



# Chapter 10: DHCP



## Routing & Switching

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# Chapter 10

10.0 Introduction

10.1 Dynamic Host Configuration Protocol v4

10.2 Dynamic Host Configuration Protocol v6

10.3 Summary



# 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.



## 10.1 Dynamic Host Configuration Protocol v4



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## DHCPv4 Operation

# Introducing DHCPv4

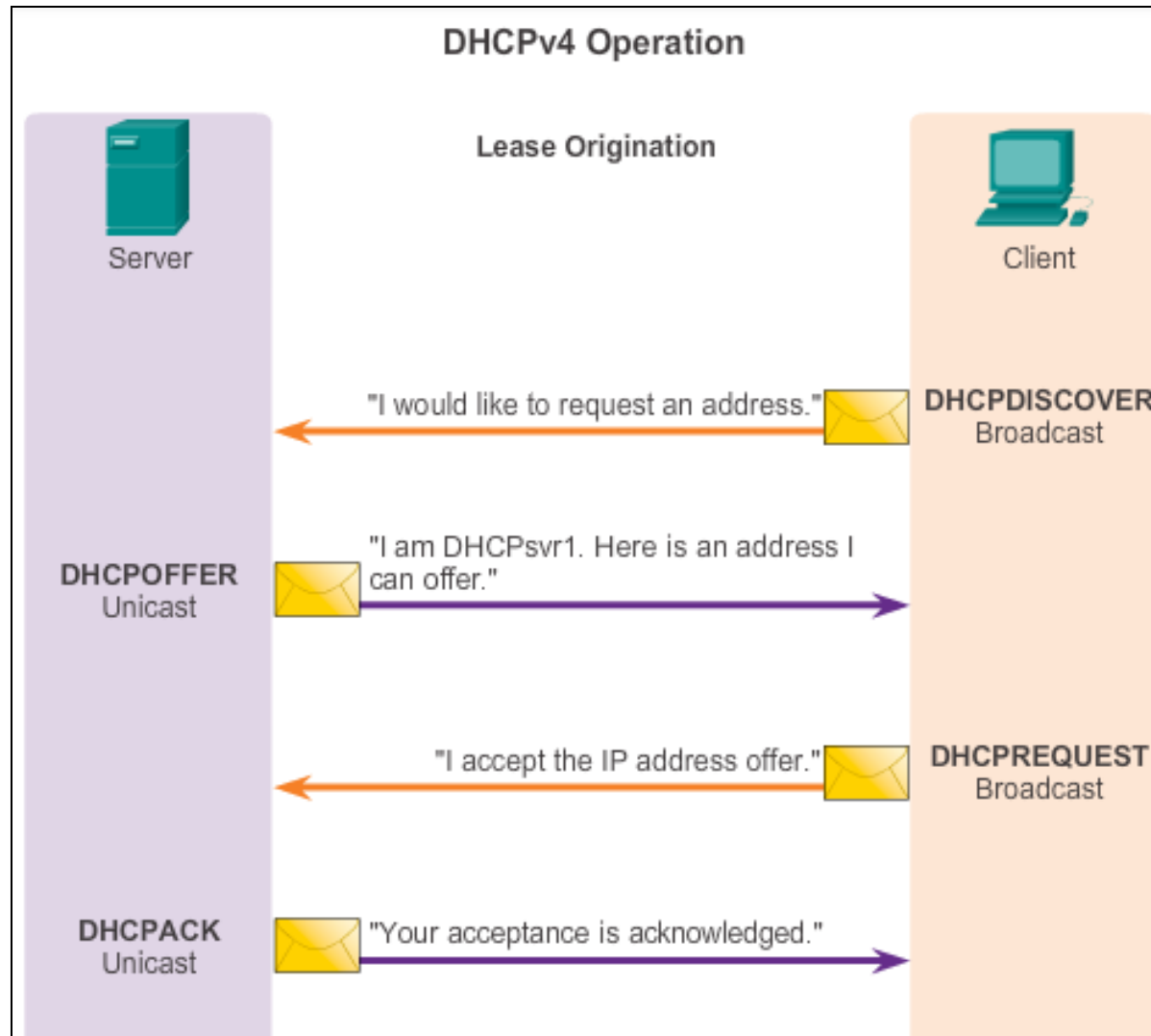
DHCPv4 uses three different address allocation methods:

- **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.
- **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. This method is the most commonly used.



# DHCPv4 Operation

## DHCPv4 Operation





## DHCPv4 Operation

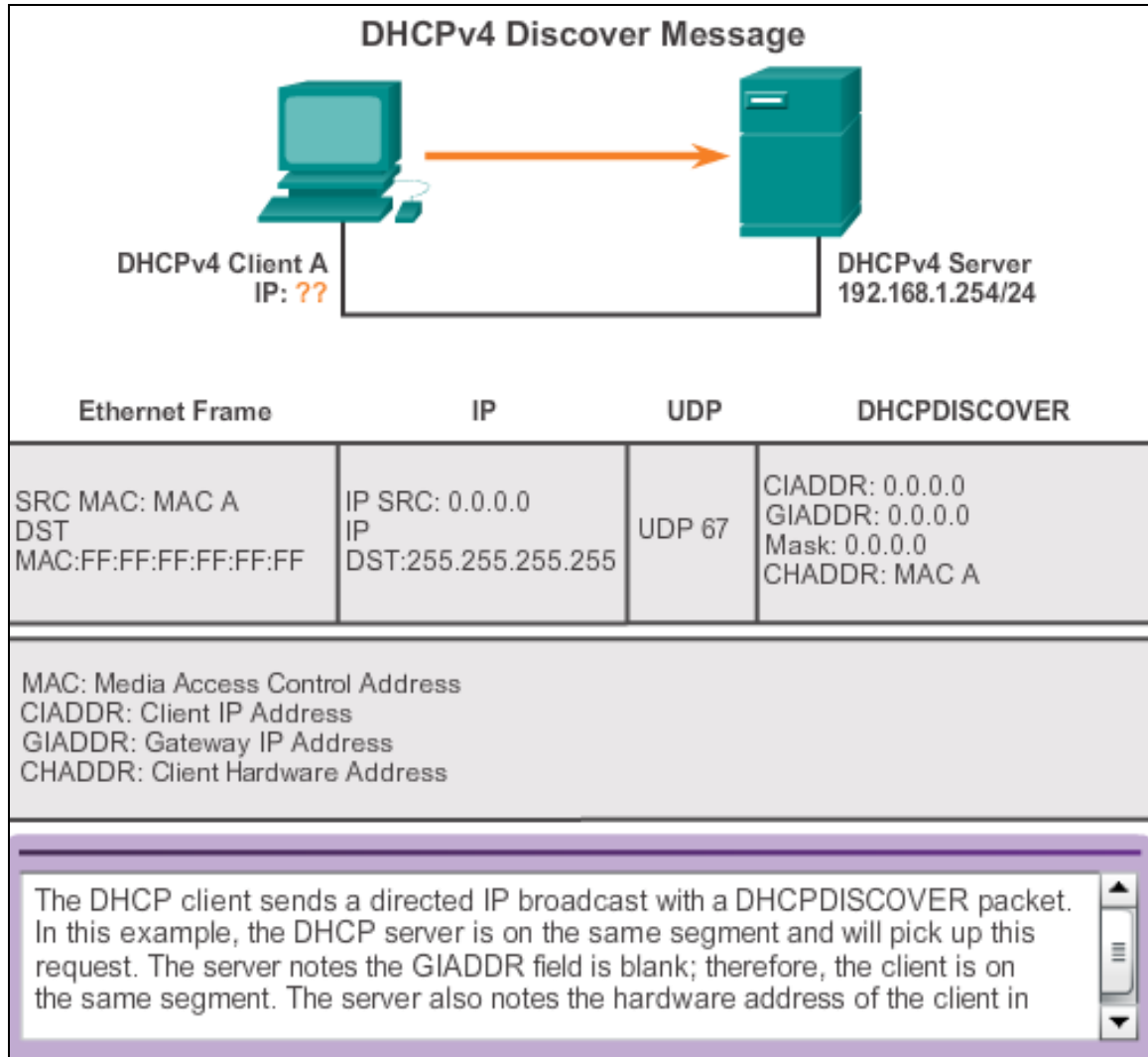
# DHCPv4 Message Format

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			



# DHCPv4 Operation

## Format DHCPv4 Discover and Offer Messages







## DHCPv4 Operation

# Configuring a DHCPv4 Server

A Cisco router running the 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 the DHCP pool name.
3. Define the range of addresses and subnet mask. Use the **default-router** command for the default gateway. Optional parameters that can be included in the *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 #
```

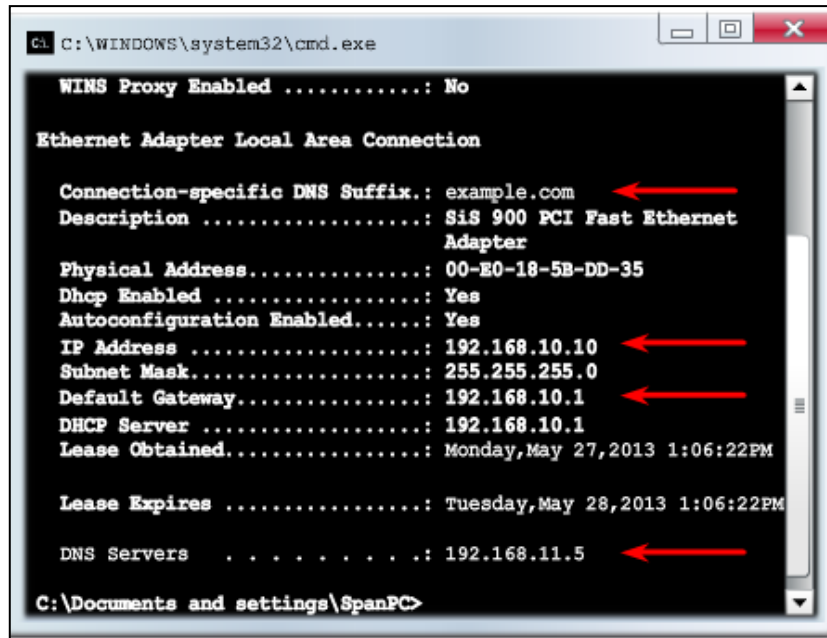
To disable DHCP, use the **no service dhcp** command.



## DHCPv4 Operation

# 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.



```

c:\WINDOWS\system32\cmd.exe

WINS Proxy Enabled .....: No

Ethernet Adapter Local Area Connection

Connection-specific DNS Suffix.: example.com
Description .....: SiS 900 PCI Fast Ethernet
Adapter
Physical Address.....: 00-E0-18-5B-DD-35
Dhcp Enabled .....: Yes
Autoconfiguration Enabled.....: Yes
IP Address .....: 192.168.10.10
Subnet Mask.....: 255.255.255.0
Default Gateway.....: 192.168.10.1
DHCP Server .....: 192.168.10.1
Lease Obtained.....: Monday, May 27, 2013 1:06:22PM

Lease Expires .....: Tuesday, May 28, 2013 1:06:22PM

DNS Servers . . . . .: 192.168.11.5
  
```



# DHCPv4 Operation

## 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>
```



## Configuring a DHCPv4 Client

# Configuring a Router as a 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>
  
```



## Troubleshoot DHCPv4

# 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.



## Troubleshoot DHCPv4

# Verifying the Router DHCPv4 Configuration

### 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#
  
```



# Troubleshoot DHCPv4

## 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

```



## 10.2 Dynamic Host Configuration Protocol v6



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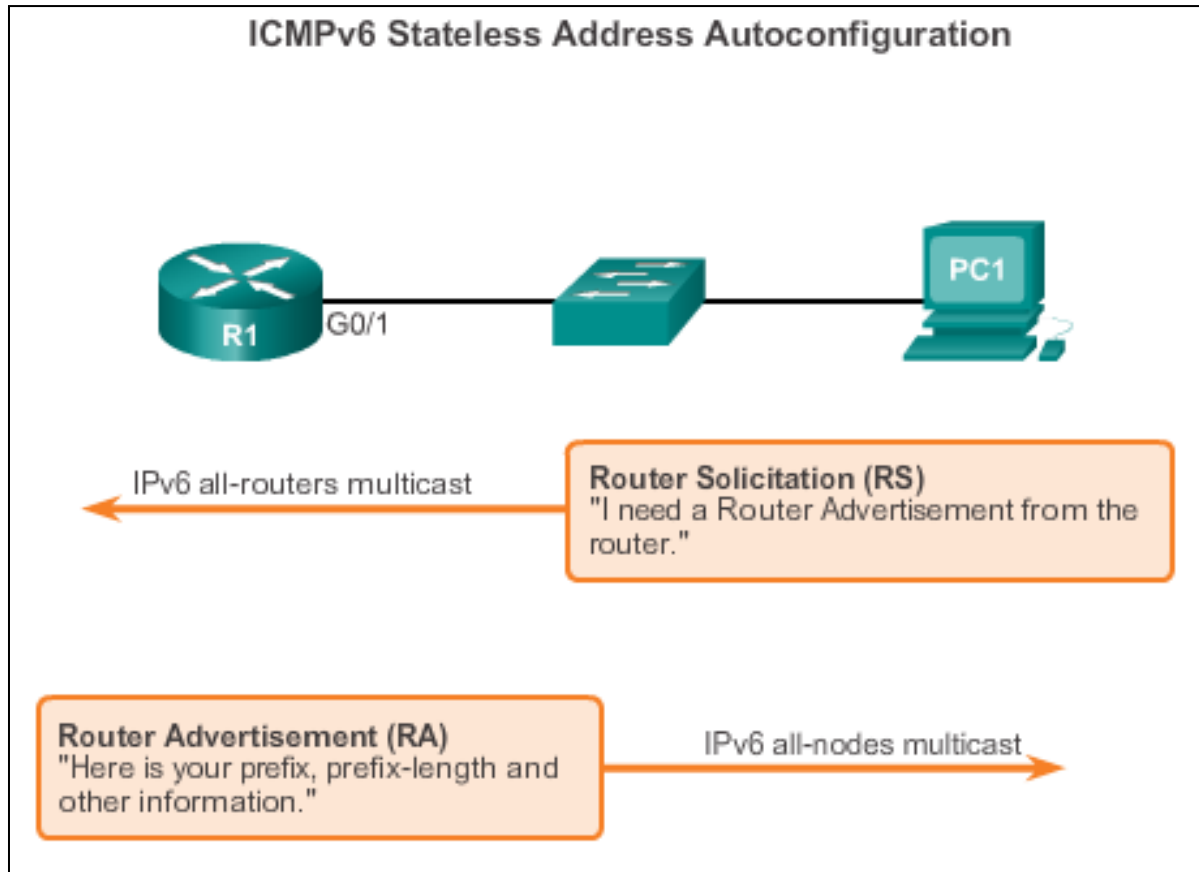




## SLAAC and DHCPv6

# Stateless Address Autoconfiguration

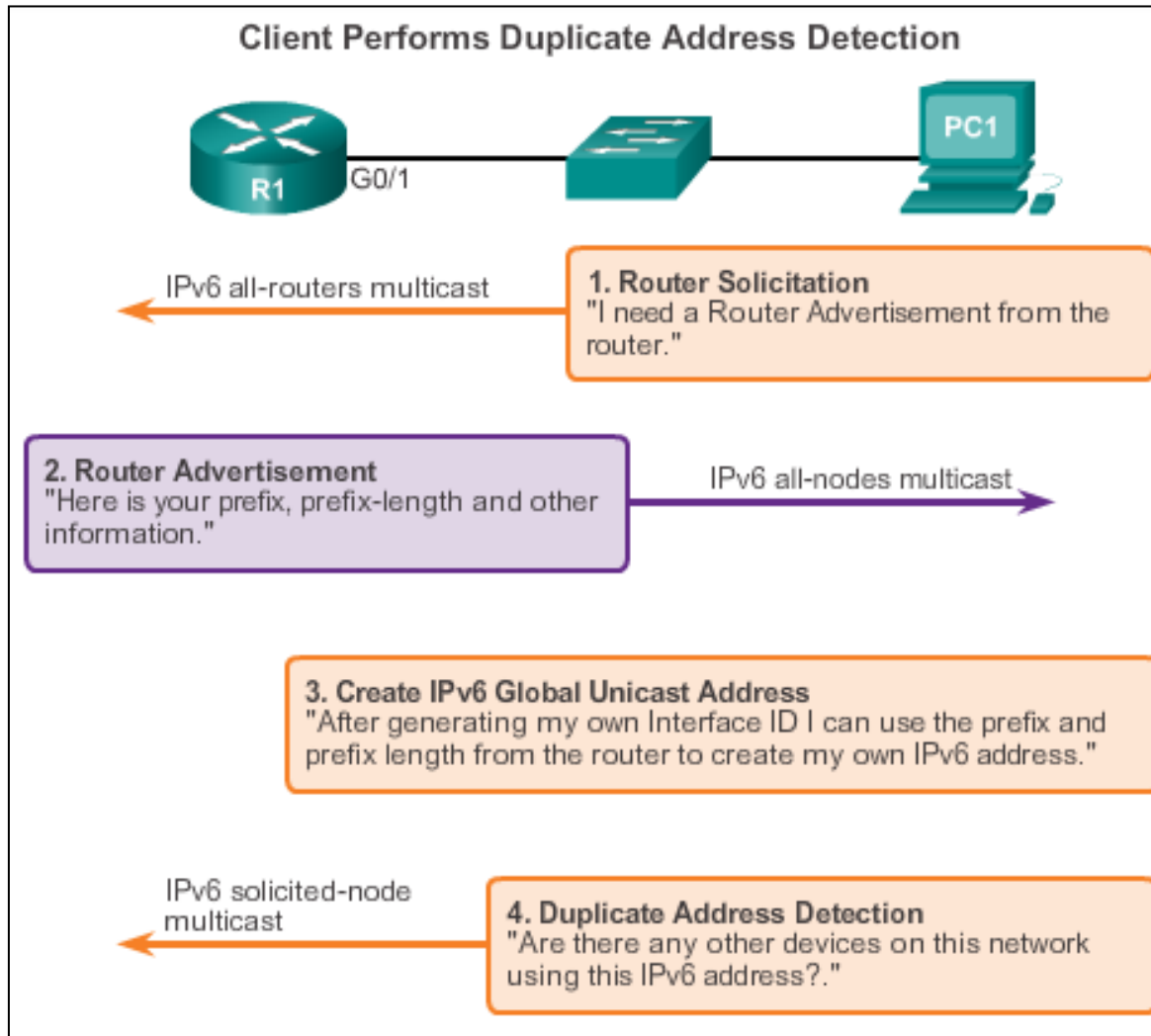
Stateless Address Autoconfiguration (SLAAC) is a method in which a device can obtain an IPv6 global unicast address without the services of a DHCPv6 server.





# SLAAC and DHCPv6

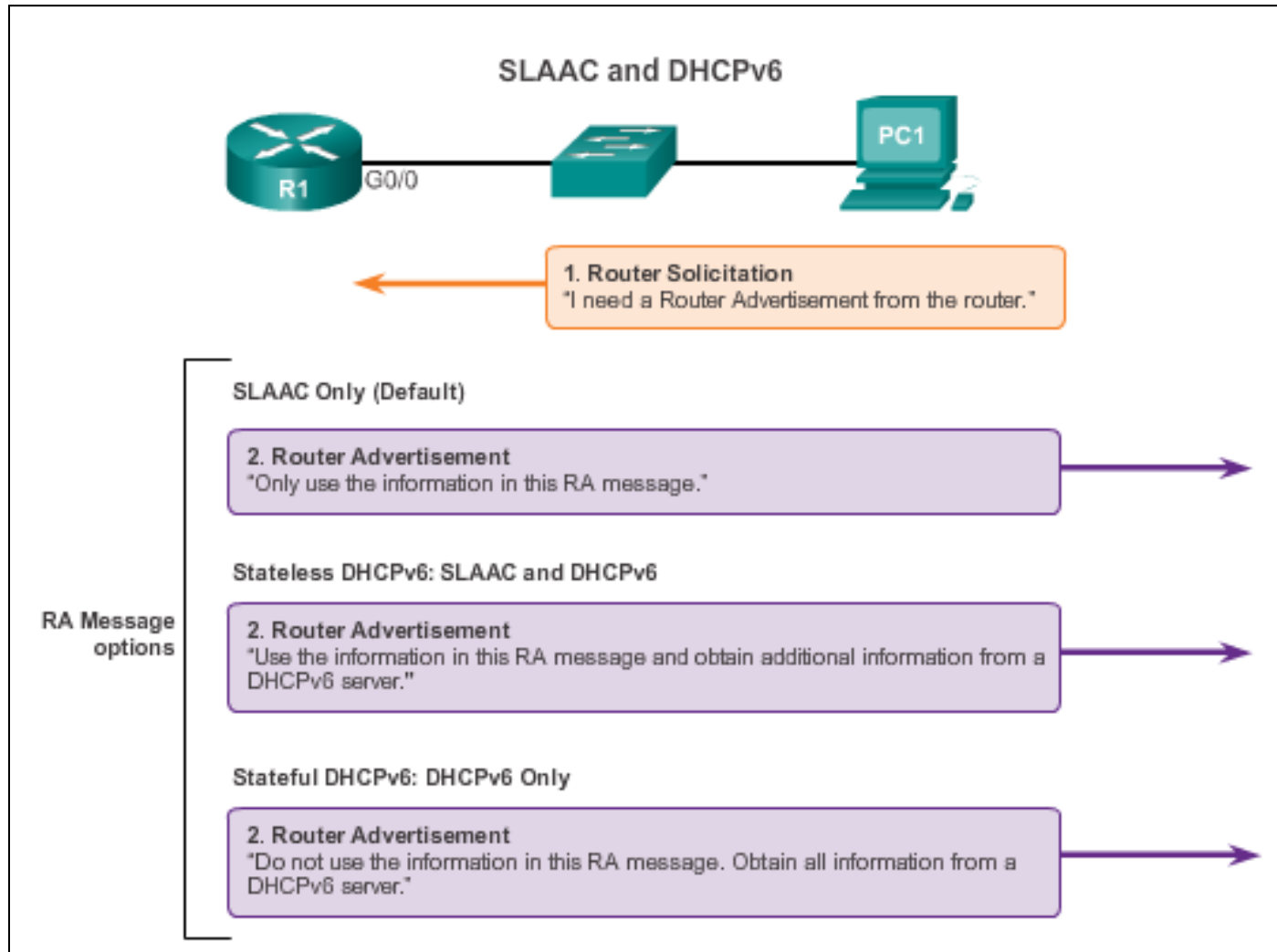
## SLAAC Operation





# SLAAC and DHCPv6

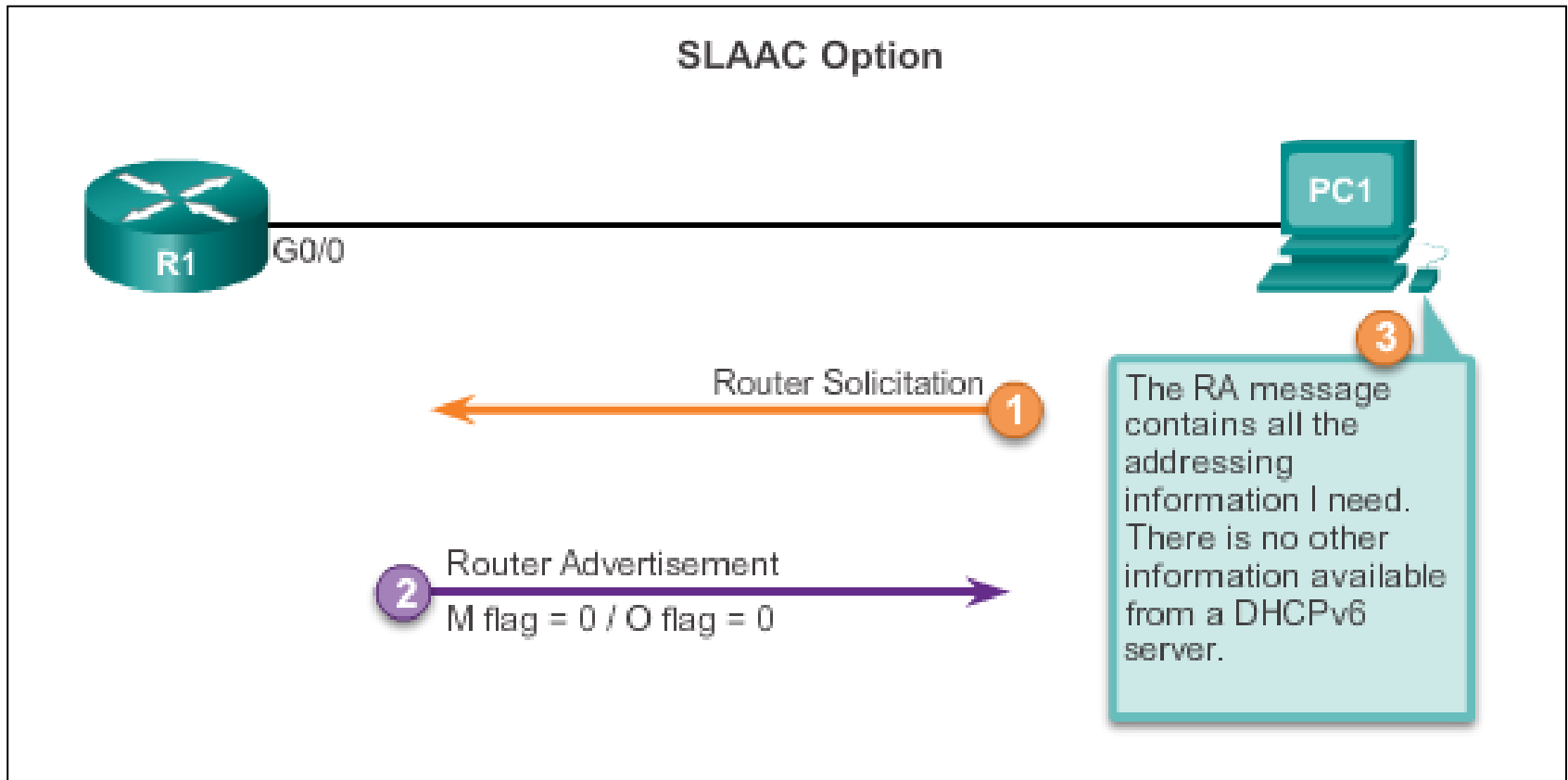
## SLAAC and DHCPv6





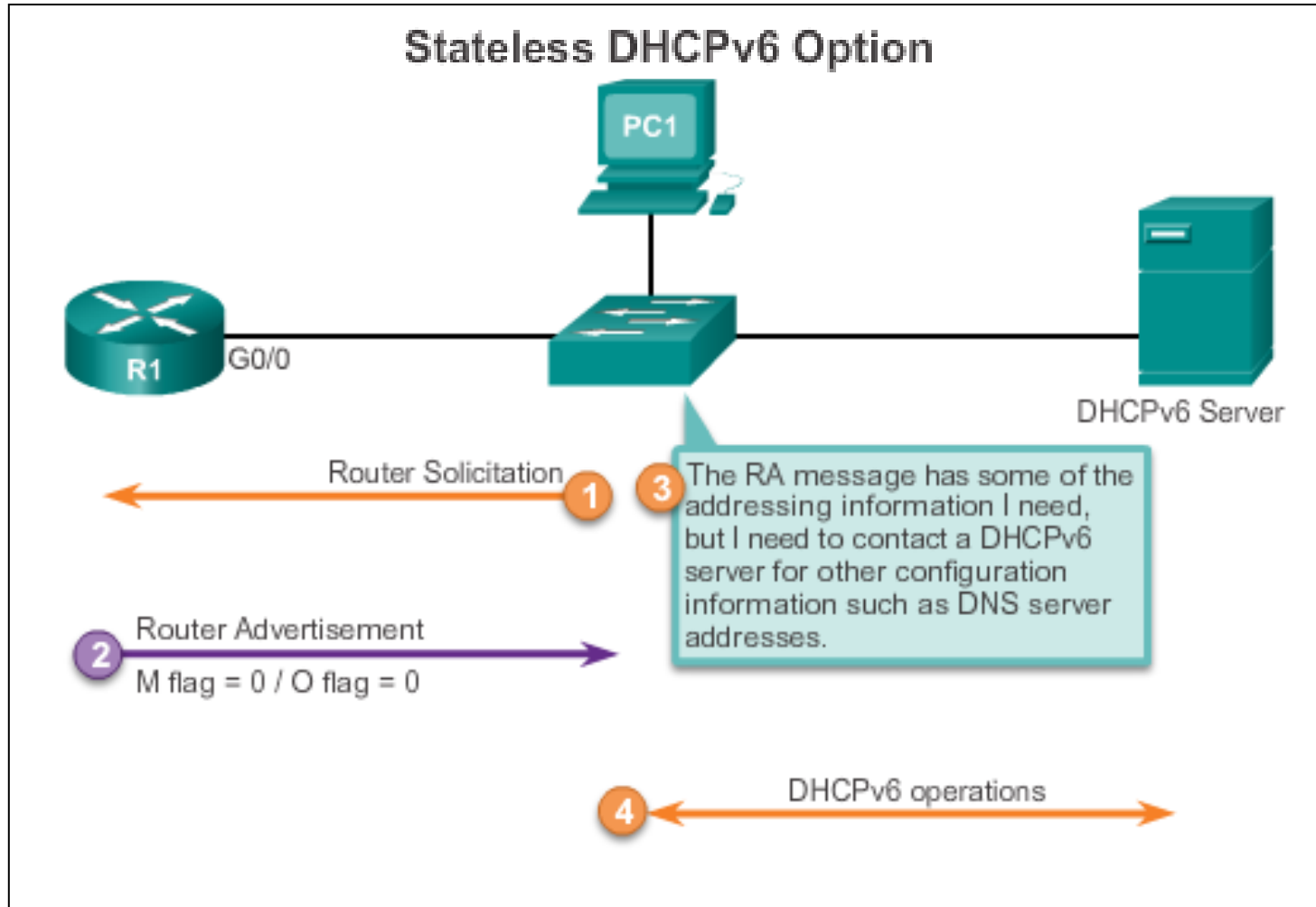
# SLAAC and DHCPv6

## SLAAC Option





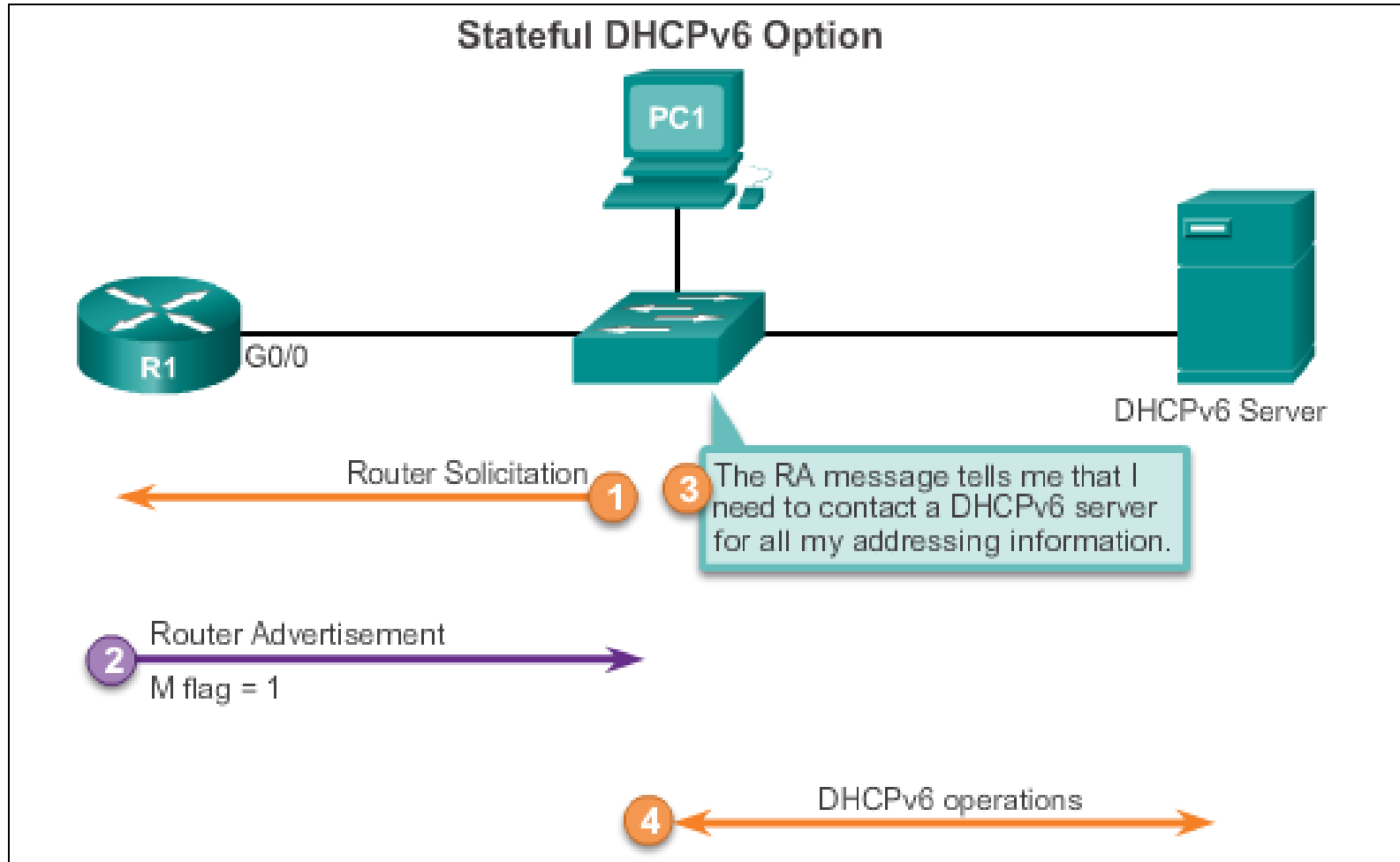
# SLAAC and DHCPv6 Stateless DHCP Option





# SLAAC and DHCPv6

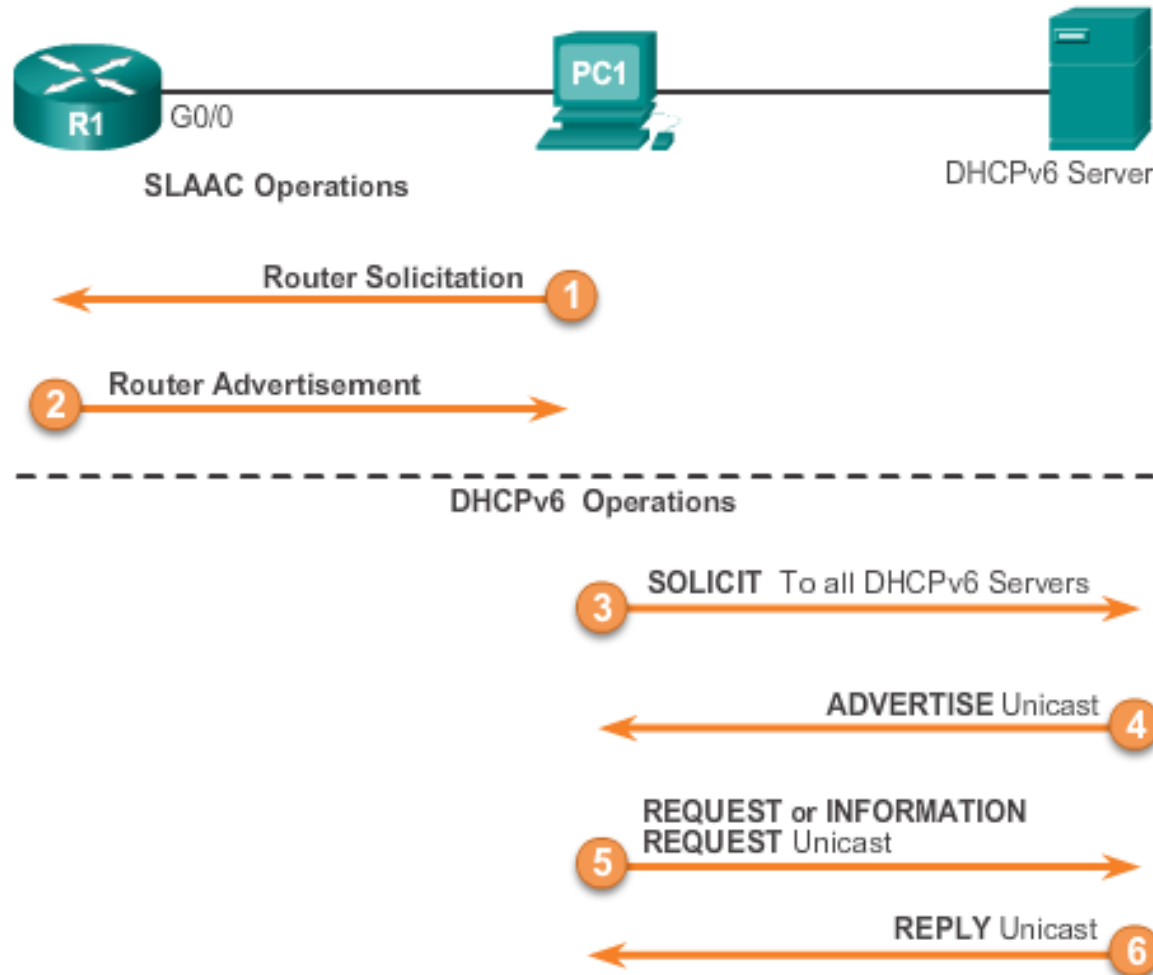
## Stateful DHCPv6 Option





# SLAAC and DHCPv6

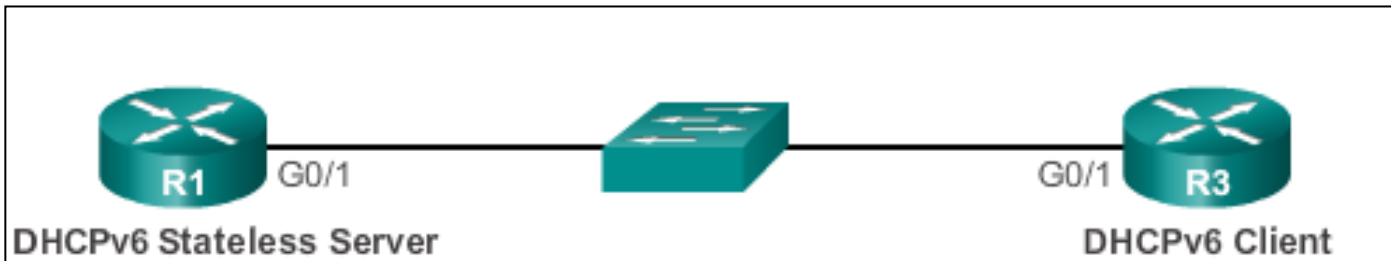
## DHCPv6 Operations





## Stateless DHCPv6

# Configuring a Router as a Stateless DHCPv6 Server



```

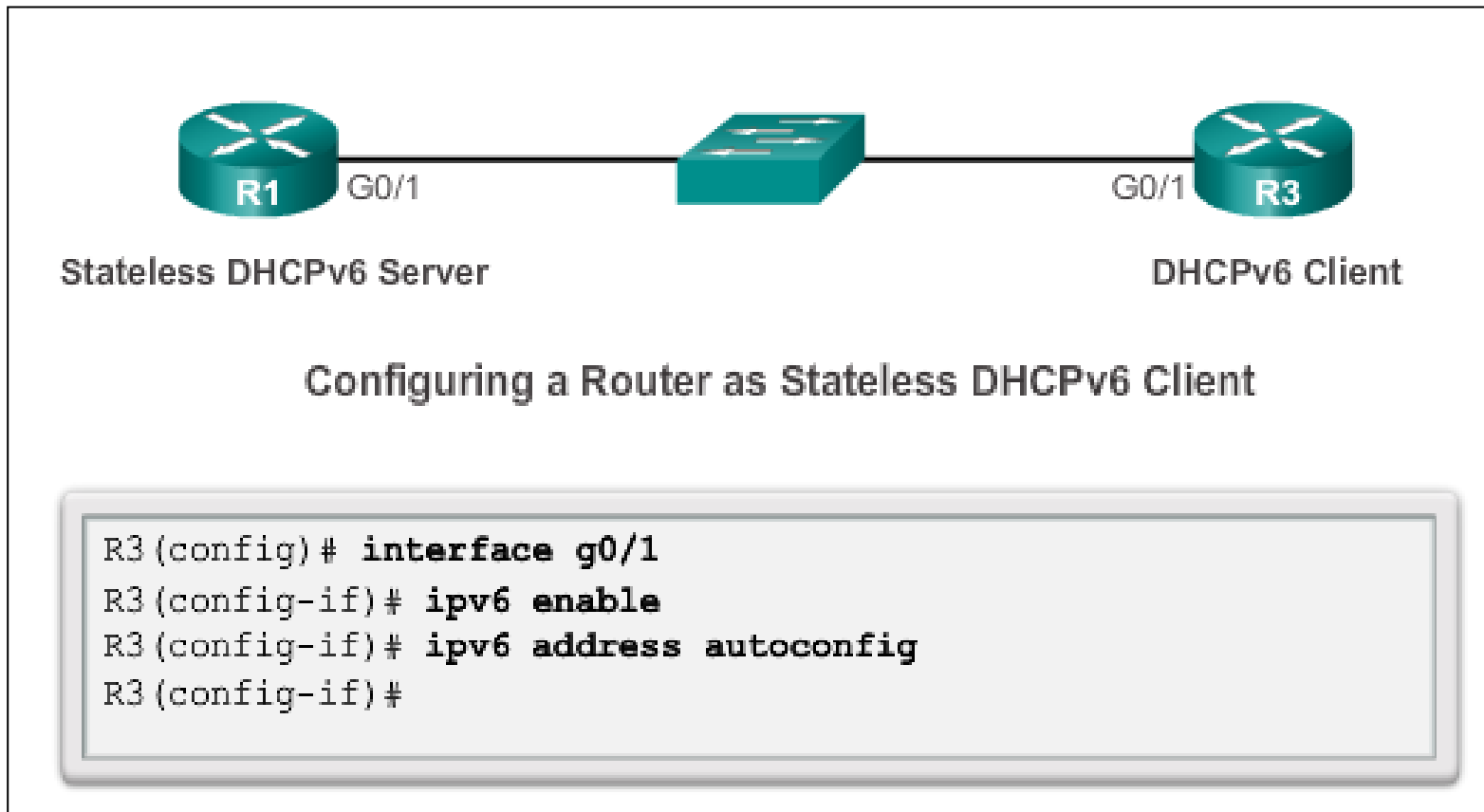
R1 (config)# ipv6 unicast-routing
R1 (config)# ipv6 dhcp pool IPV6-STATELESS
R1 (config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1 (config-dhcpv6)# domain-name example.com
R1 (config-dhcpv6)# exit
R1 (config)# interface g0/1
R1 (config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1 (config-if)# ipv6 dhcp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





## Stateless DHCPv6

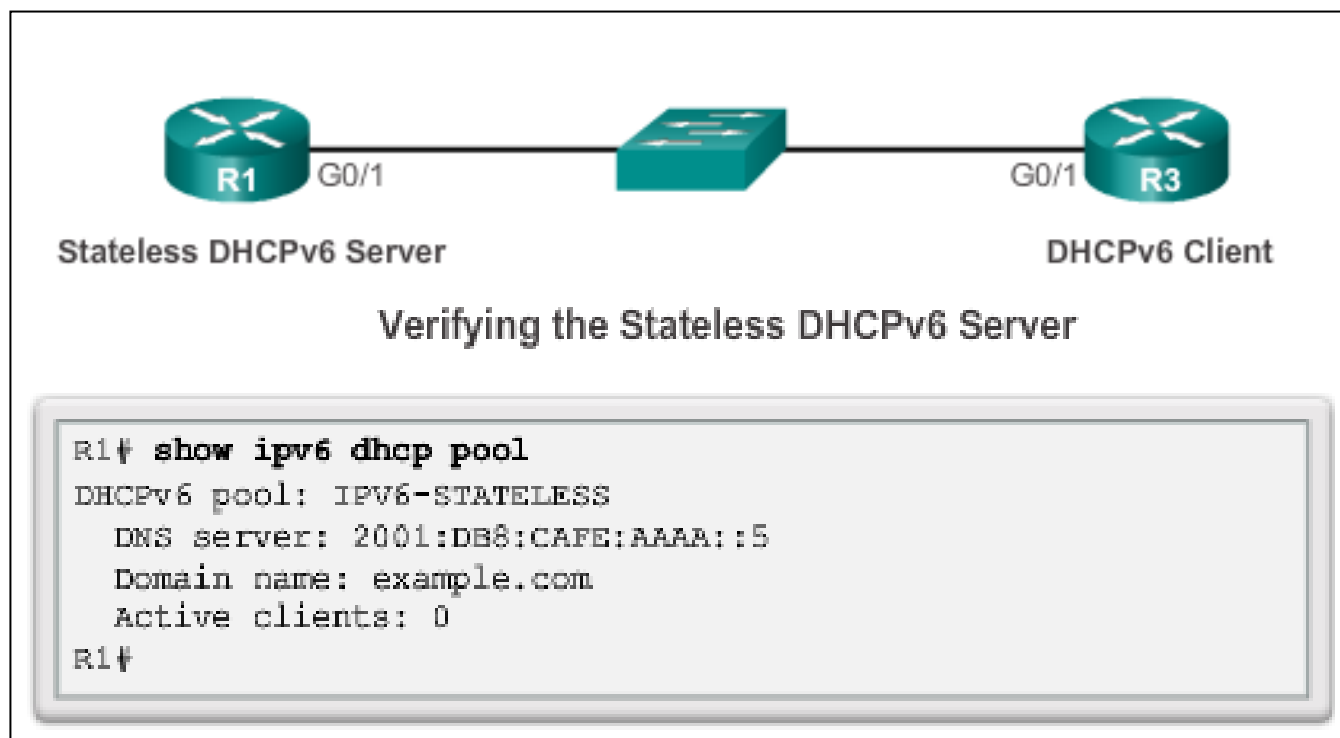
# Configuring a Router as a Stateless DHCPv6 Client





## Stateless DHCPv6

# Verifying Stateless DHCPv6



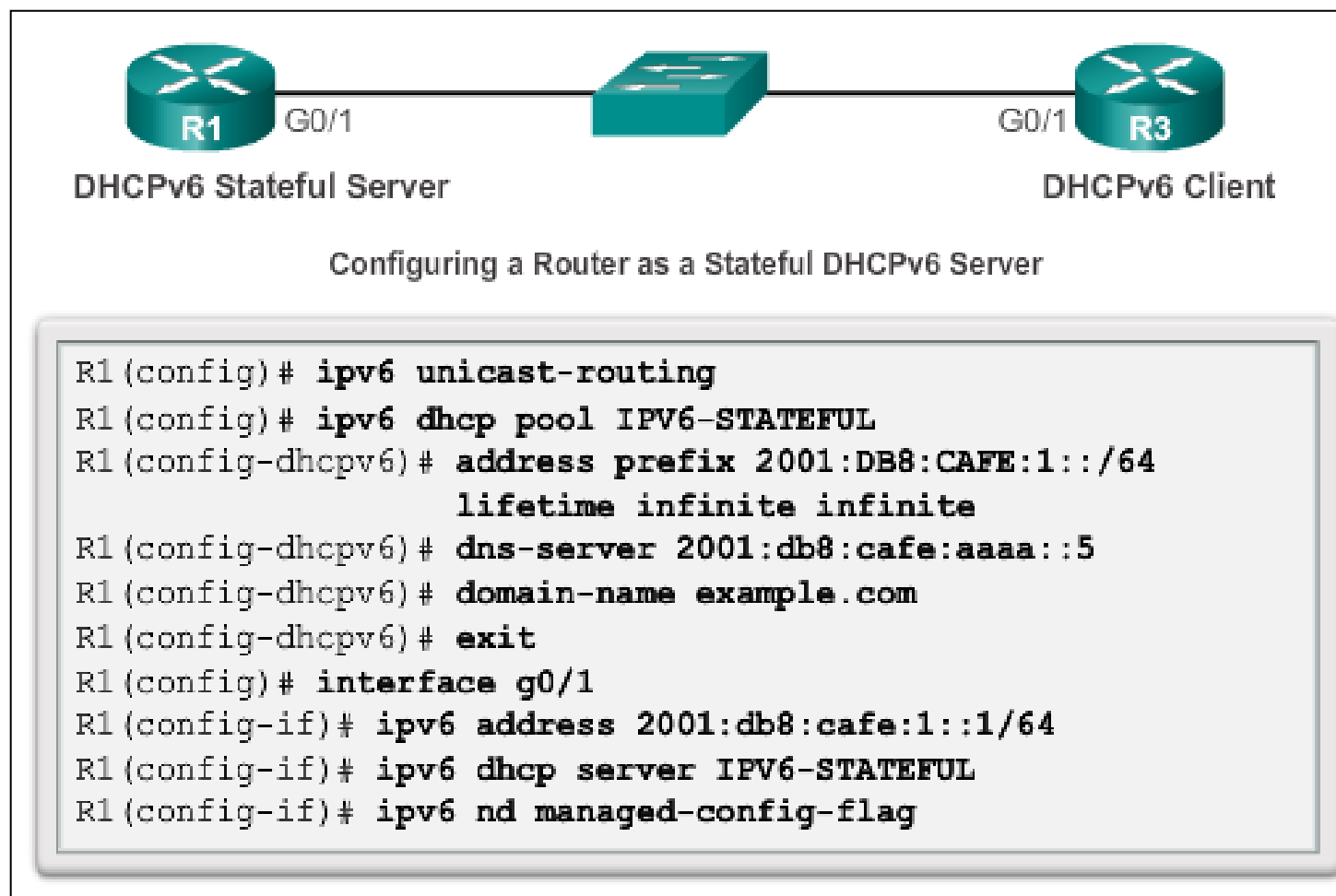
Verify the stateless DHCP client using the following commands:

- **show IPv6 interface**
- **debug ipv6 dhcp detail**



# Stateful DHCPv6

## Configuring a Router as a Stateful DHCPv6 Server





## Stateful DHCPv6

# Verifying Stateful DHCPv6

- Verify the stateful DHCPv6 server using the following commands:

```
show ipv6 dhcp pool
```

```
show ipv6 dhcp binding
```

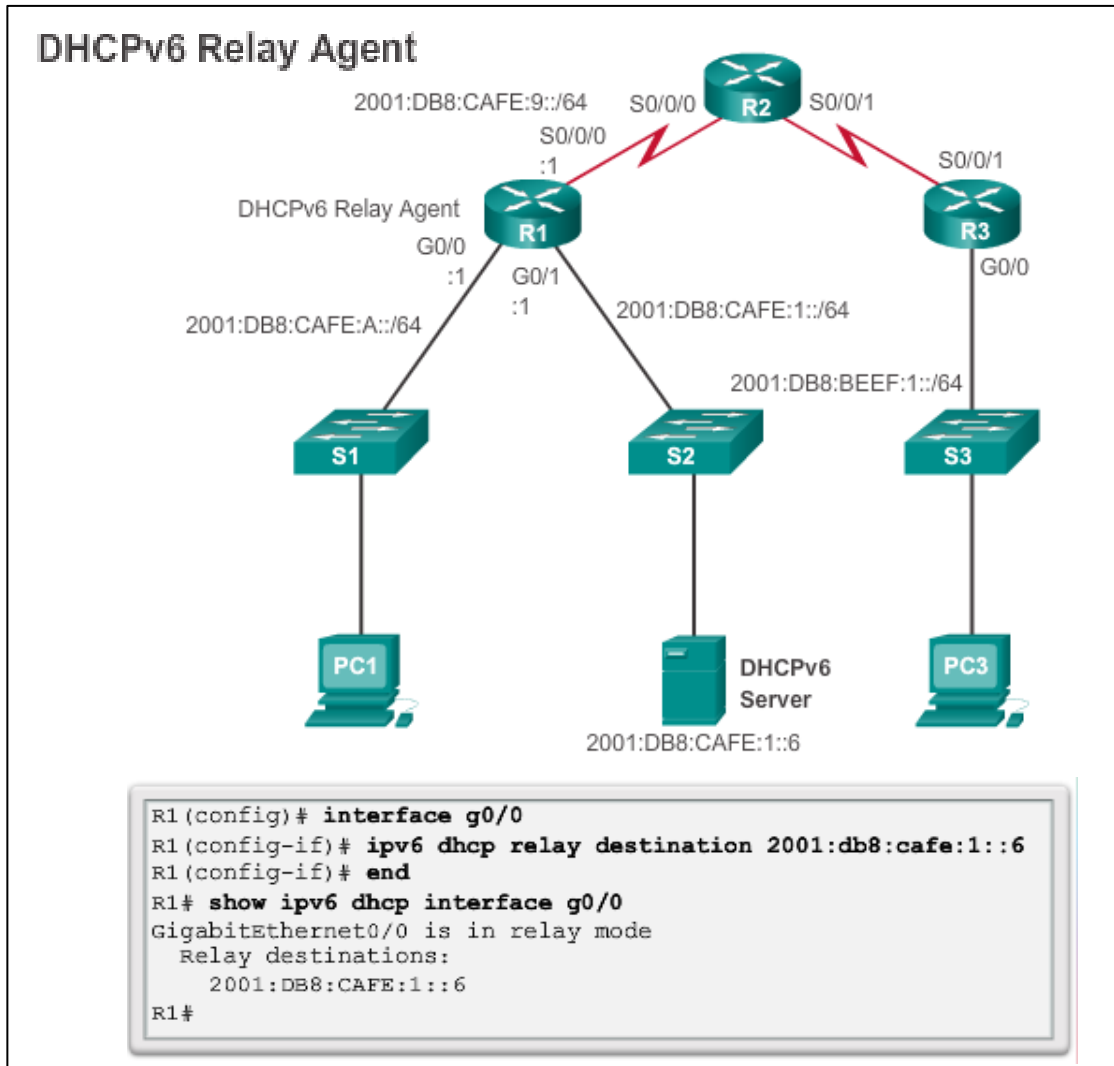
- Verify the stateful DHCPv6 client using the **show ipv6 interface** command.

```
R3# show ipv6 interface g0/1
GigabitEthernet0/1 is up, line protocol is up
IPv6 is enabled, link-local address is
FE80::32F7:DFE:FE25:2DE1
No Virtual link-local address(es):
Global unicast address(es):
  2001:DB8:CAFE:1:5844:47B2:2603:C171, subnet is
2001:DB8:CAFE:1:5844:47B2:2603:C171/128
Joined group address(es):
  FF02::1
  FF02::1:FF03:C171
  FF02::1:FF25:2DE1
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ICMP unreachable are sent
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds (using 30000)
ND NS retransmit interval is 1000 milliseconds
Default router is FE80::D68C:B5FF:FECE:A0C1 on
```



# Stateful DHCPv6

## Configuring a Router as a Stateful DHCPv6 Relay Agent





# Troubleshooting DHCPv6

## 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.



# Troubleshooting DHCPv6

## Verifying the 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

```



# Troubleshooting DHCPv6

## 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:DFE: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:DFE: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:DFE:FE25:2DE1 in pool IPV6-STATEFUL
<Output omitted>

```





## 10.3 Summary



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# 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)**



# Chapter 10: Summary (cont.)

The same tasks are involved when troubleshooting DHCPv4 and DHCPv6:

- Resolve address conflicts.
- Verify physical connectivity.
- Test connectivity using a static IP address.
- Verify the switch port configuration.
- Test the operation on the same subnet or VLAN.

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