



# 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

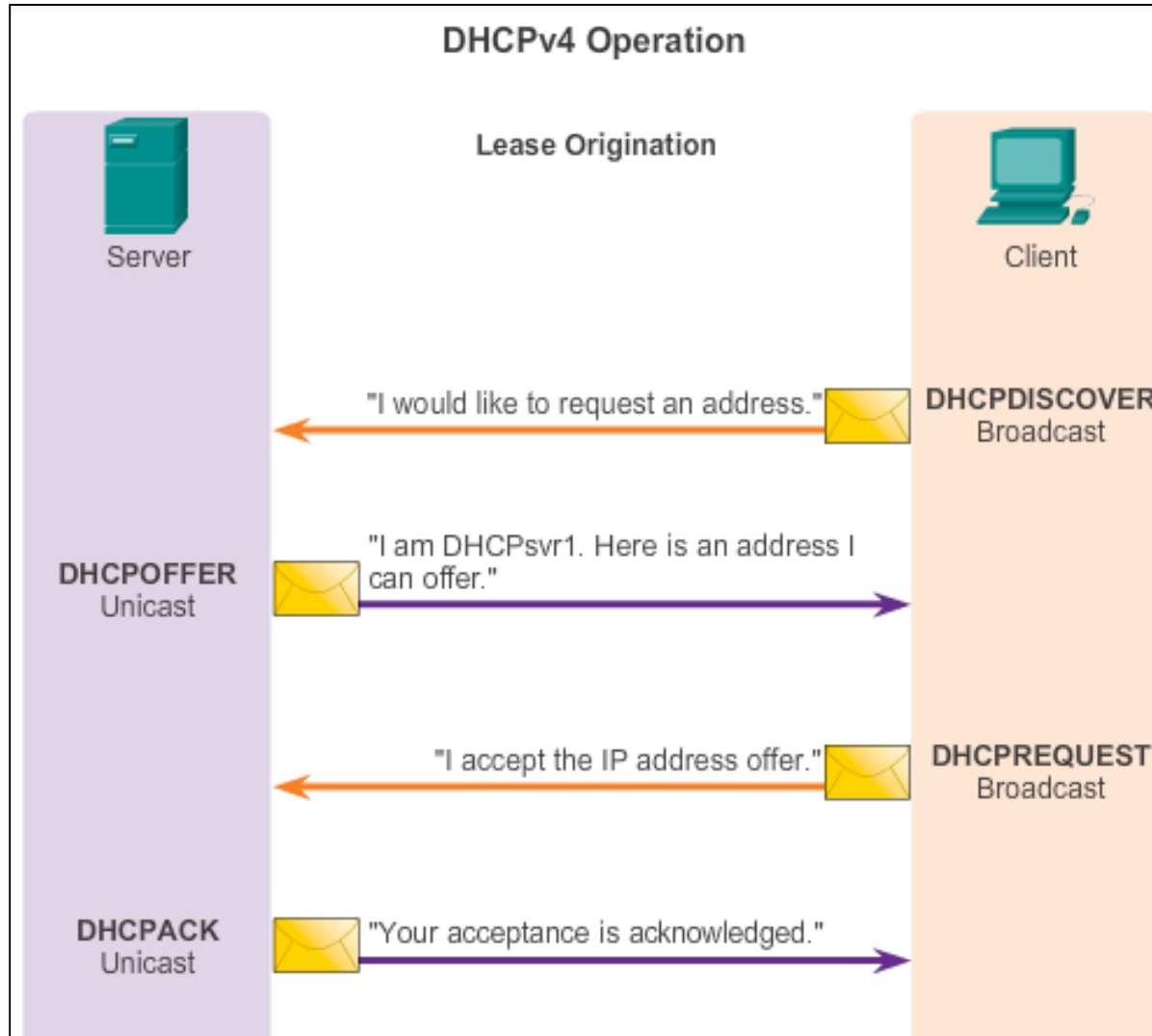
DHCPv4 uses three different address allocation methods:

- **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

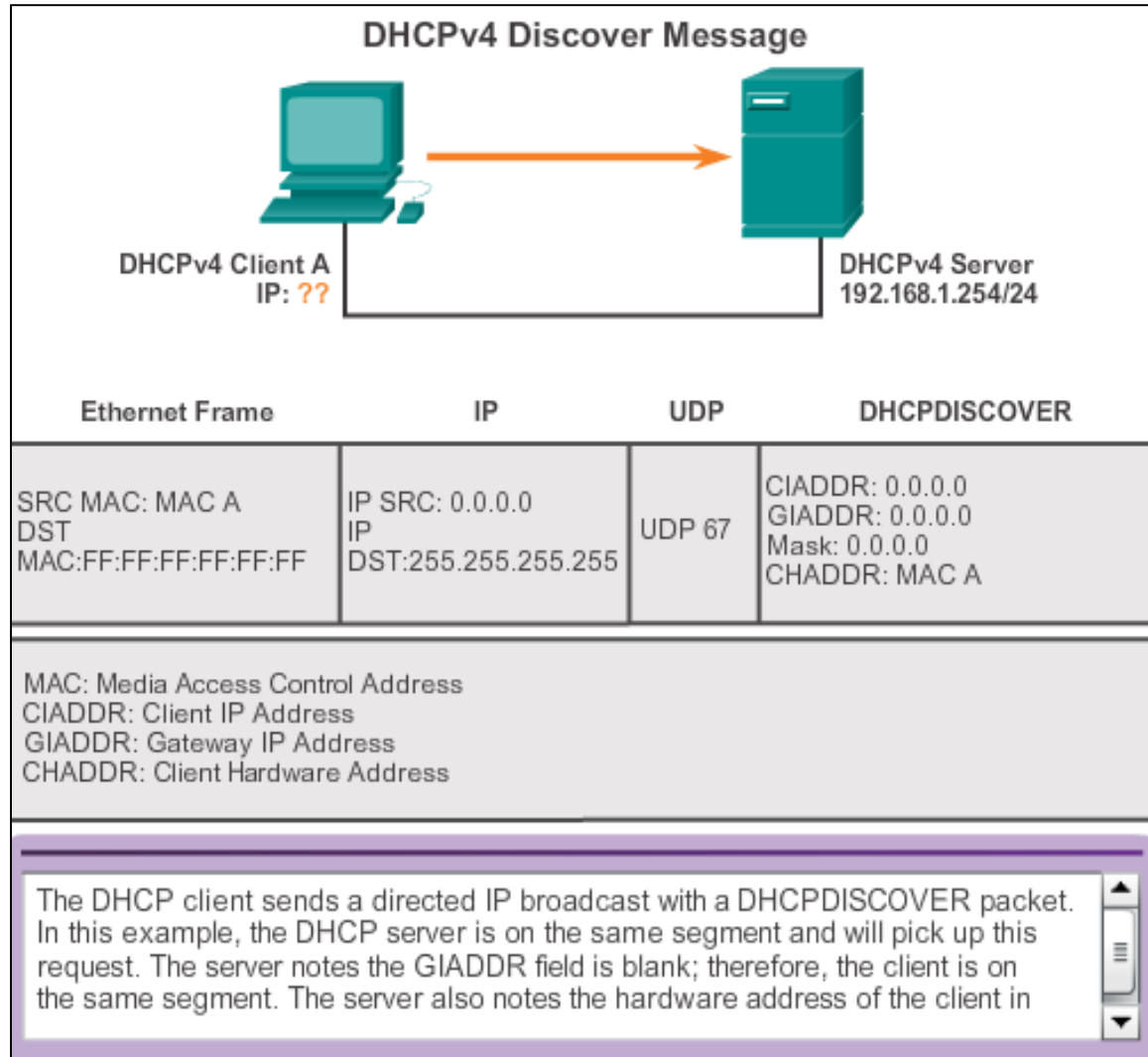
# DHCPv4 Message Format

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

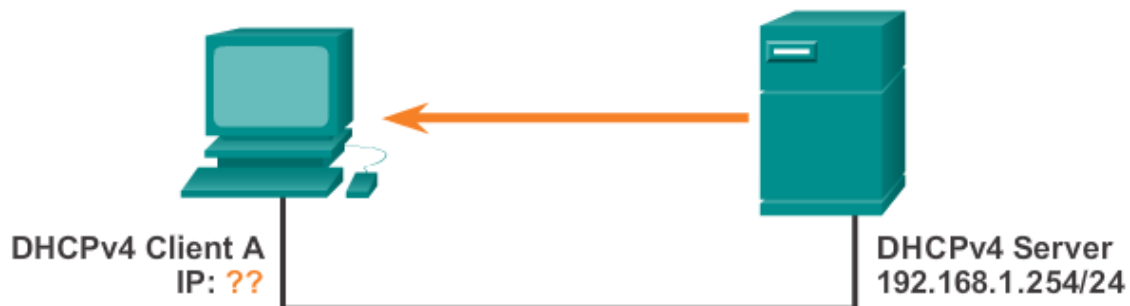
## Format DHCPv4 Discover and Offer Messages







## DHCPv4 Offer Message



Ethernet Frame	IP	UDP	DHCP Reply
DST MAC: MAC A SRC MAC: MAC Serv	IP SRC: 192.168.1.254 IP DST: 192.168.1.10	UDP 68	CIADDR: 192.168.1.10 GIADDR: 0.0.0.0 Mask: 255.255.255.0 CHADDR: MAC A

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

The DHCP server picks an IP address from the available pool for that segment, as well as the other segment and global parameters. The DHCP server puts them into the appropriate fields of the DHCP packet. The DHCP server then uses the hardware address of A (in CHADDR) to construct an appropriate frame to send back to the client.



## 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.

```
cmd 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

C:\Documents and settings\SpanPC>
```



# 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



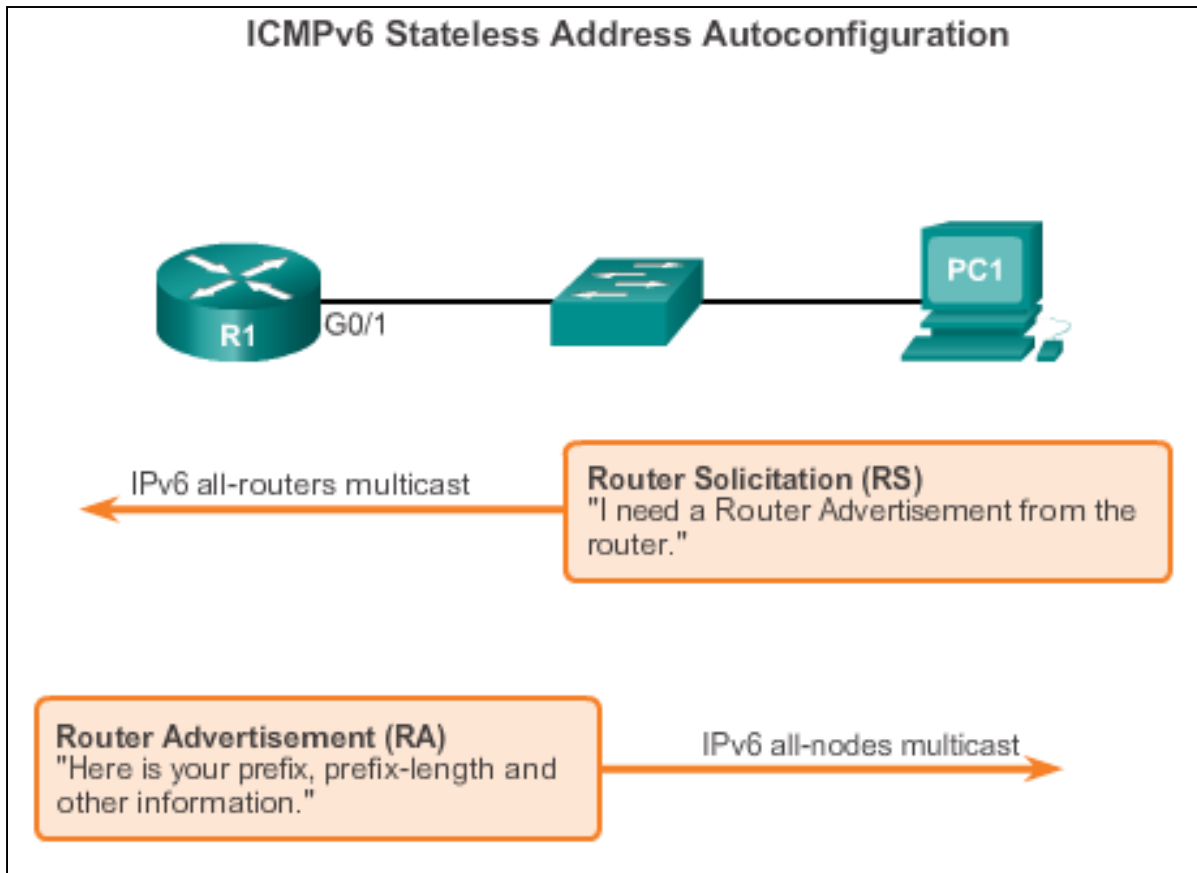
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## SLAAC and DHCPv6

# Stateless Address Autoconfiguration

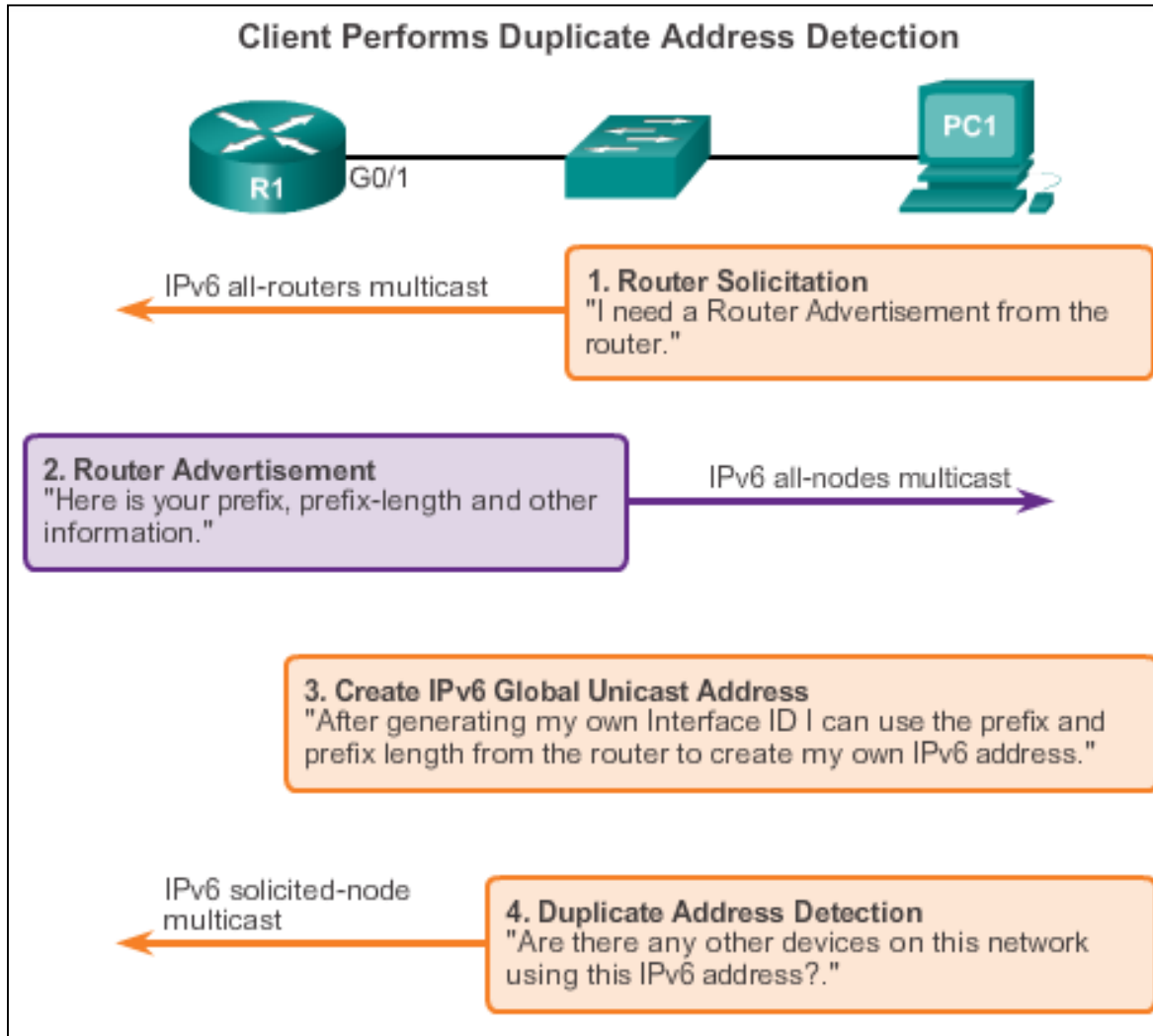
Stateless Address Autoconfiguration (SLAAC) is a method in which a device can obtain an IPv6 global unicast address without the services of a DHCPv6 server.





# SLAAC and DHCPv6

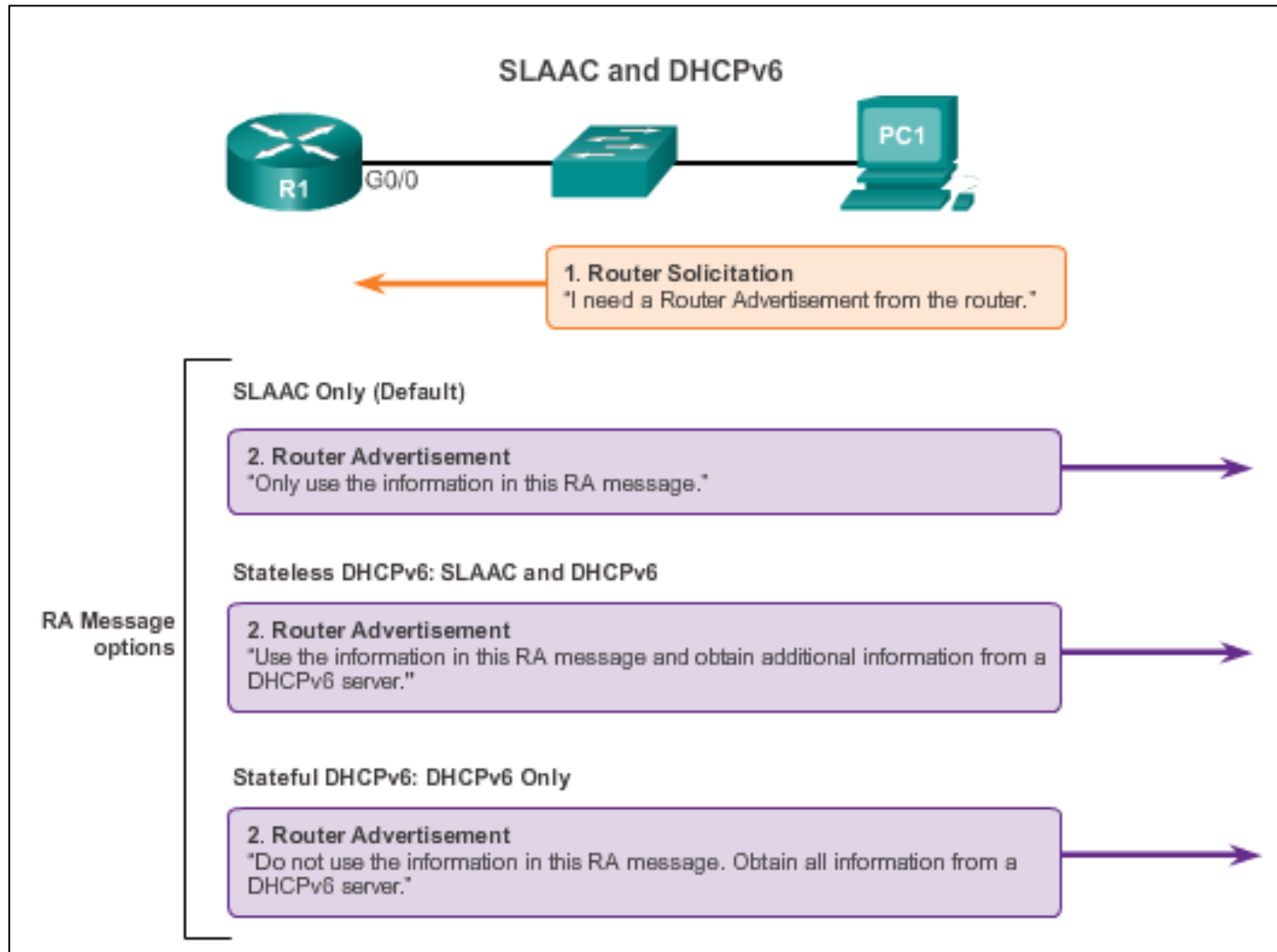
## SLAAC Operation





# SLAAC and DHCPv6

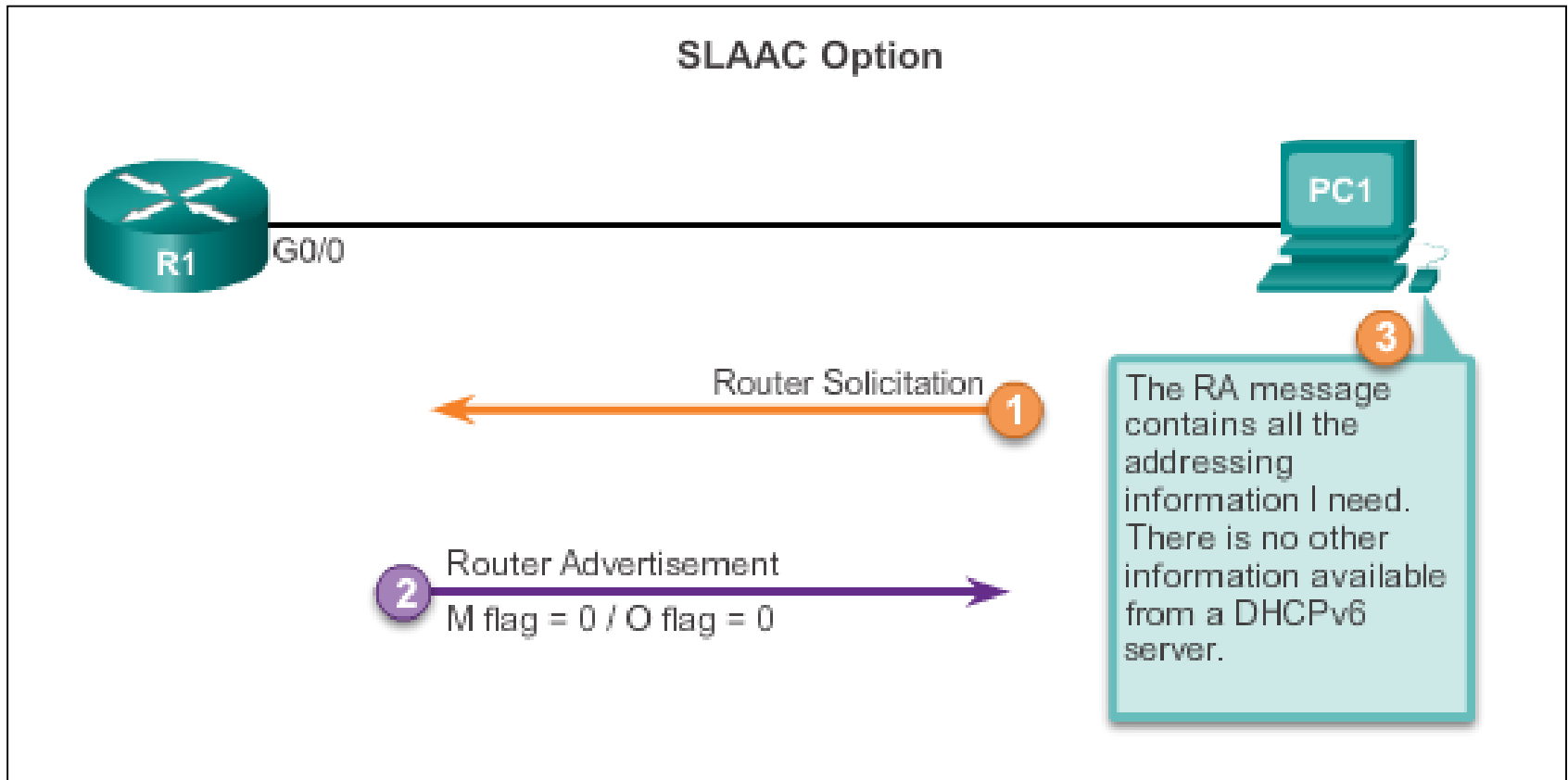
## SLAAC and DHCPv6





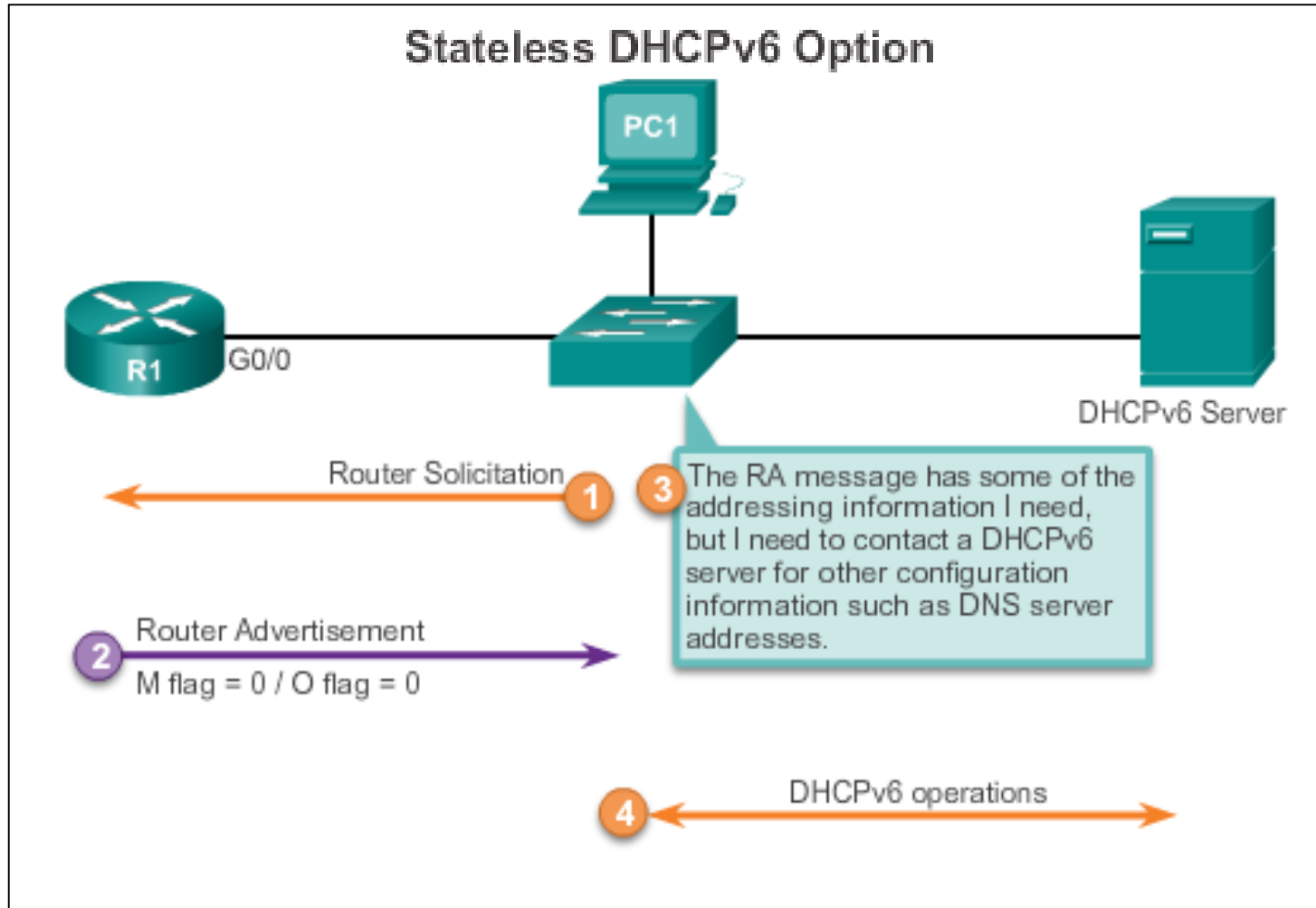
# SLAAC and DHCPv6

## SLAAC Option



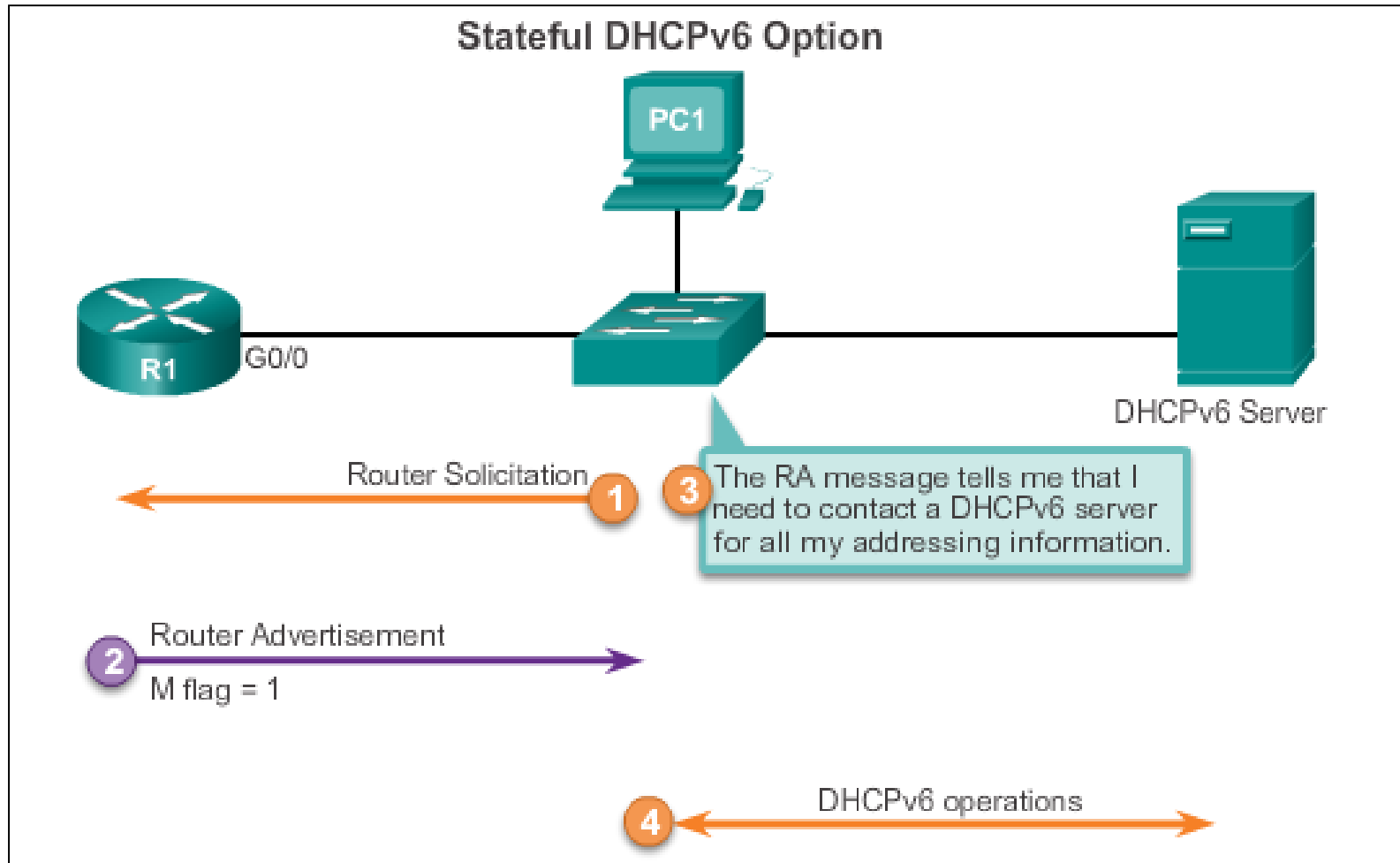


# SLAAC and DHCPv6 Stateless DHCP Option





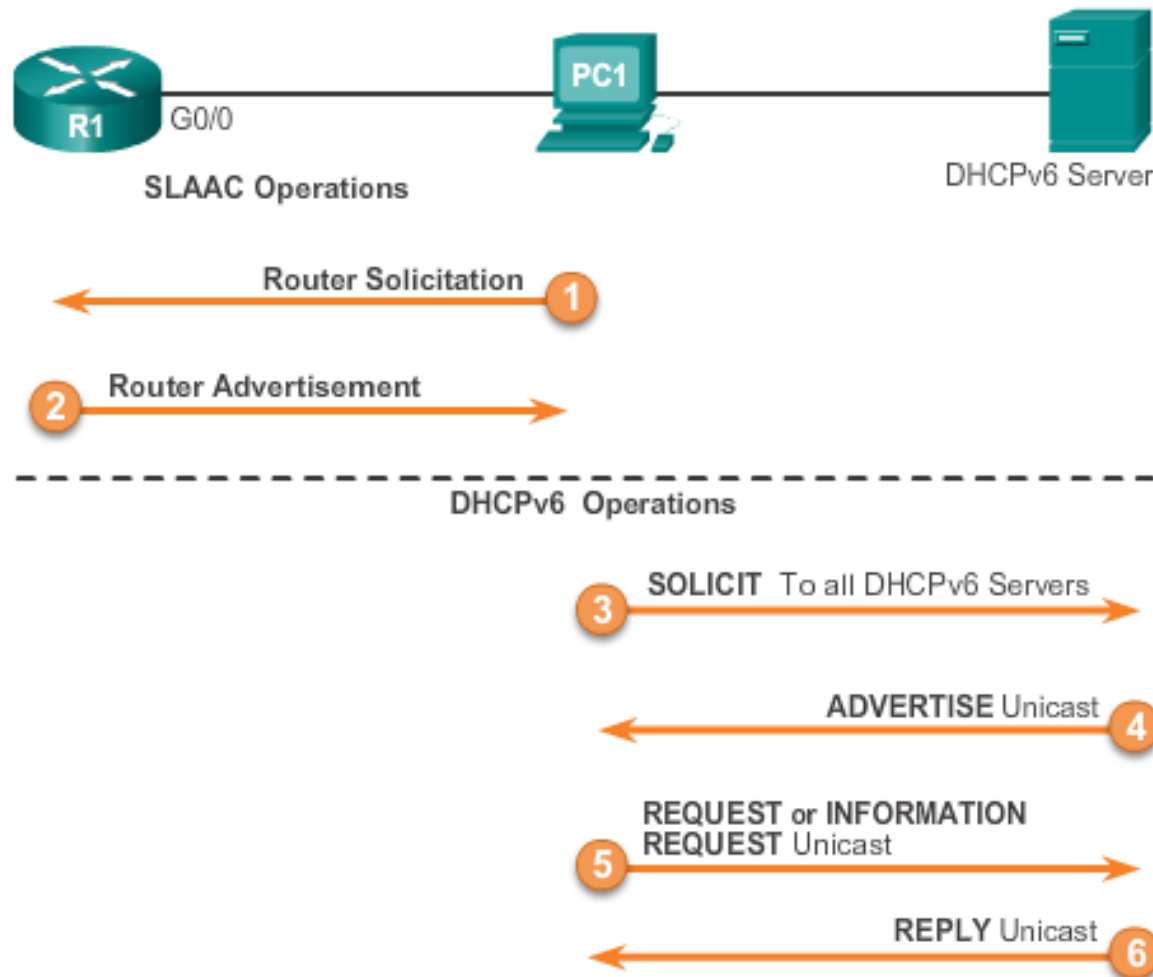
# SLAAC and DHCPv6 Stateful DHCP Option





# SLAAC and DHCPv6

## DHCPv6 Operations

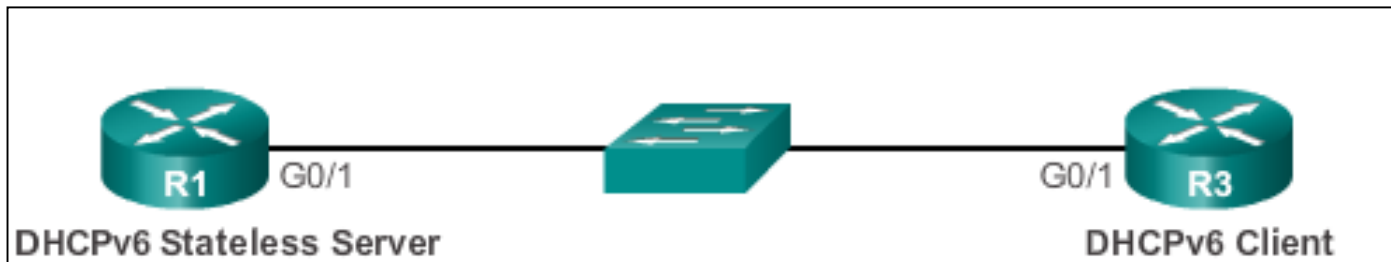






## Stateless DHCPv6

# Configuring a Router as a Stateless DHCPv6 Server



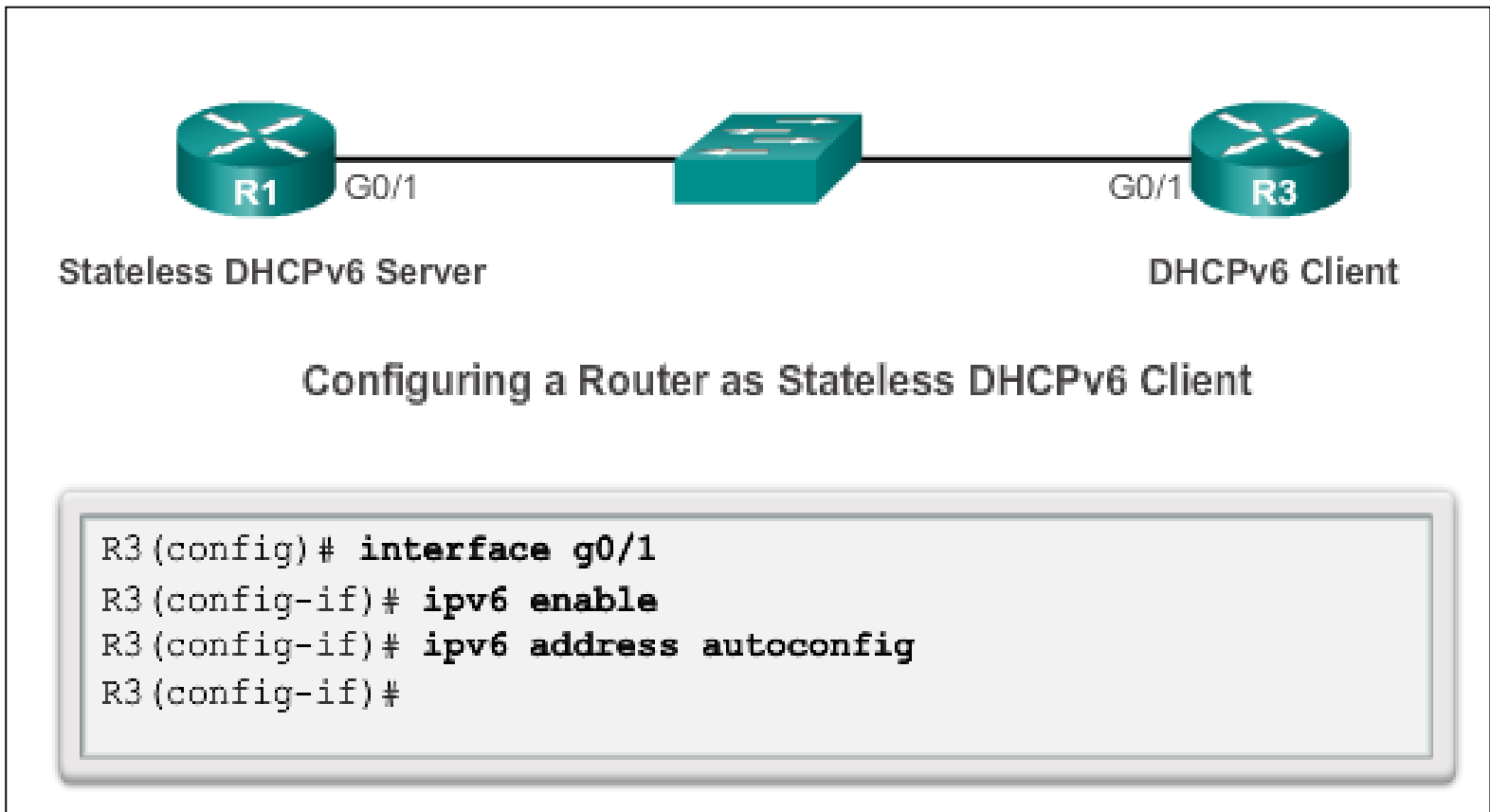
```

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

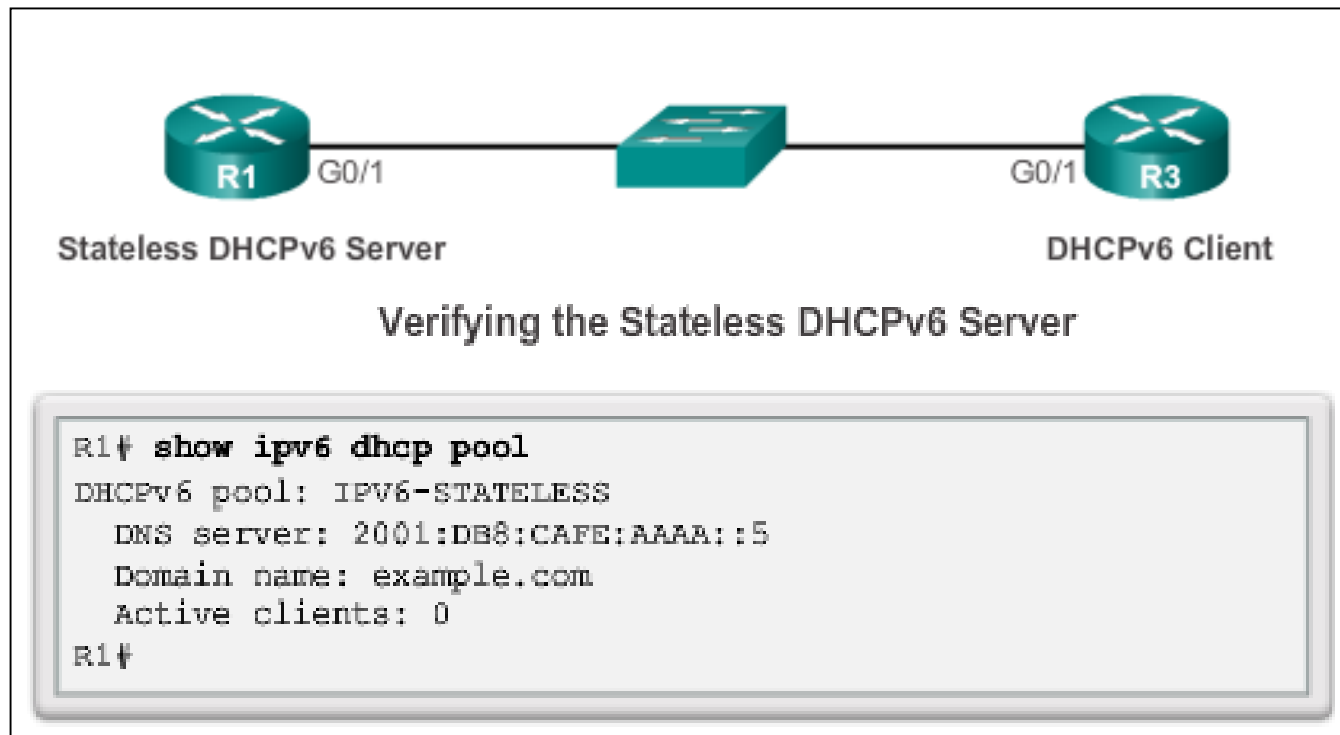
# Configuring a Router as a Stateless DHCPv6 Client





## Stateless DHCPv6

# Verifying Stateless DHCPv6



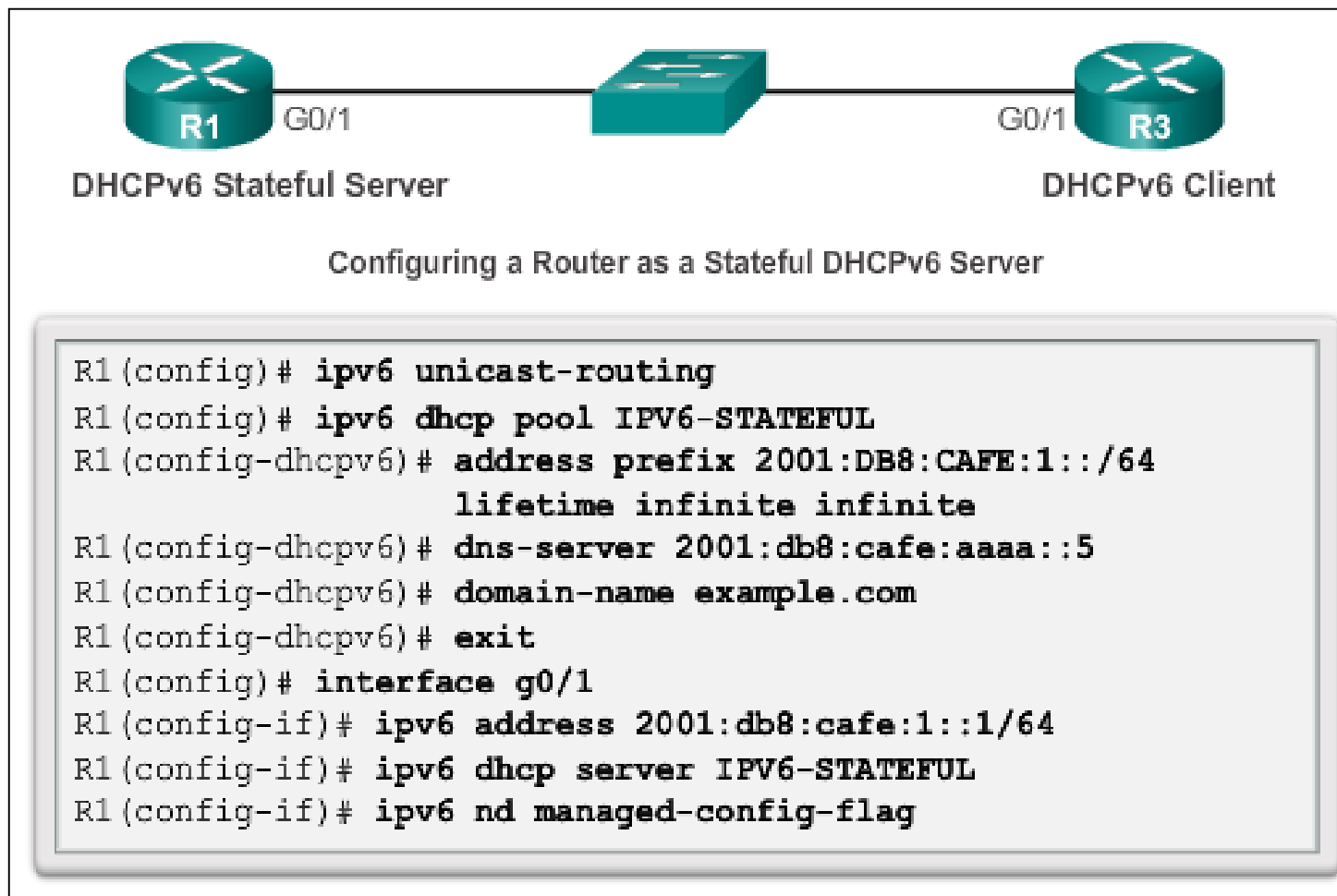
Verify the stateless DHCP client using the following commands:

- **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
```

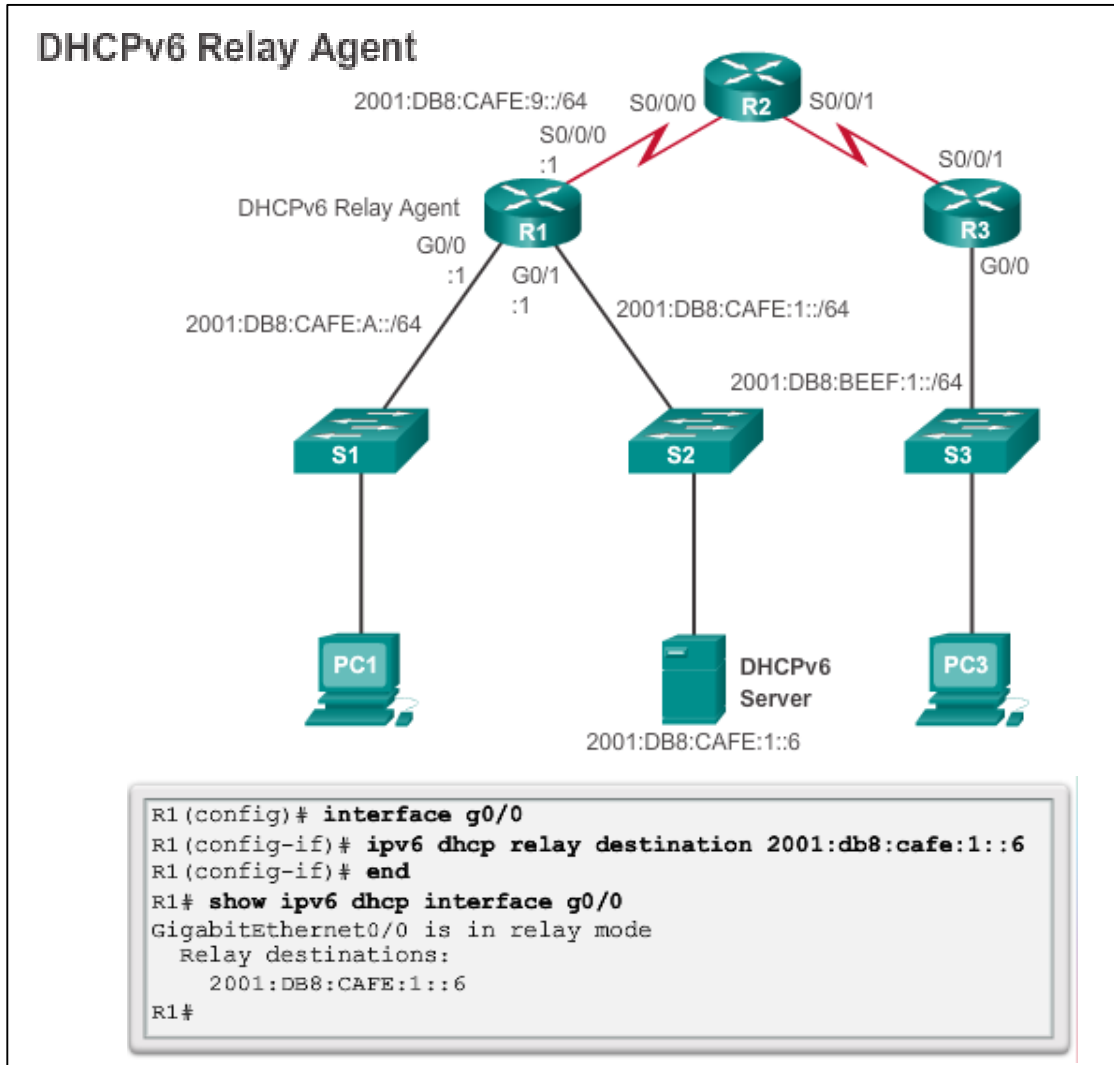
- Verify the stateful DHCPv6 client using the **show ipv6 interface** command.

```
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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