The University of Danang
University of Science and Technology

CHAPTER 2
APPLICATION LAYER
DHCP – DYNAMIC HOST CONFIGURATION PROTOCOL

FACULTY OF INFORMATION TECHNOLOGY
PhD. LE TRAN DUC

THE PURPOSE OF DHCP

- DHCP is used to allow hosts to automatically/dynamically learn various aspects of their network configuration, such as IP address, subnet mask, default gateway, DNS server, etc, without manual/static configuration.
- It is an essential part of modern networks.
  → When you connect a phone/laptop to WiFi, do you ask the network admin which IP address, subnet mask, default gateway, etc, the phone/laptop should use?
- Typically used for 'client devices' such as workstations (PCs), phones, etc.
- Devices such as routers, servers, etc, are usually manually configured.
- In small networks (such as home networks) the router typically acts as the DHCP server for hosts in the LAN.
- In larger networks, the DHCP server is usually a Windows/Linux server.

BASIC FUNCTIONS OF DHCP

```
C:\Users\user>ipconfig /all

[output omitted]

Ethernet adapter Ethernet0:

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Intel(R) 82579LM Gigabit Network Connection
   Physical Address. . . . . . . . . : 78-2B-CB-AC-08-67
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   IPv4 Address. . . . . . . . . . . : 192.168.0.167(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : Saturday, January 23, 2021 12:02:04 PM
   Lease Expires . . . . . . . . . . : Saturday, January 23, 2021 2:02:05 PM
   Default Gateway . . . . . . . . . : 192.168.0.1
   DHCP Server . . . . . . . . . . . : 192.168.0.1
   DNS Servers . . . . . . . . . . . : 192.168.0.1
   NetBIOS over Tcpip. . . . . . . . : Enabled

[output omitted]
```

This PC was previously assigned this IP address by the DHCP server, so it asked to receive the same address again this time.

BASIC FUNCTIONS OF DHCP

```
C:\Users\user>ipconfig /all

[output omitted]

Ethernet adapter Ethernet0:

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Intel(R) 82579LM Gigabit Network Connection
   Physical Address. . . . . . . . . : 78-2B-CB-AC-08-67
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   IPv4 Address. . . . . . . . . . . : 192.168.0.167(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : Saturday, January 23, 2021 12:02:04 PM
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   DHCP Server . . . . . . . . . . . : 192.168.0.1
   DNS Servers . . . . . . . . . . . : 192.168.0.1
   NetBIOS over Tcpip. . . . . . . . : Enabled

[output omitted]
```
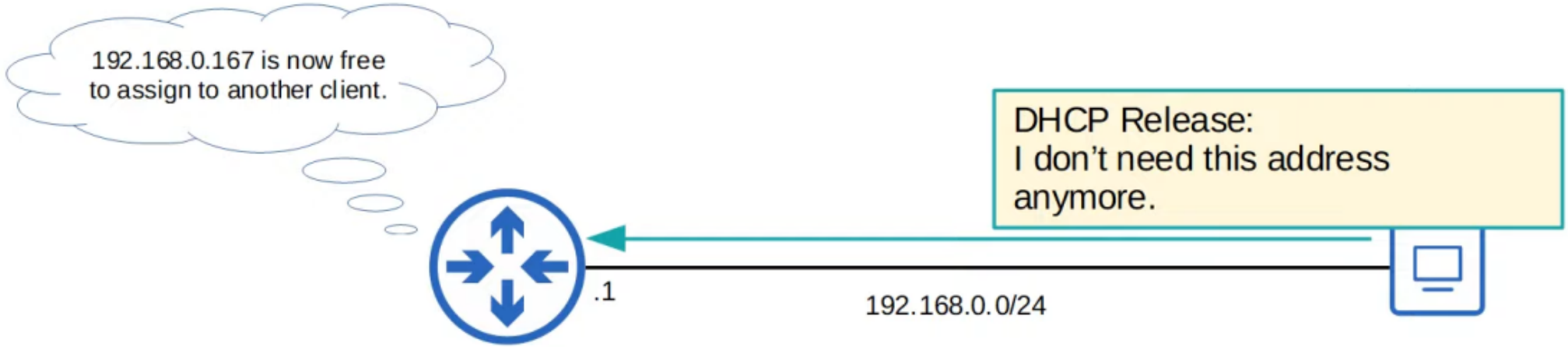

DHCP server 'lease' IP address to clients.
These leases are usually not permanent, and the client must give up the address at the end of the lease.

IPCONFIG / RELEASE

```
C:\Users\user>ipconfig /release

Windows IP Configuration

[output omitted]

Ethernet adapter Ethernet0:

   Connection-specific DNS Suffix  . :
   Default Gateway . . . . . . . . . :

[output omitted]
```



DHCP RELEASE

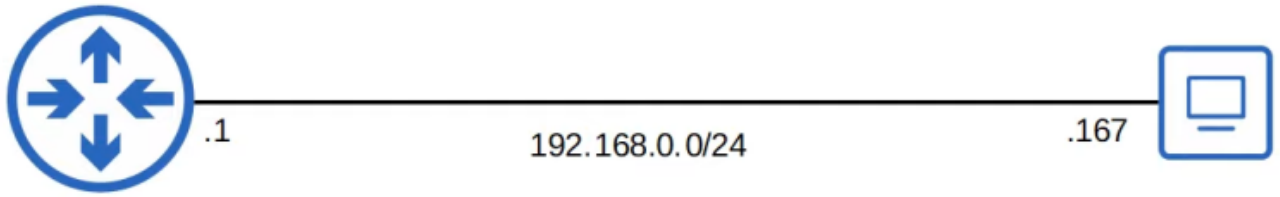
No.	Time	Source	Destination	Protocol	Length	Info
202	13:27:30.575529	192.168.0.167	192.168.0.1	DHCP	342	DHCP Release - Tran

```
> Frame 202: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits) on interface \Device\NPF_{
> Ethernet II, Src: Dell_ac:08:67 (78:2b:cb:ac:08:67), Dst: Tp-LinkT_dd:a8:e4 (98:da:c4:dd:a8:e4)
> Internet Protocol Version 4, Src: 192.168.0.167, Dst: 192.168.0.1
> User Datagram Protocol, Src Port: 68, Dst Port: 67
v Dynamic Host Configuration Protocol (Release)
    Message type: Boot Request (1)
    Hardware type: Ethernet (0x01)
    Hardware address length: 6
    Hops: 0
    Transaction ID: 0xc62f847a
    Seconds elapsed: 0
  > Bootp flags: 0x0000 (Unicast)
    Client IP address: 192.168.0.167
    Your (client) IP address: 0.0.0.0
    Next server IP address: 0.0.0.0
    Relay agent IP address: 0.0.0.0
    Client MAC address: Dell_ac:08:67 (78:2b:cb:ac:08:67)
    Client hardware address padding: 00000000000000000000
    Server host name not given
    Boot file name not given
    Magic cookie: DHCP
  > Option: (53) DHCP Message Type (Release)
  > Option: (54) DHCP Server Identifier (192.168.0.1)
  > Option: (61) Client identifier
  > Option: (255) End
    Padding: 0000000000000000000000000000000000000000000000…
```

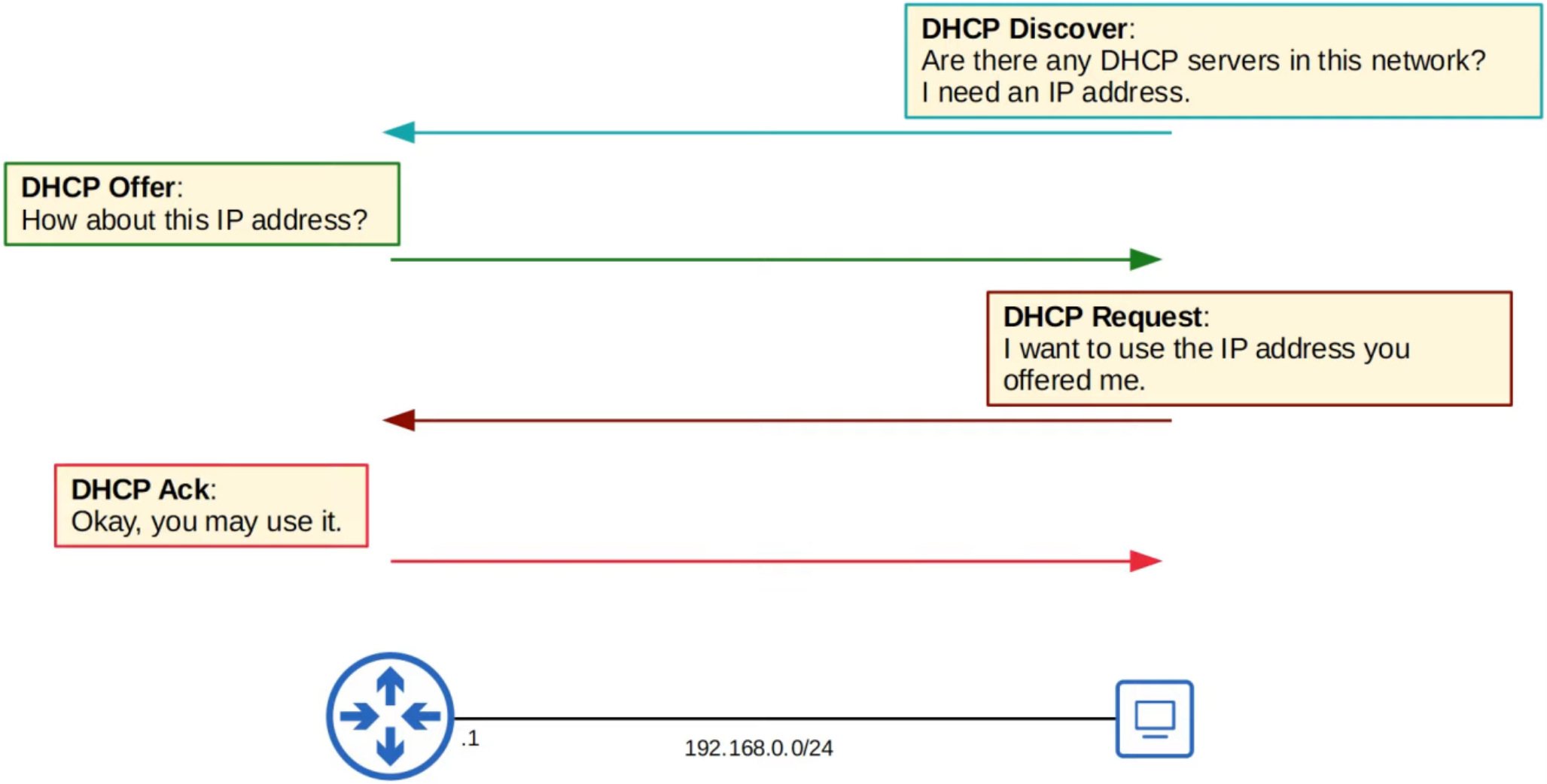
DHCP **servers** use UDP **67**.
DHCP **clients** use UDP **68**.

IPCONFIG / RENEW

```
C:\Users\user>ipconfig /renew

C:\Users\user>ipconfig /all


Ethernet adapter Ethernet0:

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Intel(R) 82579LM Gigabit Network Connection
   Physical Address. . . . . . . . . : 78-2B-CB-AC-08-67
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   IPv4 Address. . . . . . . . . . . : 192.168.0.167(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : Saturday, January 23, 2021 3:07:39 PM
   Lease Expires . . . . . . . . . . : Saturday, January 23, 2021 5:07:38 PM
   Default Gateway . . . . . . . . . : 192.168.0.1
   DHCP Server . . . . . . . . . . . : 192.168.0.1
   DNS Servers . . . . . . . . . . . : 192.168.0.1
   NetBIOS over Tcpip. . . . . . . . : Enabled
```



DHCP PROCESSES

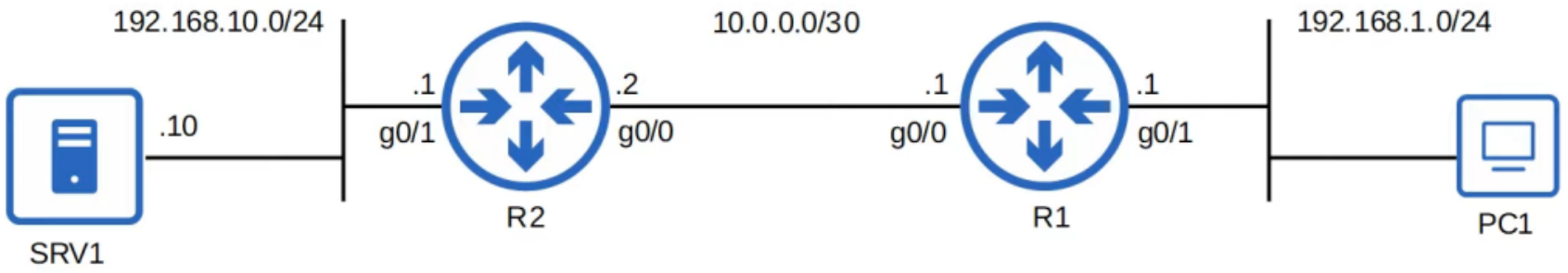


DHCP PROCESSES

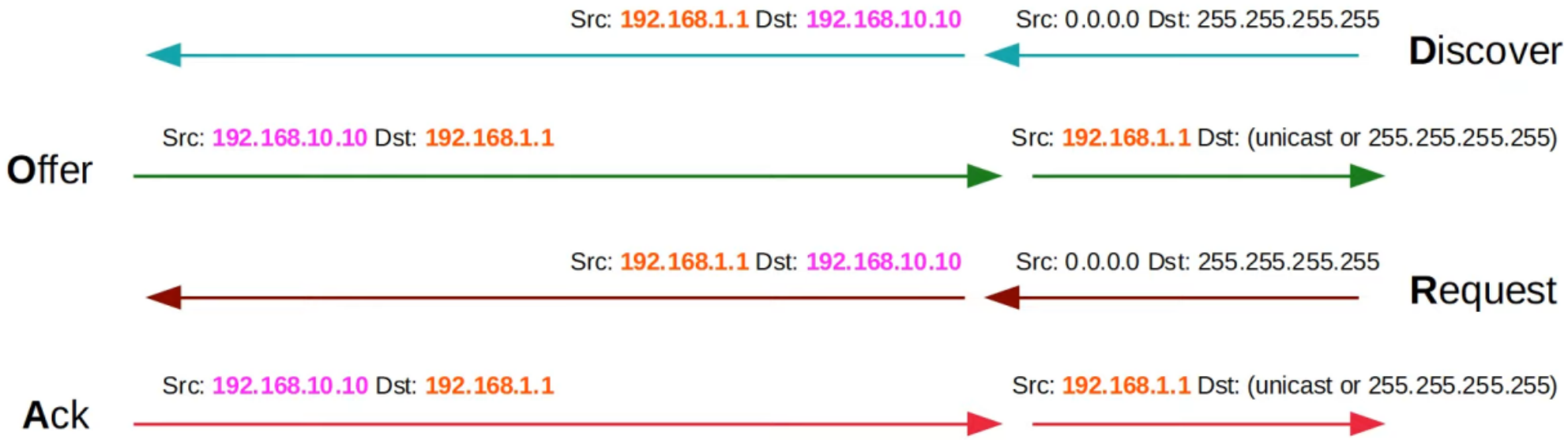
Discover	Client → Server	Broadcast
Offer	Server → Client	Broadcast or Unicast
Request	Client → Server	Broadcast
Ack	Server → Client	Broadcast or Unicast
Release	Client → Server	Unicast

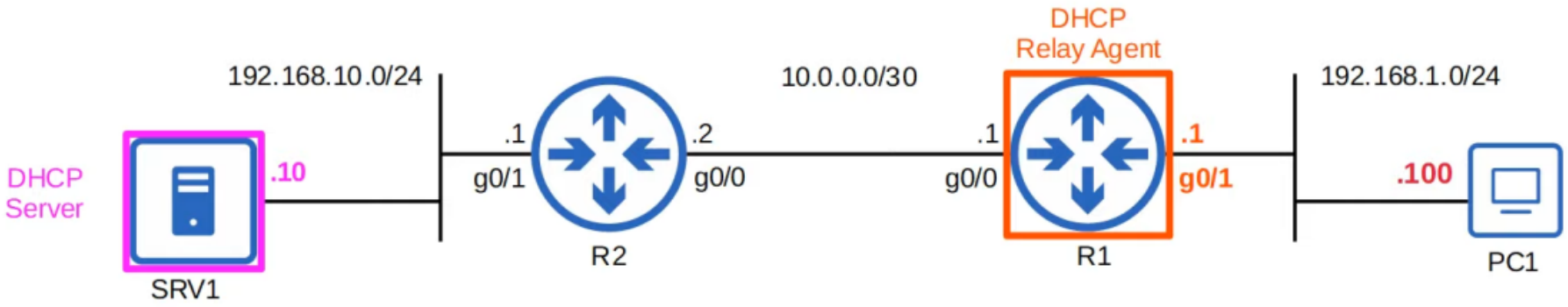
DHCP RELAY AGENT

- Some network engineers might choose to configure each router to act as the DHCP server for its connected LANs.
- However, large enterprises often choose to use a centralized DHCP server.
- If the server is centralized, it won't receive the DHCP clients' broadcast DHCP messages. (broadcast messages don't leave the local subnet)
- To fix this, you can configure a router to act as a **DHCP relay agent**.
- The router will forward the clients' broadcast DHCP messages to the remote DHCP server as unicast messages.



DHCP RELAY AGENT





CONFIGURING DHCP IN CISCO IOS

1. CONFIGURING CISCO ROUTER AS DHCP SERVER

```
R1(config)#ip dhcp excluded-address 192.168.1.1 192.168.1.10
```
Specify a range of addresses that **won't** be given to DHCP clients.

```
R1(config)#ip dhcp pool LAB_POOL
```
Create a DHCP pool.

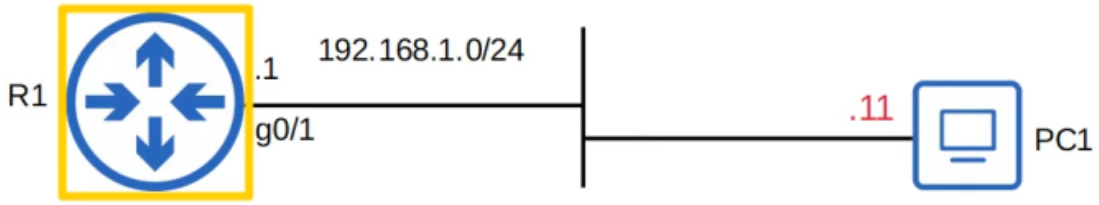
```
R1(dhcp-config)#network 192.168.1.0 ?
  /nn or A.B.C.D  Network mask or prefix length
  <cr>

R1(dhcp-config)#network 192.168.1.0 /24
```
Specify the subnet of addresses to be assigned to clients (except the excluded addresses)

```
R1(dhcp-config)#dns-server 8.8.8.8
```
Specify the DNS server that DHCP clients should use.

```
R1(dhcp-config)#default-router 192.168.1.1
```
Specify the default gateway.

We can specify the domain name here: *domain-name letranduc.com*

```
R1(dhcp-config)#lease 0 5 30
```
Specify the lease time.
lease *days hours minutes* OR
lease infinite

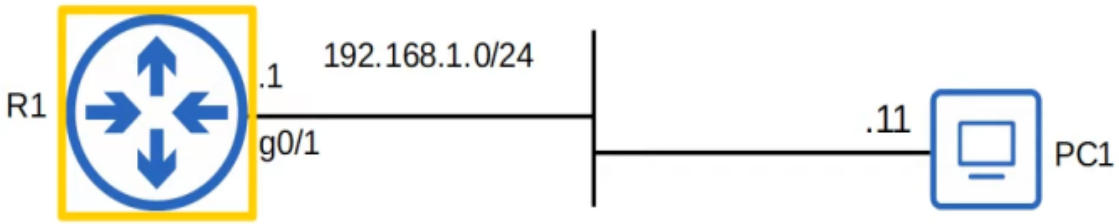


CONFIGURING DHCP IN CISCO IOS

1. CONFIGURING CISCO ROUTER AS DHCP SERVER

```
R1#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
192.168.1.11        0100.0c29.e727.39       Jan 24 2021 10:52 AM    Automatic
```

```
C:\Users\user>ipconfig /all

   Description . . . . . . . . . . . : Intel(R) PRO/1000 MT Network Connection #2
   Physical Address. . . . . . . . . : 00-0C-29-E7-27-39
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   IPv4 Address. . . . . . . . . . . : 192.168.1.11(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : Saturday, January 24, 2021 2:22:35 PM
   Lease Expires . . . . . . . . . . : Saturday, January 24, 2021 7:52:35 PM
   Default Gateway . . . . . . . . . : 192.168.1.1
   DHCP Server . . . . . . . . . . . : 192.168.1.1
   DNS Servers . . . . . . . . . . . : 8.8.8.8
   NetBIOS over Tcpip. . . . . . . . : Enabled
```



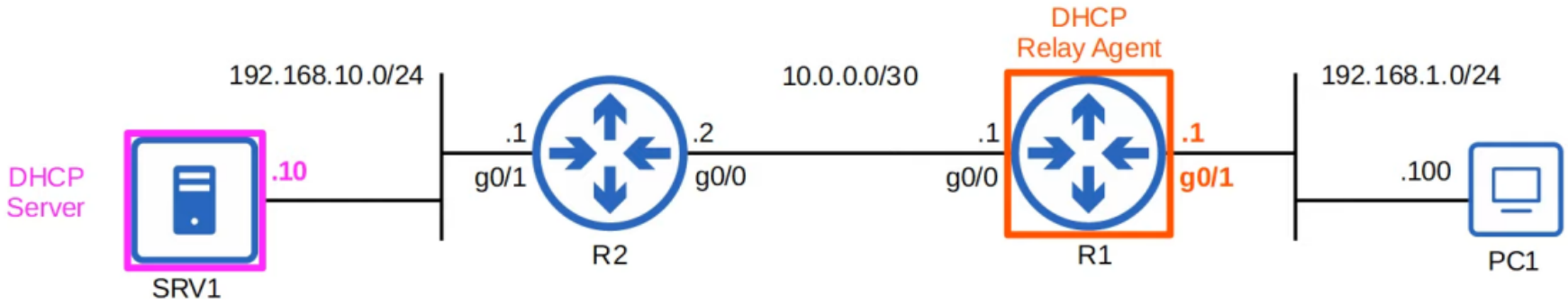
CONFIGURING DHCP IN CISCO IOS

2. CONFIGURING CISCO ROUTER AS DHCP RELAY AGENT

```
R1(config)#interface g0/1
R1(config-if)#ip helper-address 192.168.10.10

R1(config-if)#do show ip interface g0/1
GigabitEthernet0/1 is up, line protocol is up
  Internet address is 192.168.1.1/24
  Broadcast address is 255.255.255.255
  Address determined by non-volatile memory
  MTU is 1500 bytes
  Helper address is 192.168.10.10

[output omitted]
```

Configure the interface connected to the subnet of the client devices.

Configure the IP address of the DHCP server as the 'helper' address.

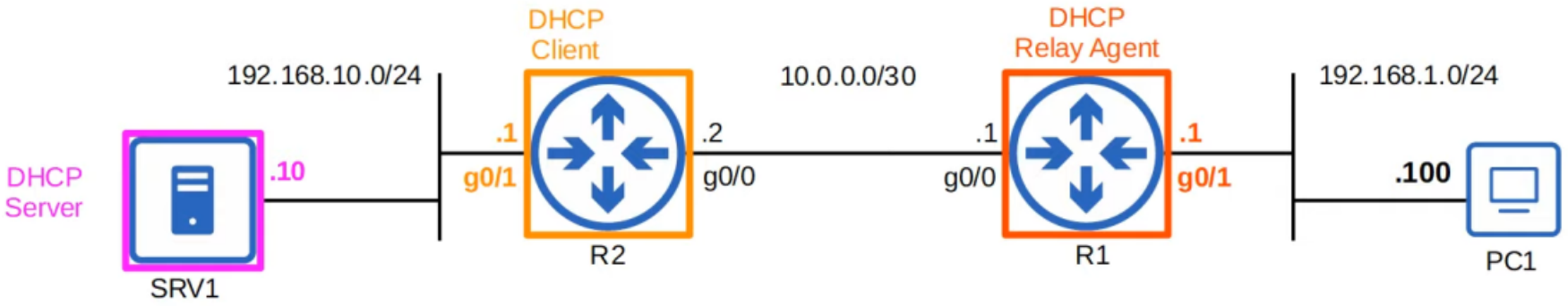


CONFIGURING DHCP IN CISCO IOS

3. CONFIGURING CISCO ROUTER AS DHCP CLIENT

```
R2(config)#interface g0/1
R2(config-if)#ip address dhcp

R2(config-if)#do sh ip interface g0/1
GigabitEthernet0/1 is up, line protocol is up
  Internet address is 192.168.10.1/24
  Broadcast address is 255.255.255.255
  Address determined by DHCP

[output omitted]
```

Use the **ip address dhcp** mode to tell the router to use DHCP to learn its IP address.



COMMAND SUMMARY

```
C:\Users\user> ipconfig /release
C:\Users\user> ipconfig /renew
```

```
R1(config)# ip dhcp excluded-address low-address high-address
R1(config)# ip dhcp pool pool-name
R1(dhcp-config)# network ip-address {/prefix-length | subnet-mask}
R1(dhcp-config)# dns-server ip-address
R1(dhcp-config)# domain-name domain-name
R1(dhcp-config)# default-router ip-address
R1(dhcp-config)# lease {days hours minutes | infinite}
R1# show ip dhcp binding
```

DHCP server

```
R1(config-if)# ip helper-address ip-address
```

DHCP relay agent

```
R1(config-if)# ip address dhcp
```

DHCP client