# Chapter 10: DHCP

## Routing and Switching Essentials

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# Chapter 10



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# Chapter 10: Objectives

- Describe the operation of DHCPv4 in a small-to-medium sized business network.
- Configure a router as a DHCPv4 server.
- Configure a router as a DHCPv4 client.
- Troubleshoot a DHCP configuration for IPv4 in a switched network.
- Explain the operation of DHCPv6.
- Configure a stateless DHCPv6 for a small to medium-sized business.
- Configure a stateful  DHCPv6 for a small to medium-sized business.
- Troubleshoot a DHCP configuration for IPv6 in a switched network.

10.0.1.1

# Introduction

- Dynamic Host Configuration Protocol (DHCP) is a network protocol that provides automatic IP addressing and other information to clients:IP address
  - Subnet mask (IPv4) or prefix length (IPv6)
  - Default gateway address
  - DNS server address
- Available for both IPv4and IPv6
- This chapter explores the functionality, configuration, and troubleshooting of both DHCPv4 and DHCPv6

10.0.1.1

# Introducing DHCPv4

- DHCPv4 uses three different address allocation methods

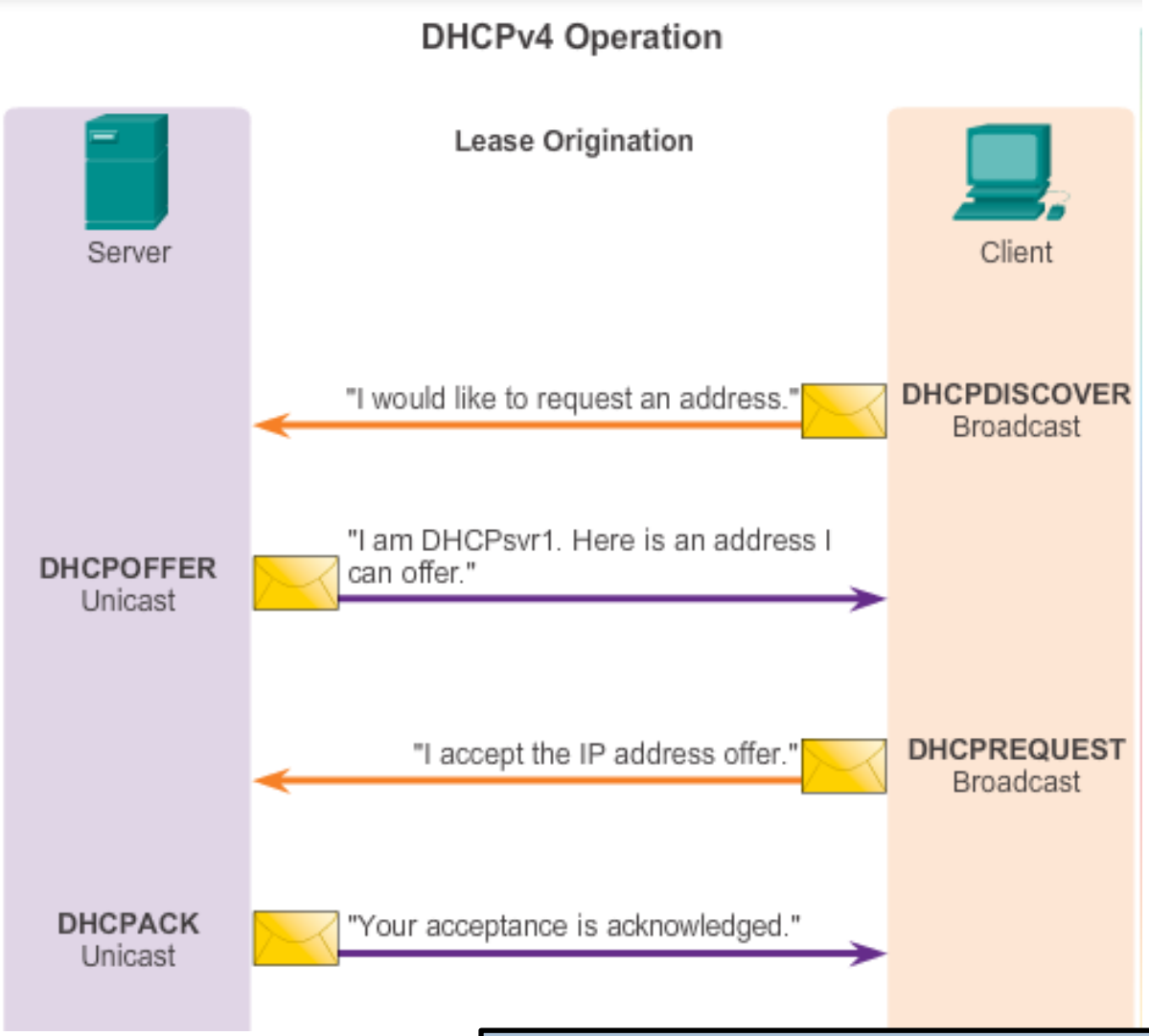
  **Manual Allocation** - The administrator assigns a pre-allocated IPv4 address to the client, and DHCPv4 communicates only the IPv4 address to the device.

  **Automatic Allocation** - DHCPv4 automatically assigns a static IPv4 address permanently to a device, selecting it from a pool of available addresses. No lease.

  **Dynamic Allocation** - DHCPv4 dynamically assigns, or leases, an IPv4 address from a pool of addresses for a limited period of time chosen by the server, or until the client no longer needs the address. Most commonly used.

10.1.1.1

# Introducing DHCPv4




10.1.1.2

Do buttons on 10.1.1.2

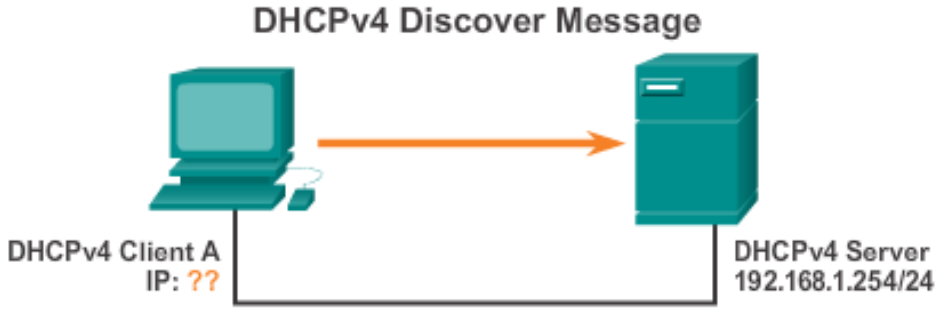
# DHCPv4 Message Format

**DHCPv4 Message Format**

| 8 | 16 | 24 | 32 |
|---|---|---|---|
| OP Code (1) | Hardware type (1) | Hardware address length (1) | Hops (1) |
| Transaction Identifier | | | |
| Seconds - 2 bytes | | Flags - 2 bytes | |
| Client IP Address (CIADDR) - 4 bytes | | | |
| Your IP Address (YIADDR) - 4 bytes | | | |
| Server IP Address (SIADDR) - 4 bytes | | | |
| Gateway IP Address (GIADDR) - 4 bytes | | | |
| Client Hardware Address (CHADDR) - 16 bytes | | | |
| Server name (SNAME) - 64 bytes | | | |
| Boot Filename - 128 bytes | | | |
| DHCP Options - variable | | | |

10.1.1.3

# DHCPv4 Discover and Offer Messages




| Ethernet Frame | IP | UDP | DHCPDISCOVER |
|---|---|---|---|
| SRC MAC: MAC A<br>DST MAC:FF:FF:FF:FF:FF:FF | IP SRC: 0.0.0.0<br>IP DST:255.255.255.255 | UDP 67 | CIADDR: 0.0.0.0<br>GIADDR: 0.0.0.0<br>Mask: 0.0.0.0<br>CHADDR: MAC A |

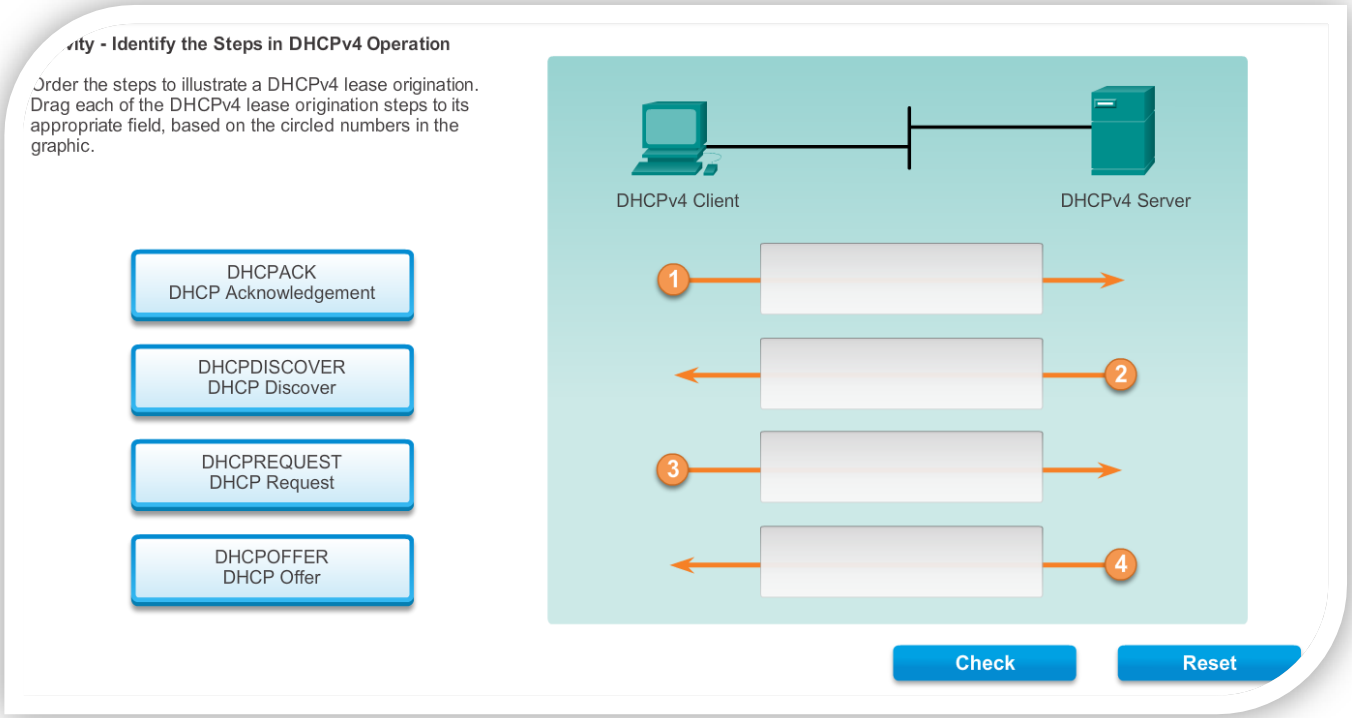
MAC: Media Access Control Address
CIADDR: Client IP Address
GIADDR: Gateway IP Address
CHADDR: Client Hardware Address

The DHCP client sends a directed IP broadcast with a DHCPDISCOVER packet. In this example, the DHCP server is on the same segment and will pick up this request. The server notes the GIADDR field is blank; therefore, the client is on the same segment. The server also notes the hardware address of the client in

10.1.1.4

Do buttons on 10.1.1.4

# DHCPv4 Discover and Offer Messages




Students do activity on 10.1.1.5

10.1.1.5

# Configuring a DHCPv4 Server

- A Cisco router running Cisco IOS software can be configured to act as a DHCPv4 server. To set up DHCP

  1.Exclude addresses from the pool.

  2. Set up DHCP pool name

  3. Configuring Specific Tasks –define range of addresses and subnet mask. Use default-router command for default gateway. Optional items that can be included in pool – dns server, domain-name

```
R1(config)# ip dhcp excluded-address 192.168.10.1 192.168.10.9
R1(config)# ip dhcp excluded-address 192.168.10.254
R1(config)# ip dhcp pool LAN-POOL-1
R1(dhcp-config)# network 192.168.10.0 255.255.255.0
R1(dhcp-config)# default-router 192.168.10.1
R1(dhcp-config)# dns-server 192.168.11.5
R1(dhcp-config)# domain-name example.com
R1(dhcp-config)# end
R1#
```

- To disable dhcp **- no service dhcp**

10.1.2.1

Do buttons on 10.1.2.1
Student practice on button 6

# Verifying a DHCPv4 Server

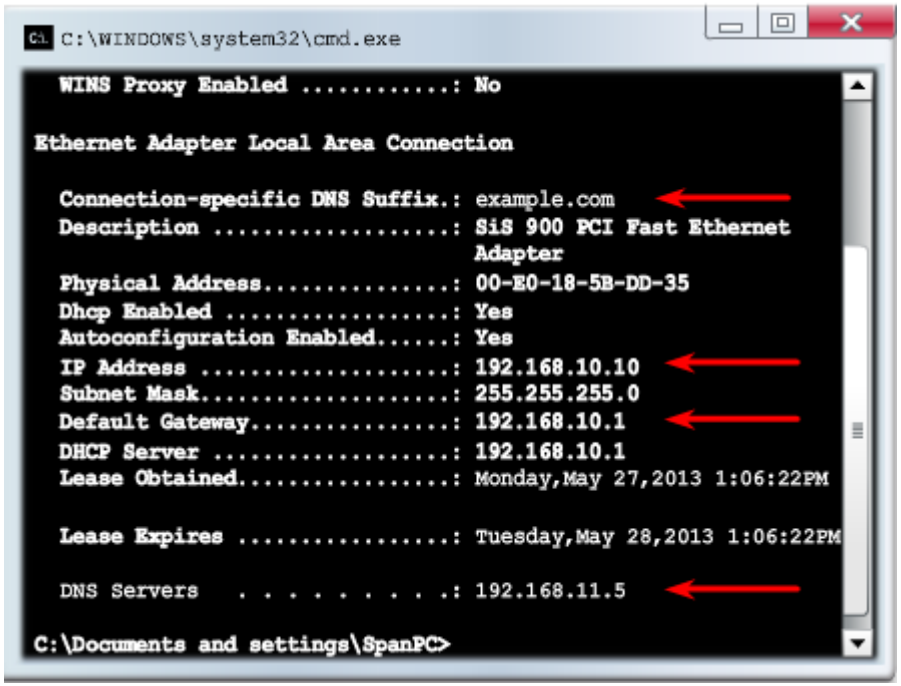
- Commands to verify DHCP

  **show running-config | section dhcp**

  **show ip dhcp binding**

  **show ip dhcp server statistics**

- On the PC **–issue the ipconfig /all command**




10.1.2.2

Do buttons on 10.1.2.2

# DHCPv4 Relay

- Using an IP helper address enables a router to forward DHCPv4 broadcasts to the DHCPv4 server. Acting as a relay.

```
R1(config)# interface g0/0
R1(config-if)# ip helper-address 192.168.11.6
R1(config-if)# end
R1# show ip interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet address is 192.168.10.1/24
  Broadcast address is 255.255.255.255
  Address determined by setup command
  MTU is 1500 bytes
  Helper address is 192.168.11.6
<Output omitted>
```

10.1.2.3

Do buttons on 10.1.2.3
Student practice on button 5

# Configuring a Router as DHCPv4 client


```
SOHO(config)# interface g0/1
SOHO(config-if)# ip address dhcp
SOHO(config-if)# no shutdown
SOHO(config-if)#
*Jan 31 17:31:11.507: %DHCP-6-ADDRESS_ASSIGN: Interface
GigabitEthernet0/1 assigned DHCP address 209.165.201.12, mask
255.255.255.224, hostname SOHO
SOHO(config-if)# end
SOHO# show ip interface g0/1
GigabitEthernet0/1 is up, line protocol is up
  Internet address is 209.165.201.12/27
  Broadcast address is 255.255.255.255
  Address determined by DHCP
  <Output omitted>
```

10.1.3.1

Do buttons on 10.1.3.1
Student practice on button 2

# Configuring a SOHO Router as a DHCPv4 Client

- Home routers are typically configured to get its Global IP address via DHCP from the ISP


10.1.3.2

# Troubleshooting Tasks

| | |
|---|---|
| Troubleshooting Task 1: | Resolve conflicts. |
| Troubleshooting Task 2: | Verify physical connectivity. |
| Troubleshooting Task 3: | Test with a static IPv4 address. |
| Troubleshooting Task 4: | Verify switch port configuration. |
| Troubleshooting Task 5: | Test from the same subnet or VLAN. |

10.1.4.1

# Verify Router DHCPv4 Configuration

When the DHCPv4 server is located on a separate LAN from the client,

**Verify:**

**Step 1.** Verify that the **ip helper-address** command is configured on the correct interface.

**Step 2:** Verify **no service dhcp**

## Verifying DHCPv4 Relay and DHCPv4 Services

```
R1# show running-config | section interface GigabitEthernet0/0
interface GigabitEthernet0/0
 ip address 192.168.10.1 255.255.255.0
 ip helper-address 192.168.11.6
 duplex auto
 speed auto
R1#

R1# show running-config | include no service dhcp
R1#
```

10.1.4.2

# Debugging DHCPv4

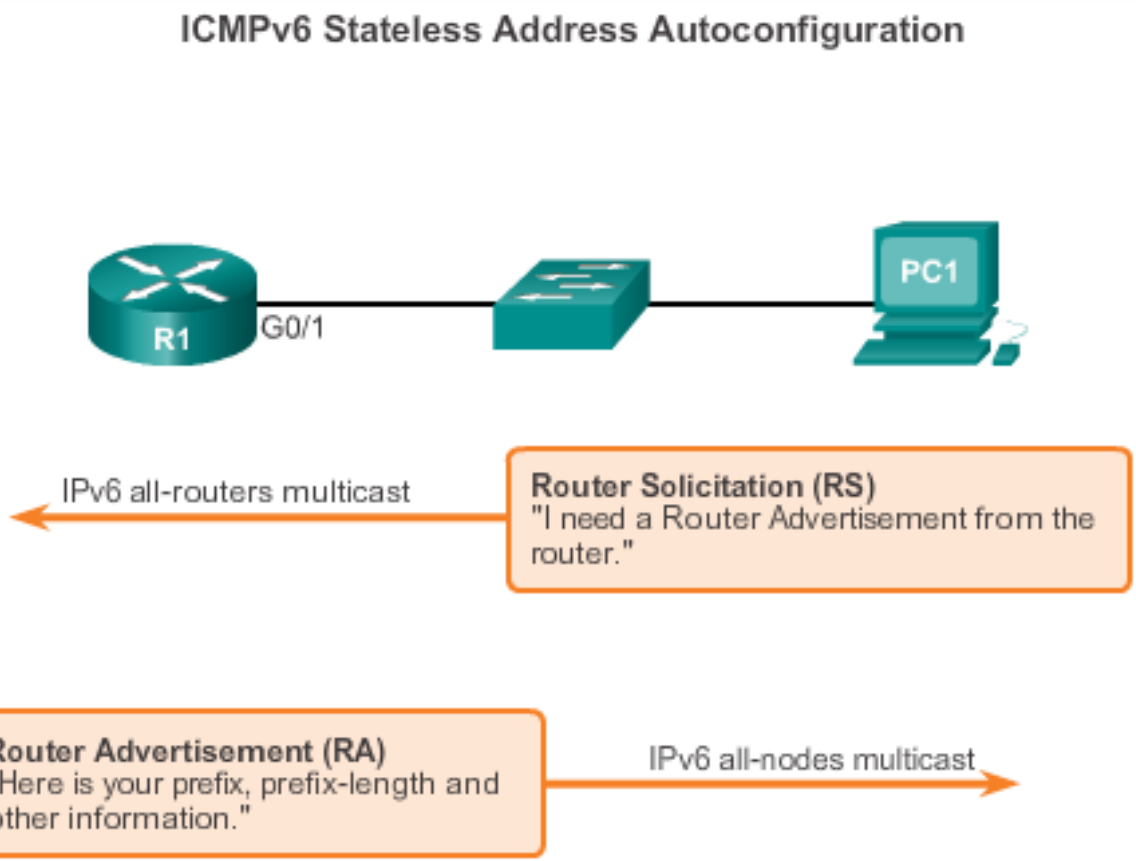
## Verifying DHCPv4 Using Router debug Commands

```
R1(config)# access-list 100 permit udp any any eq 67
R1(config)# access-list 100 permit udp any any eq 68
R1(config)# end
R1# debug ip packet 100
IP packet debugging is on for access list 100
*IP: s=0.0.0.0 (GigabitEthernet0/1), d=255.255.255.255, len 333,
rcvd 2
*IP: s=0.0.0.0 (GigabitEthernet0/1), d=255.255.255.255, len 333,
stop process pak for forus packet
*IP: s=192.168.11.1 (local), d=255.255.255.255
(GigabitEthernet0/1), len 328, sending broad/multicast

<Output omitted>

Router1# debug ip dhcp server events
DHCPD: returned 192.168.10.11 to address pool LAN-POOL-1
DHCPD: assigned IP address 192.168.10.12 to client
0100.0103.85e9.87.
DHCPD: checking for expired leases.
DHCPD: the lease for address 192.168.10.10 has expired.
DHCPD: returned 192.168.10.10 to address pool LAN-POOL-1
```

10.1.4.3

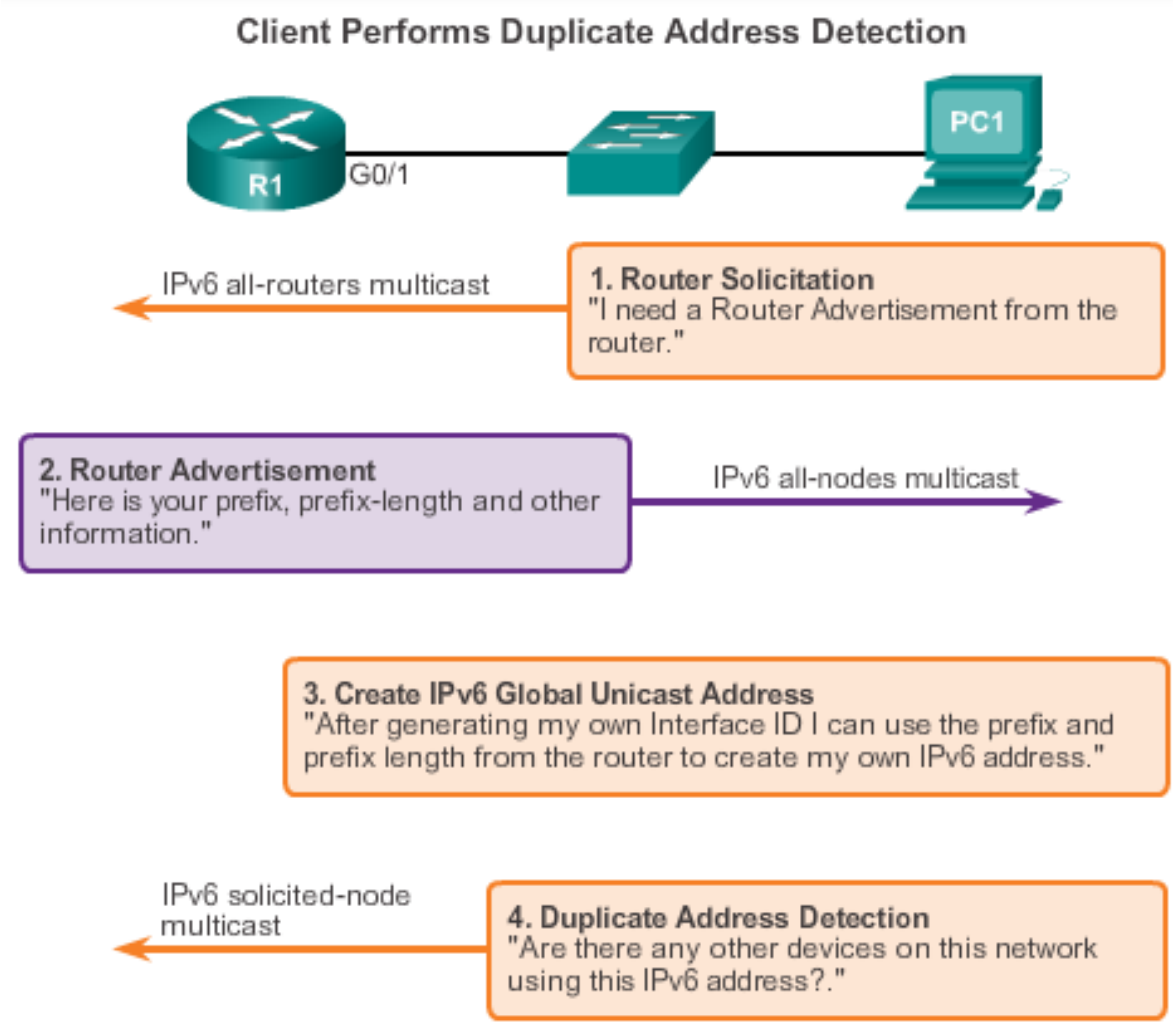
# Stateless Address Autoconfiguration (SLAAC)

SLAAC is a method in which a device can obtain an IPv6 global unicast address without the services of a DHCPv6 server.




10.2.1.1

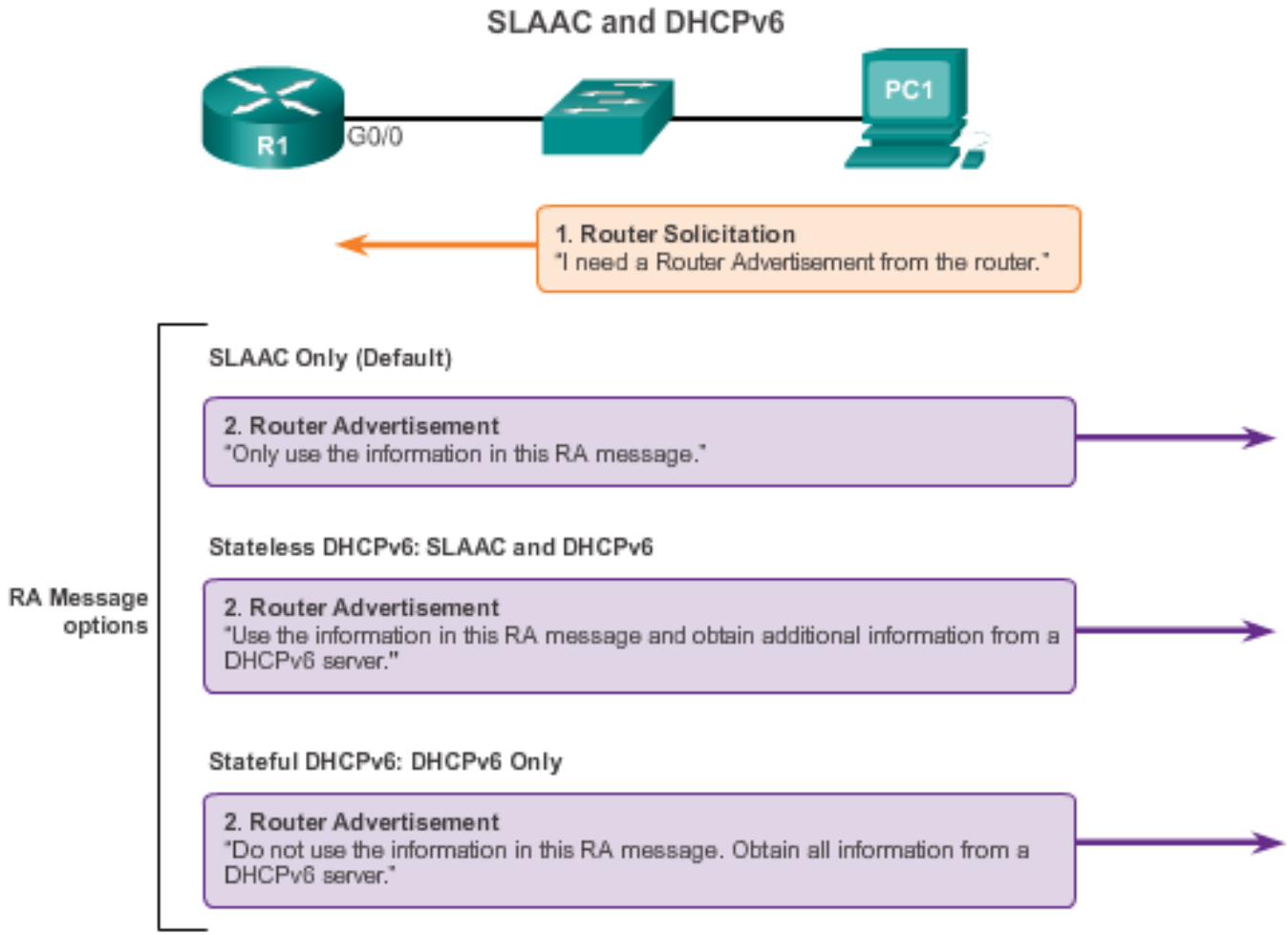
# SLAAC Operation




10.2.1.2

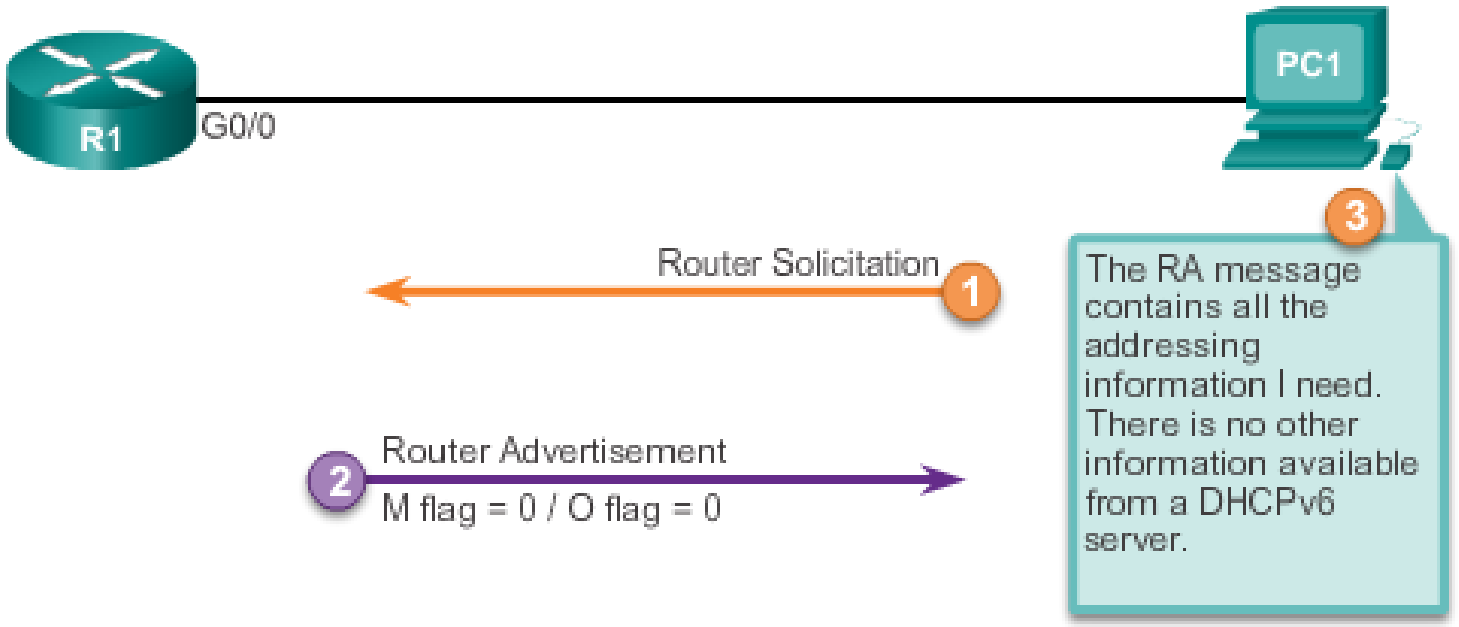
Do buttons on 10.2.1.2

# SLAAC and DHCPv6



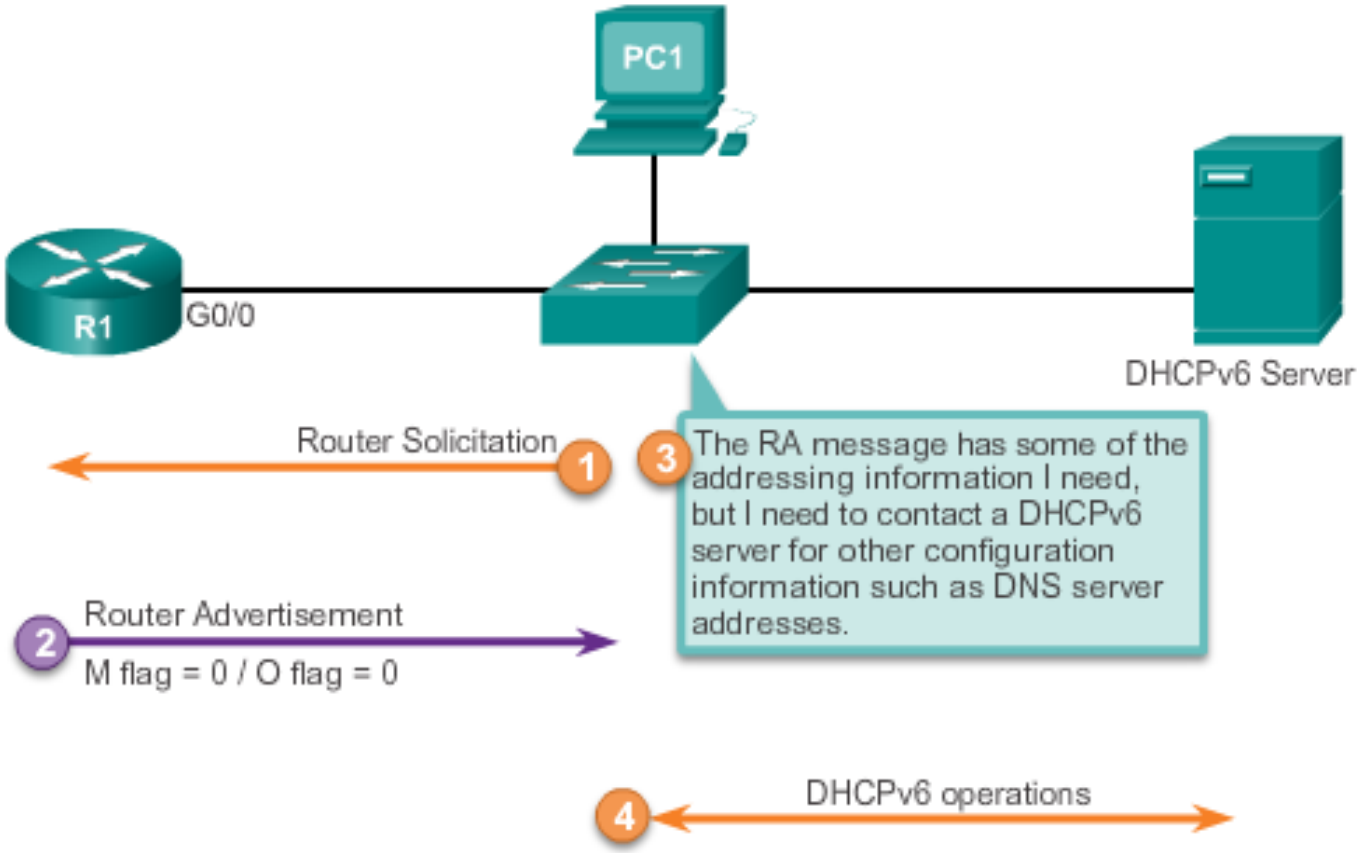

10.2.1.3

# SLAAC Option



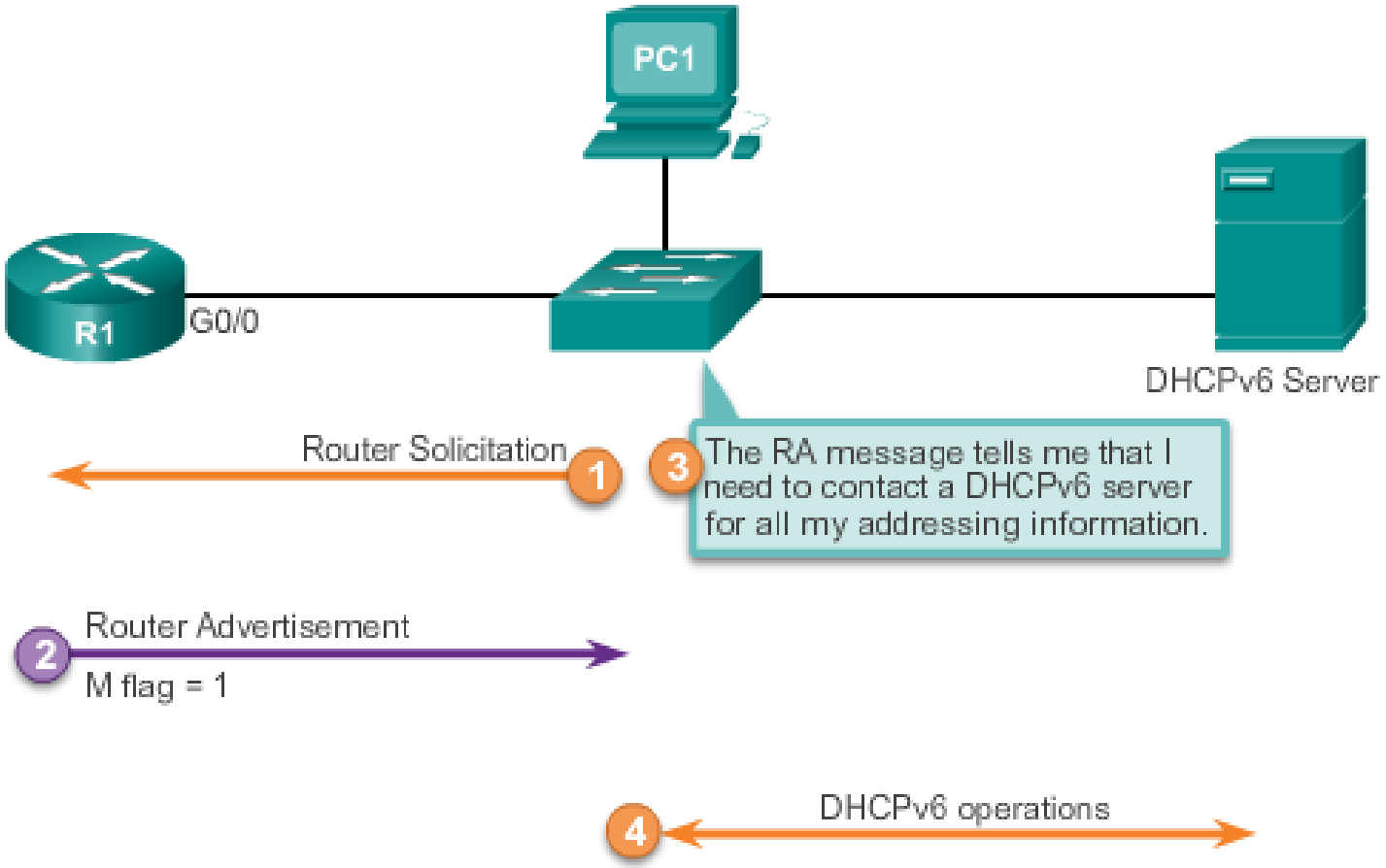

10.2.1.4

# Stateless DHCP Option



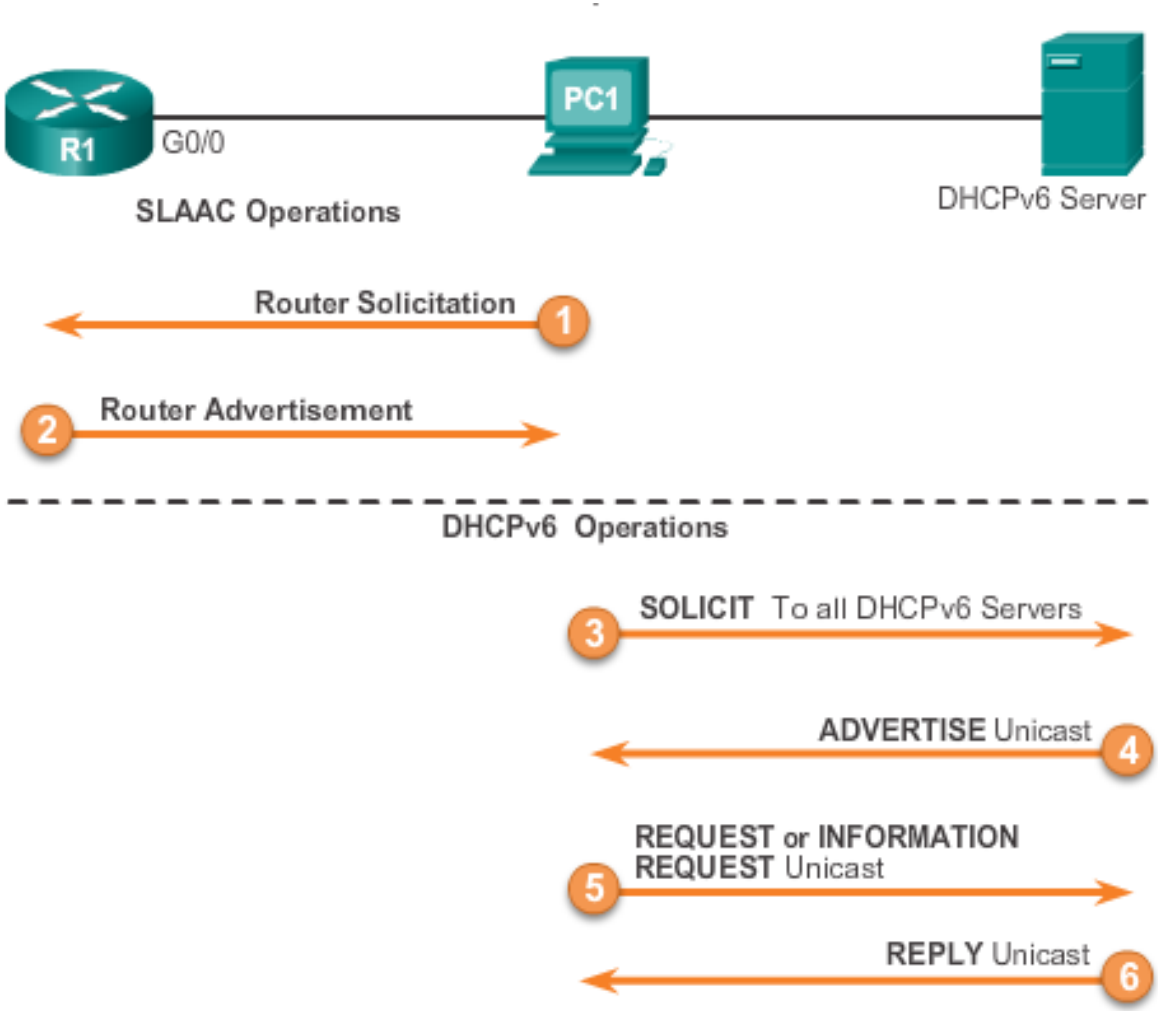

10.2.1.5

# Stateful DHCP Option




10.2.1.6

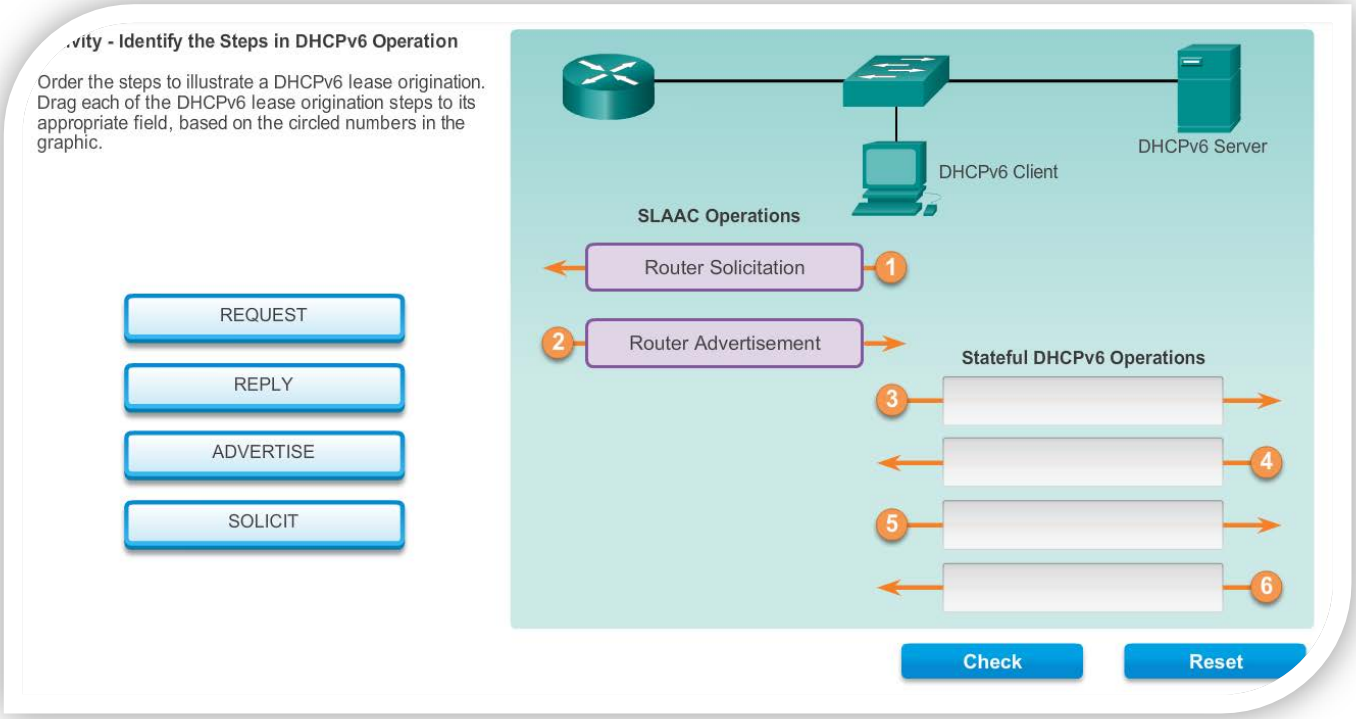
# DHCPv6 Operations




10.2.1.7

Do buttons on 10.2.1.7

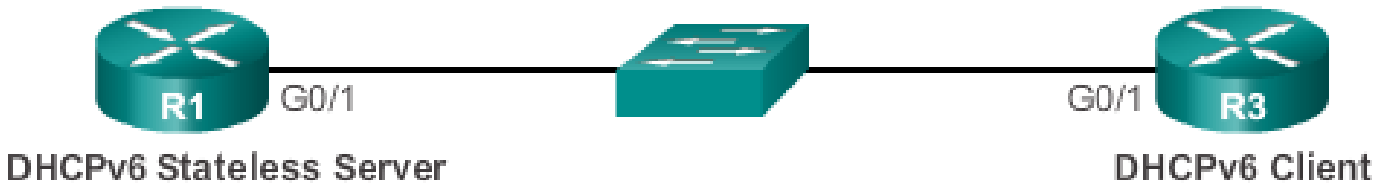
# SLAAC and DHCPv6
# 10.2.1.8 Activity - Identify the Steps in DHCPv6 Operation




Do activity on 10.2.1.8

10.2.1.8

# Configuring a Router as a Stateless DHCPv6 Server

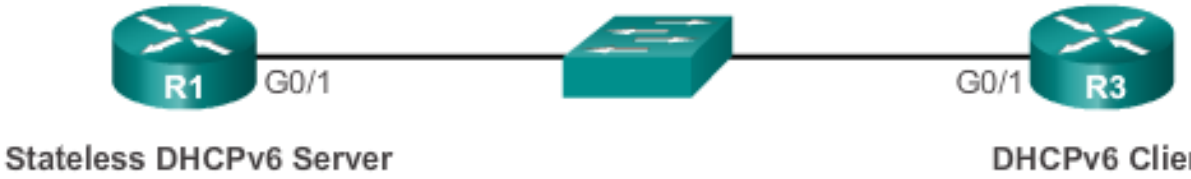



```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATELESS
R1(config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1(config-dhcpv6)# domain-name example.com
R1(config-dhcpv6)# exit
R1(config)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 dhcp server IPV6-STATELESS
R1(config-if)# ipv6 nd other-config-flag
```

10.2.2.1

Do buttons on 10.2.2.1

# Configuring a Router as a Stateless DHCPv6 Client




```
R3(config)# interface g0/1
R3(config-if)# ipv6 enable
R3(config-if)# ipv6 address autoconfig
R3(config-if)#
```

- Verify the Stateless DHCP Client using:

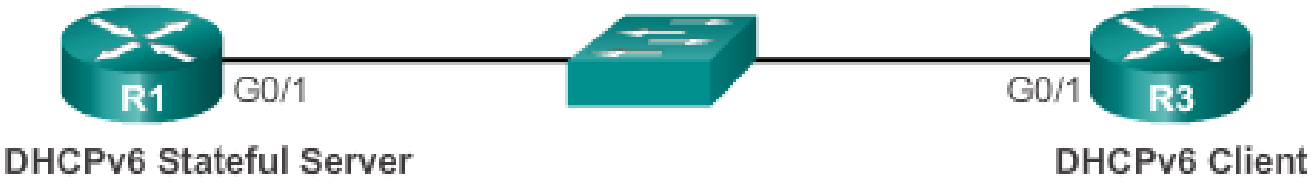
  Show IPv6 interface

  Debug ipv6 dhcp detail

10.2.2.2, 10.2.2.3

Do buttons on 10.2.2.3

# Configuring a Router as a Stateful DHCPv6 Server

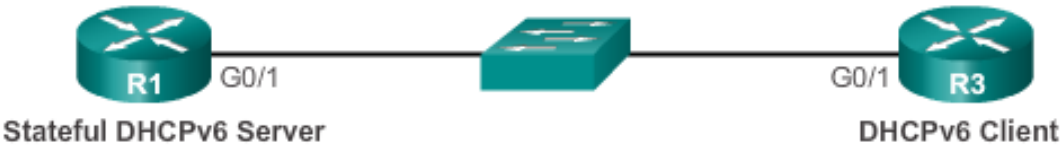



```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATEFUL
R1(config-dhcpv6)# address prefix 2001:DB8:CAFE:1::/64
                    lifetime infinite infinite
R1(config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1(config-dhcpv6)# domain-name example.com
R1(config-dhcpv6)# exit
R1(config)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 dhcp server IPV6-STATEFUL
R1(config-if)# ipv6 nd managed-config-flag
```

10.2.3.1

Do buttons on 10.2.3.1

# Configuring a Router as a Stateful DHCPv6 Client




```
R3(config)# interface g0/1
R3(config-if)# ipv6 enable
R3(config-if)# ipv6 address dhcp
R3(config-if)#
```

Verify Stateful DHCPv6 Server using:

**show ipv6 dhcp pool**

**show ipv6 dhcp binding**

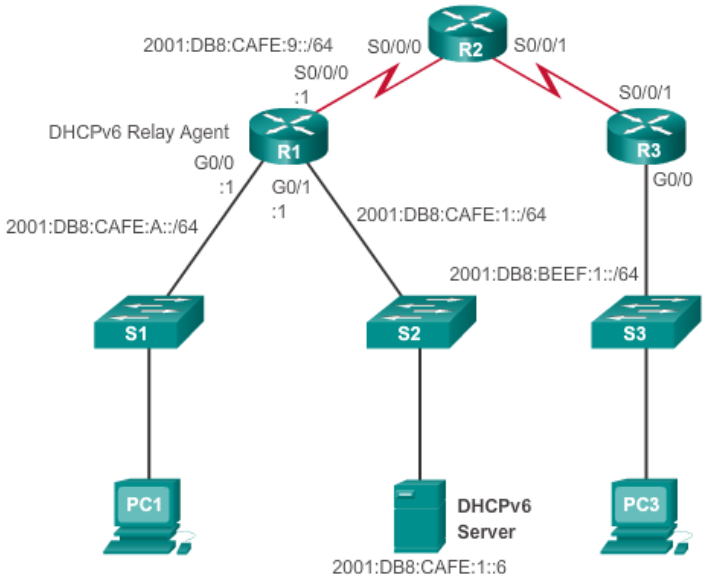
Verify Stateful DHCPv6 client using:

**show ipv6 interface**

10.2.3.2, 10.2.3.3

Do buttons on 10.2.3.3

# Config a Router as a Stateful DHCPv6 Relay Agent




```
R1(config)# interface g0/0
R1(config-if)# ipv6 dhcp relay destination 2001:db8:cafe:1::6
R1(config-if)# end
R1# show ipv6 dhcp interface g0/0
GigabitEthernet0/0 is in relay mode
  Relay destinations:
    2001:DB8:CAFE:1::6
R1#
```

10.2.3.4

Do buttons on 10.2.3.4

# Troubleshooting Tasks

| | |
|---|---|
| Troubleshooting Task 1: | Resolve conflicts. |
| Troubleshooting Task 2: | Verify allocation method. |
| Troubleshooting Task 3: | Test with a static IPv6 address. |
| Troubleshooting Task 4: | Verify switch port configuration. |
| Troubleshooting Task 5: | Test from the same subnet or VLAN. |

10.2.4.1

# Verify Router DHCPv6 Configuration

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATEFUL
R1(config-dhcpv6)# address prefix 2001:DB8:CAFE:1::/64 lifetime
infinite infinite
R1(config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1(config-dhcpv6)# domain-name example.com
R1(config-dhcpv6)# exit
R1(config)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 dhcp server IPV6-STATEFUL
R1(config-if)# ipv6 nd managed-config-flag
```

Stateless DHCPv6 Services

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATELESS
R1(config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1(config-dhcpv6)# domain-name example.com
R1(config-dhcpv6)# exit
R1(config)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 dhcp server IPV6-STATELESS
R1(config-if)# ipv6 nd other-config-flag
```

10.2.4.2

Do buttons on 10.2.4.2

# Debugging DHCPv6

```
R1# debug ipv6 dhcp detail
   IPv6 DHCP debugging is on (detailed)
R1#
*Feb  3 21:27:41.123: IPv6 DHCP: Received SOLICIT from
FE80::32F7:DFF:FE25:2DE1 on GigabitEthernet0/1
*Feb  3 21:27:41.123: IPv6 DHCP: detailed packet contents
*Feb  3 21:27:41.123:   src FE80::32F7:DFF:FE25:2DE1
(GigabitEthernet0/1)
*Feb  3 21:27:41.127:   dst FF02::1:2
*Feb  3 21:27:41.127:   type SOLICIT(1), xid 13190645
*Feb  3 21:27:41.127:   option ELAPSED-TIME(8), len 2
*Feb  3 21:27:41.127:     elapsed-time 0
*Feb  3 21:27:41.127:   option CLIENTID(1), len 10
*Feb  3 21:27:41.127:     000
*Feb  3 21:27:41.127: IPv6 DHCP: Using interface pool IPV6-
STATEFUL
*Feb  3 21:27:41.127: IPv6 DHCP: Creating binding for
FE80::32F7:DFF:FE25:2DE1 in pool IPV6-STATEFUL
```

<Output omitted>

10.2.4.3

# Chapter 10: Summary

- All nodes on a network require a unique IP address to communicate with other devices.
- DHCPv4 includes three different address allocation methods:

  **Manual Allocation**

  **Automatic Allocation**

  **Dynamic Allocation**

- There are two methods available for the dynamic configuration of IPv6 global unicast addresses.

  **Stateless Address Autoconfiguration (SLAAC )**

  **Dynamic Host Configuration Protocol for IPv6 (Stateful DHCPv6)**

10.3.1.1

# Chapter 10: Summary (Continued)

- The same tasks are involved when troubleshooting DHCPv4 and DHCPv6:
  - Resolve Address Conflicts
  - Verify Physical Connectivity
  - Test Connectivity using a Static IP Address
  - Verify Switch Port Configuration
  - Test Operation on the Same Subnet or VLAN

10.3.1.1

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