DHCP server located at IP 172.4.0.100 via VLAN 30, 31 default gateways 172.30.0.1 & 172.31.0.1. Distribution switches DIS-SW1 & DIS-SW2 contain the VLAN 30, 31 virtual interfaces and these layer 3 switches were configured as DHCP relays. The DHCP binding table in figure 7 provides further confirmation that DHCP is configured for each accessible VLAN at the Access layer.

```
C:\>ipconfig /release

IP Address. . . . .: 0.0.0.0
Subnet Mask. . . . .: 0.0.0.0
Default Gateway. . . . .: 0.0.0.0
DNS Server. . . . .: 0.0.0.0

C:\>ipconfig /renew

IP Address. . . . .: 172.31.0.16
Subnet Mask. . . . .: 255.255.0.0
Default Gateway. . . . .: 172.31.0.1
DNS Server. . . . .: 172.4.0.100

C:\>|
```

Figure 5- CompSci-PC2 IP configuration via DHCP

```
C:\>ipconfig /release

IP Address. . . . .: 0.0.0.0
Subnet Mask. . . . .: 0.0.0.0
Default Gateway. . . . .: 0.0.0.0
DNS Server. . . . .: 0.0.0.0

C:\>ipconfig /renew

IP Address. . . . .: 172.30.0.25
Subnet Mask. . . . .: 255.255.0.0
Default Gateway. . . . .: 172.30.0.1
DNS Server. . . . .: 172.4.0.100
```

Figure 6-Eng-PC4 IP Configuration via DHCP

```
ACC-SW3#show ip dhcp snooping binding
```

MacAddress	IpAddress	Lease(sec)	Type	VLAN	Interface
00:0B:BE:A1:45:5B	172.30.0.25	0	dhcp-snooping	30	FastEthernet0/4
00:04:9A:B2:7E:EA	172.31.0.16	0	dhcp-snooping	31	FastEthernet0/1

Total number of bindings: 2
ACC-SW3#

Figure 7-DHCP Binding table on ACC-SW3 showing Eng-PC4 & Compsci-PC2 binding information.