**DHCP configuration in a 3-Tier Campus LAN Architecture**

*Created by: Antonio Scotland*

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# Abstract

Diagram

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This packet Tracer project is an extension of a previous project tiled as “[3-Tier Campus LAN Architecture with VLANs](https://bit.ly/3EMmdMm)”. 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](https://bit.ly/3EMmdMm)”. 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

Graphical user interface, text, application, email

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Figure -Global Setting DHCP Server GUI

Graphical user interface, text, application, email

Description automatically generated

Figure -FastEthernet0 Interface settings on DHCP Server GUI

Graphical user interface, application

Description automatically generated

Figure - CompSci DHCP pool settings

Graphical user interface, text, application

Description automatically generated

Figure -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 there 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.

A picture containing table

Description automatically generated

Figure - CompSci-PC2 IP configuration via DHCP

A picture containing calendar

Description automatically generated

Figure -Eng-PC4 IP Configuration via DHCP

Text, letter

Description automatically generated

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