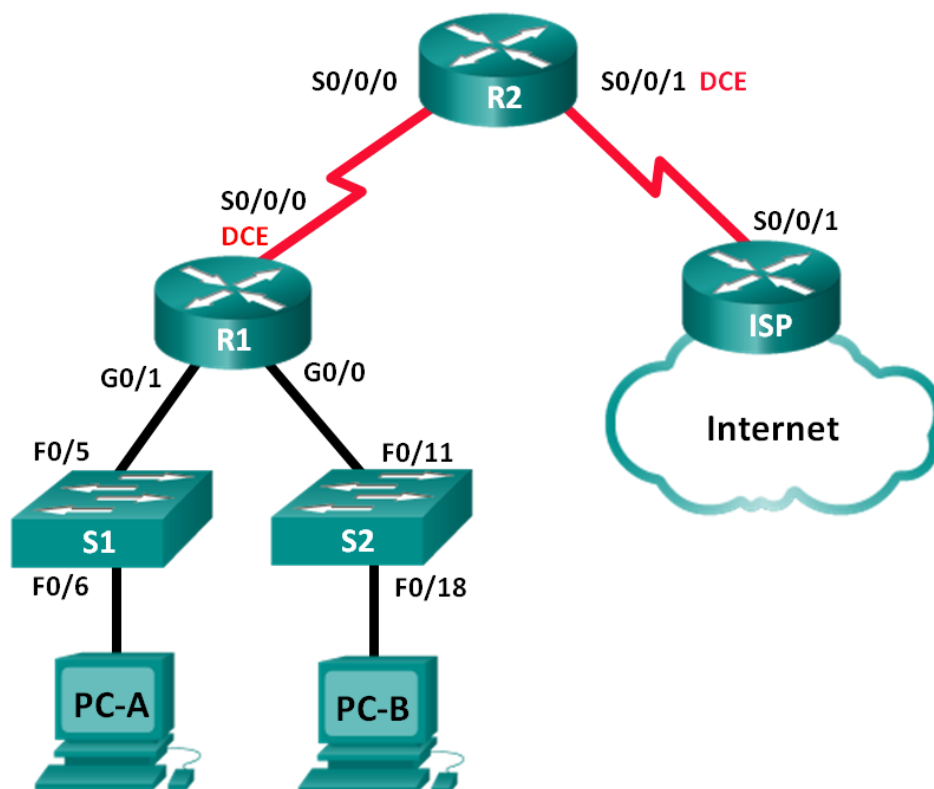# Lab - Configuring Basic DHCPv4 on a Router (Solution)

Topology

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0	192.168.0.1	255.255.255.0	N/A
	G0/1	192.168.1.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.2.253	255.255.255.252	N/A
R2	S0/0/0	192.168.2.254	255.255.255.252	N/A
	S0/0/1 (DCE)	209.165.200.226	255.255.255.224	N/A
ISP	S0/0/1	209.165.200.225	255.255.255.224	N/A
PC-A	NIC	DHCP	DHCP	DHCP
PC-B	NIC	DHCP	DHCP	DHCP

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure a DHCPv4 Server and a DHCP Relay Agent

Background / Scenario

The Dynamic Host Configuration Protocol (DHCP) is a network protocol that lets network administrators manage and automate the assignment of IP addresses. Without DHCP, the administrator must manually assign and configure IP addresses, preferred DNS servers, and default gateways. As the network grows in size, this becomes an administrative problem when devices are moved from one internal network to another.

In this scenario, the company has grown in size, and the network administrators can no longer assign IP addresses to devices manually. Your job is to configure the R2 router to assign IPv4 addresses on two different subnets connected to router R1.

Note: This lab provides minimal assistance with the actual commands necessary to configure DHCP. However, the required commands are provided in Appendix A. Test your knowledge by trying to configure the devices without referring to the appendix.

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.

Required Resources

- 3 Routers (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 and serial cables as shown in the topology

Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure the routers and switches with basic settings, such as passwords and IP addresses. You will also configure the IP settings for the PCs in the topology.

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

Step 2: Initialize and reload the routers and switches.

Step 3: Configure basic settings for each router.

a. Console into the router and enter global configuration mode.

b. Copy the following basic configuration and paste it to the running-configuration on the router.

```
no ip domain-lookup
service password-encryption
enable secret class
banner motd #
Unauthorized access is strictly prohibited. #
line con 0
password cisco
```

```
        login
        logging synchronous
        line vty 0 4
        password cisco
        login
```

   c. Configure the host name as shown in the topology.

   d. Configure the IPv4 addresses on the router as shown in the topology.

   e. Set the DCE serial interfaces with a clock rate of 128000.

Step 4: Configure dynamic, default, and static routing on the routers.

   a. Configure RIPv2 for R1.

```
        R1(config)# router rip
        R1(config-router)# version 2
        R1(config-router)# network 192.168.0.0
        R1(config-router)# network 192.168.1.0
        R1(config-router)# network 192.168.2.252
        R1(config-router)# no auto-summary
```

   b. Configure RIPv2 and a default route to the ISP on R2.

```
        R2(config)# router rip
        R1(config-router)# version 2
        R2(config-router)# network 192.168.2.252
        R2(config-router)# default-information originate
        R2(config-router)# exit
        R2(config)# ip route 0.0.0.0 0.0.0.0 209.165.200.225
```

   c. Configure a summary static route on ISP to reach the networks on the R1 and R2 routers.

```
        ISP(config)# ip route 192.168.0.0 255.255.252.0 209.165.200.226
```

   d. Copy the running configuration to the startup configuration.

Step 5: Verify network connectivity between the routers.

   If any pings between routers fail, correct the errors before proceeding to the next step. Use **show ip route** and **show ip interface brief** to locate possible issues.

Step 6: Verify the host PCs are configured for DHCP.

Part 2: Configure a DHCPv4 Server and a DHCP Relay Agent

   To automatically assign address information on the network, you will configure R2 as a DHCPv4 server and R1 as a DHCP relay agent.

Step 1: Configure DHCPv4 server settings on router R2.

   On R2, you will configure a DHCP address pool for each of the R1 LANs. Use the pool name **R1G0** for the G0/0 LAN and **R1G1** for the G0/1 LAN. You will also configure the addresses to be excluded from the address pools. Best practice dictates that excluded addresses be configured first, to guarantee that they are not accidentally leased to other devices.

Exclude the first 9 addresses in each R1 LAN starting with .1. All other addresses should be available in the DHCP address pool. Make sure that each DHCP address pool includes a default gateway, the domain **ccna-lab.com**, a DNS server (209.165.200.225), and a lease time of 2 days.

On the lines below, write the commands necessary for configuring DHCP services on router R2, including the DHCP-excluded addresses and the DHCP address pools.

Note: The required commands for Part 2 are provided in Appendix A. Test your knowledge by trying to configure DHCP on R1 and R2 without referring to the appendix.

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```
R2(config)# ip dhcp excluded-address 192.168.0.1 192.168.0.9
R2(config)# ip dhcp excluded-address 192.168.1.1 192.168.1.9
R2(config)# ip dhcp pool R1G1
R2(dhcp-config)# network 192.168.1.0 255.255.255.0
R2(dhcp-config)# default-router 192.168.1.1
R2(dhcp-config)# dns-server 209.165.200.225
R2(dhcp-config)# domain-name ccna-lab.com
R2(dhcp-config)# lease 2
R2(dhcp-config)# exit
R2(config)# ip dhcp pool R1G0
R2(dhcp-config)# network 192.168.0.0 255.255.255.0
R2(dhcp-config)# default-router 192.168.0.1
R2(dhcp-config)# dns-server 209.165.200.225
R2(dhcp-config)# domain-name ccna-lab.com
R2(dhcp-config)# lease 2
```

On PC-A or PC-B, open a command prompt and enter the **ipconfig /all** command. Did either of the host PCs receive an IP address from the DHCP server? Why?

_____

The host computers will not have received IP addresses from the DHCP server at R2 until R1 is configured as a DHCP relay agent.

Step 2: Configure R1 as a DHCP relay agent.

Configure IP helper addresses on R1 to forward all DHCP requests to the R2 DHCP server.

On the lines below, write the commands necessary to configure R1 as a DHCP relay agent for the R1 LANs.

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```
R1(config)# interface g0/0
R1(config-if)# ip helper-address 192.168.2.254
R1(config-if)# exit
R1(config)# interface g0/1
R1(config-if)# ip helper-address 192.168.2.254
```

Step 3: Record IP settings for PC-A and PC-B.

On PC-A and PC-B, issue the **ipconfig /all** command to verify that the PCs have received IP address information from the DHCP server on R2. Record the IP and MAC address for each PC.

_____

Answers may vary.

Based on the DHCP pool that was configured on R2, what are the first available IP addresses that PC-A and PC-B can lease?

_____

PC-B: 192.168.0.10, and PC-A: 192.168.1.10

Step 4: Verify DHCP services and address leases on R2.

a. On R2, enter the **show ip dhcp binding** command to view DHCP address leases.

```
R2# show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
192.168.0.10        011c.c1de.91c3.5d       Mar 13 2013 02:07 AM    Automatic
192.168.1.10        0100.2170.0c05.0c       Mar 13 2013 02:09 AM    Automatic
```

Along with the IP addresses that were leased, what other piece of useful client identification information is in the output?

_____

The client hardware addresses identify the specific computers that have joined the network.

b. On R2, enter the **show ip dhcp server statistics** command to view the DHCP pool statistics and message activity.

```
R2# show ip dhcp server statistics
Memory usage         42175
```

```
Address pools       2
Database agents     0
Automatic bindings  2
Manual bindings     0
Expired bindings    0
Malformed messages  0
Secure arp entries  0

Message             Received
BOOTREQUEST         0
DHCPDISCOVER        2
DHCPREQUEST         2
DHCPDECLINE         0
DHCPRELEASE         0
DHCPINFORM          2

Message             Sent
BOOTREPLY           0
DHCPOFFER           2
DHCPACK             4
DHCPNAK             0
```

How many types of DHCP messages are listed in the output?

_____

Ten different types of DHCP messages are listed.

c. On R2, enter the **show ip dhcp pool** command to view the DHCP pool settings.

```
R2# show ip dhcp pool

Pool R1G1 :
 Utilization mark (high/low)    : 100 / 0
 Subnet size (first/next)       : 0 / 0
 Total addresses                : 254
 Leased addresses               : 1
 Pending event                  : none
 1 subnet is currently in the pool :
 Current index       IP address range                    Leased addresses
 192.168.1.11        192.168.1.1     - 192.168.1.254    1

Pool R1G0 :
 Utilization mark (high/low)    : 100 / 0
 Subnet size (first/next)       : 0 / 0
 Total addresses                : 254
 Leased addresses               : 1
 Pending event                  : none
 1 subnet is currently in the pool :
 Current index       IP address range                    Leased addresses
 192.168.0.11        192.168.0.1     - 192.168.0.254    1
```

In the output of the **show ip dhcp pool** command, what does the current index refer to?

_____

The next available address for leasing.

d. On R2, enter the **show run | section dhcp** command to view the DHCP configuration in the running configuration.

```
R2# show run | section dhcp
ip dhcp excluded-address 192.168.0.1 192.168.0.9
ip dhcp excluded-address 192.168.1.1 192.168.1.9
ip dhcp pool R1G1
 network 192.168.1.0 255.255.255.0
 default-router 192.168.1.1
 domain-name ccna-lab.com
 dns-server 209.165.200.225
 lease 2
ip dhcp pool R1G0
 network 192.168.0.0 255.255.255.0
 default-router 192.168.0.1
 domain-name ccna-lab.com
 dns-server 209.165.200.225
 lease 2
```

e. On R1, enter the **show run interface** command for interfaces G0/0 and G0/1 to view the DHCP relay configuration in the running configuration.

```
R1# show run interface g0/0
Building configuration...

Current configuration : 132 bytes
!
interface GigabitEthernet0/0
 ip address 192.168.0.1 255.255.255.0
 ip helper-address 192.168.2.254
 duplex auto
 speed auto
end

R1# show run interface g0/1
Building configuration...

Current configuration : 132 bytes
!
interface GigabitEthernet0/1
 ip address 192.168.1.1 255.255.255.0
 ip helper-address 192.168.2.254
 duplex auto
 speed auto
end
```

Reflection

What do you think is the benefit of using DHCP relay agents instead of multiple routers acting as DHCP servers?

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Having a separate router DHCP server for each subnet would add more complexity and decrease centralized management for the network. It would also require that each router work harder to manage its own DHCP addressing, in addition to the primary function of routing traffic. One DHCP server (router or computer) that is dedicated to the job is easier to manage and more centralized.

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.

Appendix A – DHCP Configuration Commands

Router R1

```
R1(config)# interface g0/0
R1(config-if)# ip helper-address 192.168.2.254
R1(config-if)# exit
R1(config-if)# interface g0/1
R1(config-if)# ip helper-address 192.168.2.254
```

Router R2

```
R2(config)# ip dhcp excluded-address 192.168.0.1 192.168.0.9
```

```
R2(config)# ip dhcp excluded-address 192.168.1.1 192.168.1.9
R2(config)# ip dhcp pool R1G1
R2(dhcp-config)# network 192.168.1.0 255.255.255.0
R2(dhcp-config)# default-router 192.168.1.1
R2(dhcp-config)# dns-server 209.165.200.225
R2(dhcp-config)# domain-name ccna-lab.com
R2(dhcp-config)# lease 2
R2(dhcp-config)# exit
R2(config)# ip dhcp pool R1G0
R2(dhcp-config)# network 192.168.0.0 255.255.255.0
R2(dhcp-config)# default-router 192.168.0.1
R2(dhcp-config)# dns-server 209.165.200.225
R2(dhcp-config)# domain-name ccna-lab.com
R2(dhcp-config)# lease 2
```

Device Configs

Router R1

```
R1# show run
Building configuration...

Current configuration : 1478 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
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
no ip domain lookup
ip cef
no ipv6 cef
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.0.1 255.255.255.0
 ip helper-address 192.168.2.254
```

```
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 ip address 192.168.1.1 255.255.255.0
 ip helper-address 192.168.2.254
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 192.168.2.253 255.255.255.252
 clock rate 128000
!
interface Serial0/0/1
 no ip address
 shutdown!
!
router rip
 version 2
 network 192.168.0.0
 network 192.168.1.0
 network 192.168.2.252
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
!
line con 0
 password cisco
 logging synchronous
 login
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
 password cisco
login
 transport input all
!
scheduler allocate 20000 1000
```

```
!
end
```

Router R2

```
R2# show run
Building configuration...

Current configuration : 1795 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
ip dhcp excluded-address 192.168.0.1 192.168.0.9
ip dhcp excluded-address 192.168.1.1 192.168.1.9
!
ip dhcp pool R1G1
 network 192.168.1.0 255.255.255.0
 default-router 192.168.1.1
 domain-name ccna-lab.com
 dns-server 209.165.200.225
 lease 2
!
ip dhcp pool R1G0
 network 192.168.0.0 255.255.255.0
 default-router 192.168.0.1
 domain-name ccna-lab.com
 dns-server 209.165.200.225
 lease 2
!
!
!
no ip domain lookup
ip cef
no ipv6 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
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 192.168.2.254 255.255.255.252
!
interface Serial0/0/1
 ip address 209.165.200.226 255.255.255.224
 clock rate 128000
!
!
router rip
 version 2
 network 192.168.2.252
 default-information originate
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ip route 0.0.0.0 0.0.0.0 209.165.200.225
!
control-plan
!
line con 0
 password cisco
 logging synchronous
 login
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
```

```
 password cisco
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router ISP

```
ISP# show run
Building configuration...

Current configuration : 1247 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname ISP
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 10
!
no ip domain lookup
ip cef
no ipv6 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
 no ip address
 shutdown
 duplex auto
 speed auto
```

```
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 ip address 209.165.200.225 255.255.255.224
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ip route 192.168.0.0 255.255.252.0 209.165.200.226
!
control-plane
!
line con 0
 password cisco
 logging synchronous
 login
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
 password cisco
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```