



Chapter 8: DHCP



Routing and Switching Essentials v6.0

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Chapter 8 - Sections & Objectives

8.1 DHCPv4

- Explain how DHCPv4 operates 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.

8.2 DHCPv6

- Explain the operation of DHCPv6.
- Configure stateless DHCPv6 for a small to medium-sized business.
- Configure stateful DHCPv6 for a small to medium-sized business.
- Troubleshoot a DHCP configuration for IPv6 in a switched network.



8.1 DHCPv4



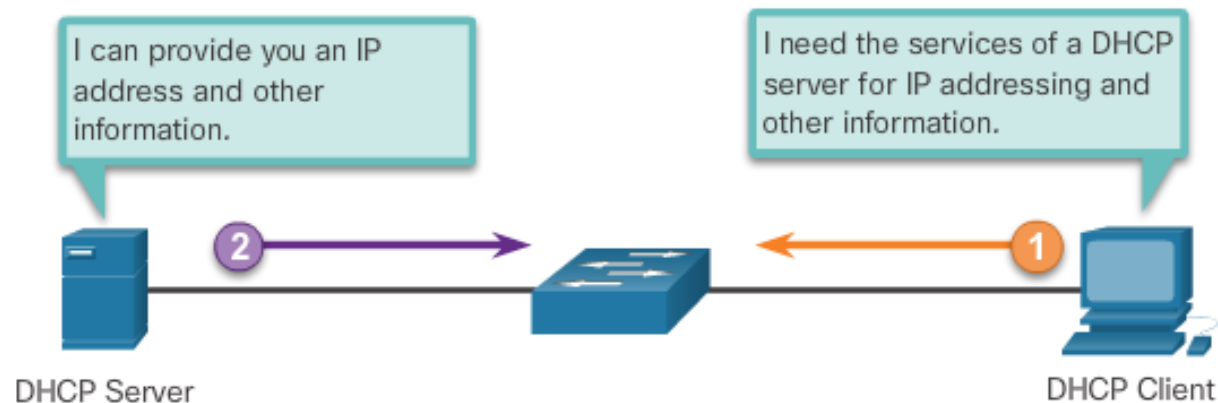
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DHCPv4 Operation

Introducing DHCPv4

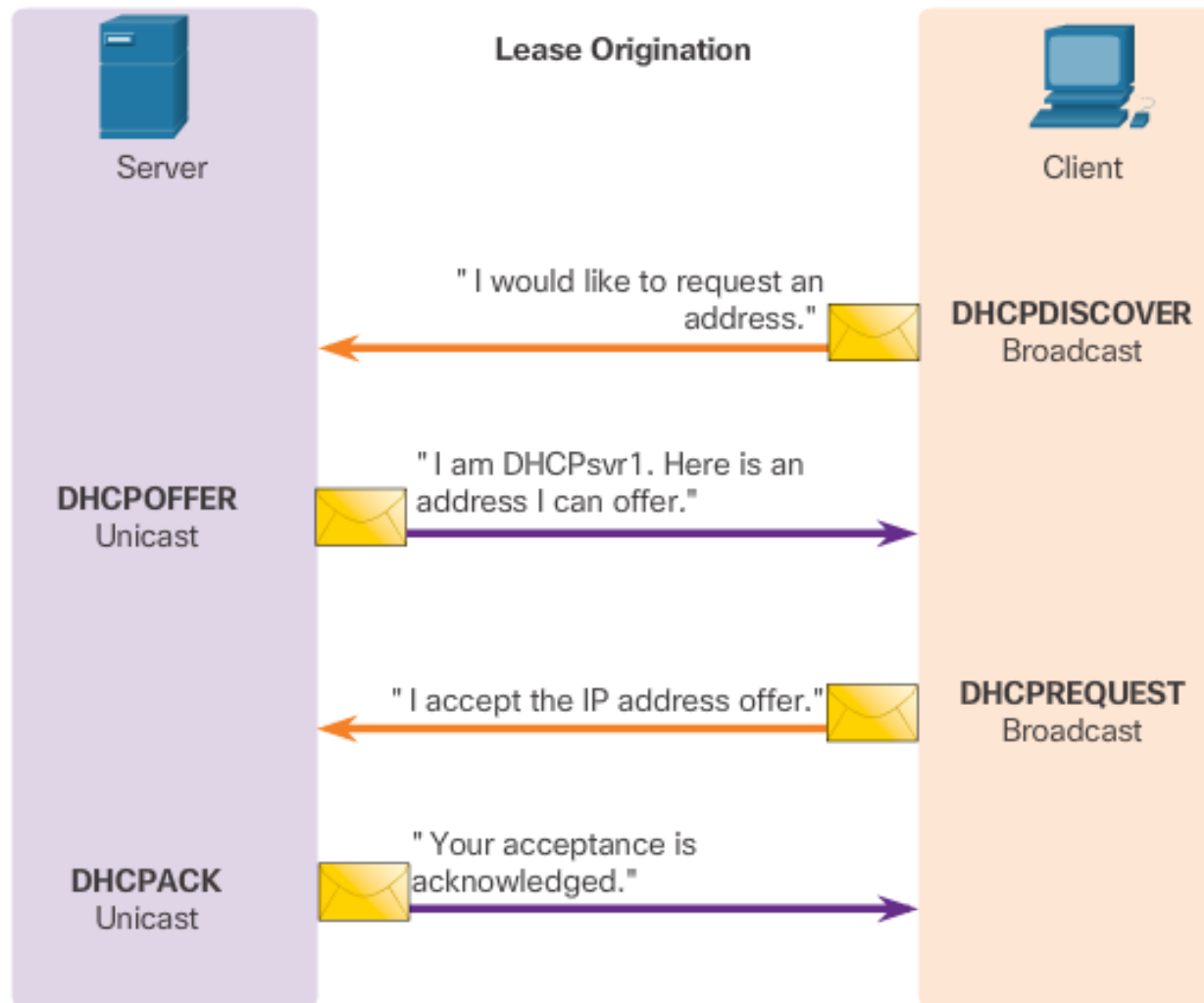
- DHCPv4:
 - assigns IPv4 addresses and other network configuration information dynamically
 - useful and timesaving tool for network administrators
 - dynamically assigns, or leases, an IPv4 address from a pool of addresses
- A Cisco router can be configured to provide DHCPv4 services.
- Administrators configure DHCPv4 servers so that leases expire. Then the client must ask for another address, although the client is typically reassigned the same address.





DHCPv4 Operation

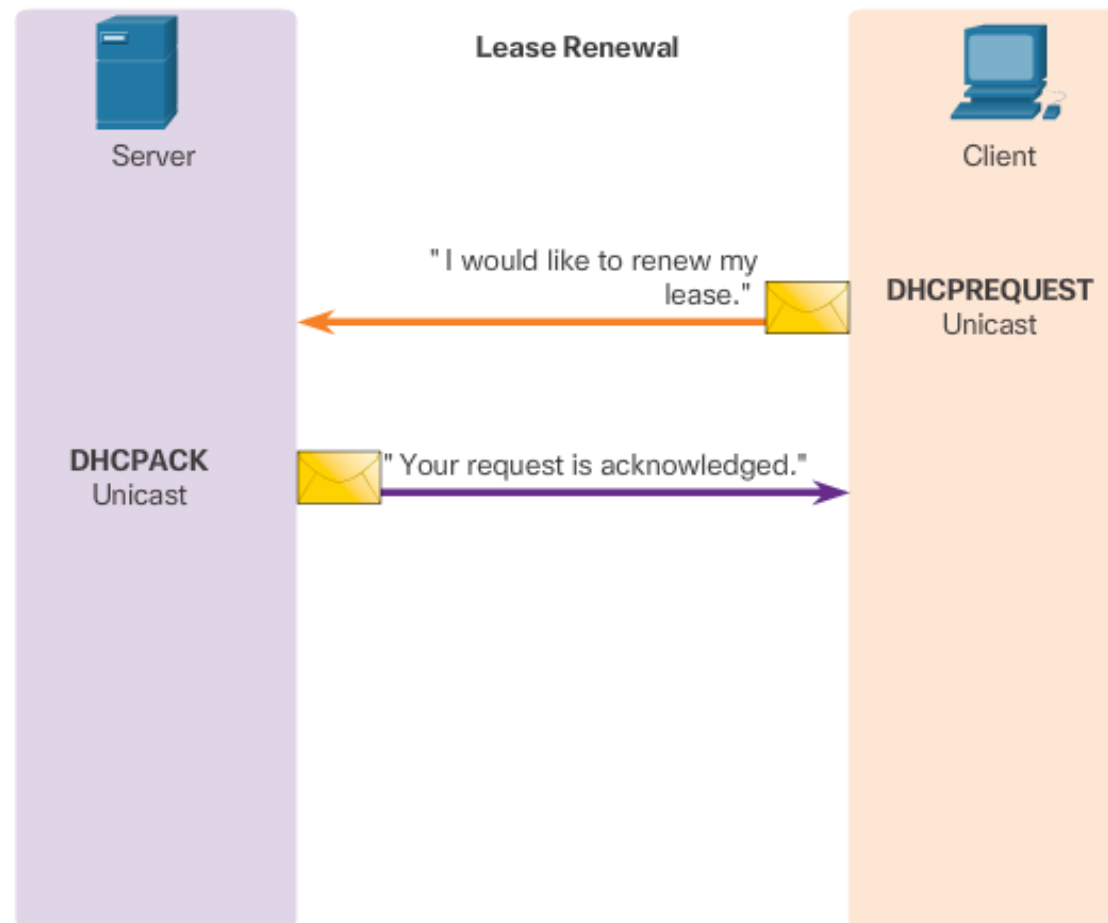
DHCPv4 Operation





DHCPv4 Operation

DHCPv4 Operation (cont.)





DHCPv4 Operation

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

DHCPv4 Discover and Offer Messages



Ethernet Frame	IP	UDP	DHCPDISCOVER
DST MAC: FF:FF:FF:FF:FF:FF SRC MAC: MAC A	IP SRC: 0.0.0.0 IP DST: 255.255.255.255	UDP 67	CIADDR: 0.0.0.0 GIADDR: 0.0.0.0 Mask: 0.0.0.0 CHADDR: MAC A

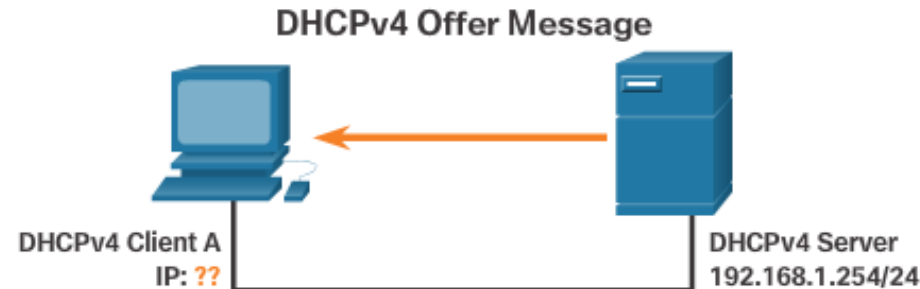
MAC: Media Access Control Address
 CIADDR: Client IP Address
 GIADDR: Gateway IP Address
 CHADDR: Client Hardware Address

The DHCP client sends an 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 the request packet.



DHCPv4 Operation

DHCPv4 Discover and Offer Messages (cont.)



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



Configure DHCPv4 Server

Configure a Basic 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#
```

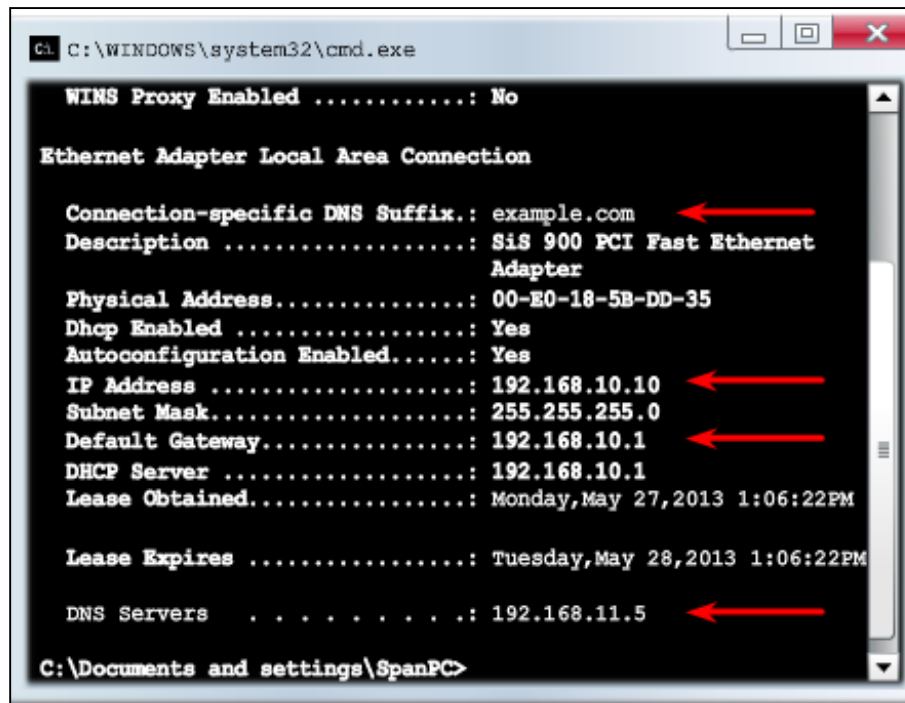
To disable DHCP, use the **no service dhcp** command.



Configure DHCPv4 Server

Verifying DHCPv4

- 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

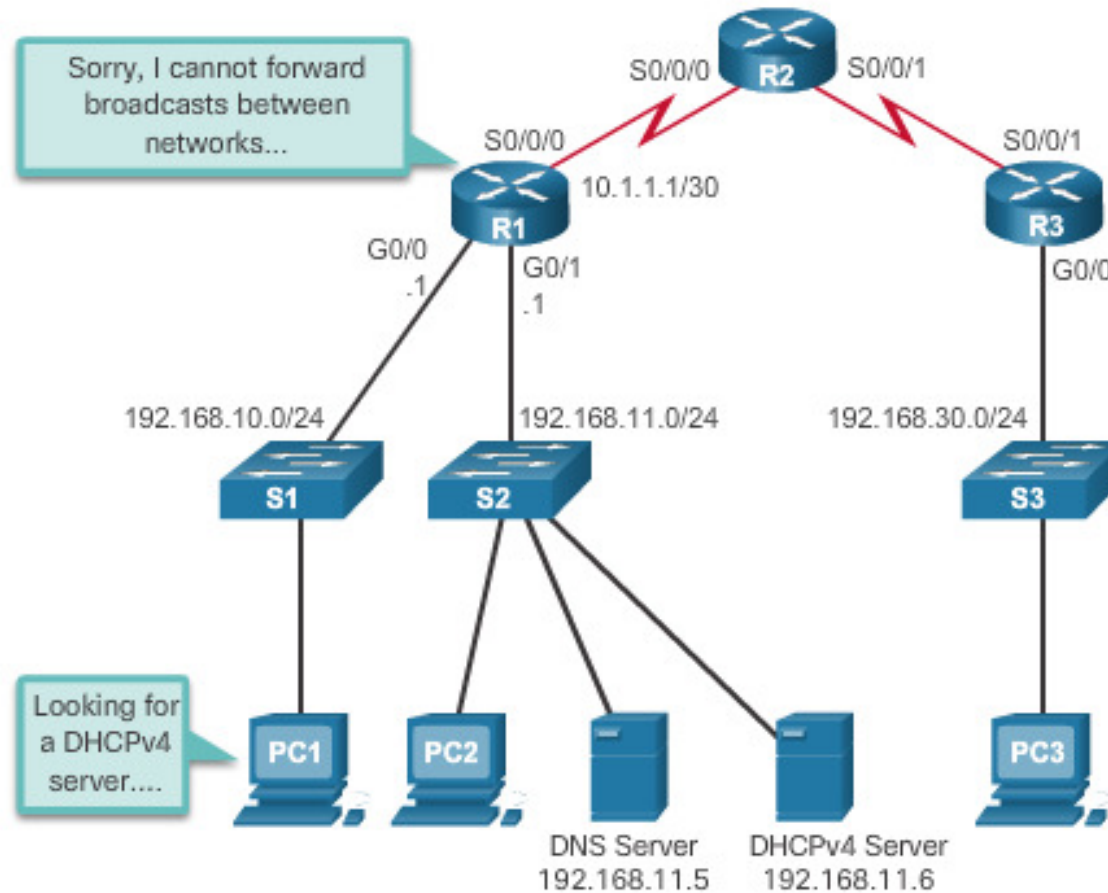
C:\Documents and settings\SpanPC>
  
```



Configure DHCPv4 Server

DHCPv4 Relay

DHCPv4 Problems





Configure DHCPv4 Server

DHCPv4 Relay (cont.)

- 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>
```



Configure DHCPv4 Client

Configuring a Router as a DHCPv4 client

Configuring a Router as DHCP 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>
  
```



Configure DHCPv4 Client

Configuring a Wireless Router as a DHCPv4 Client

Wireless Router DHCPv4 Client Configuration

Wireless-N
Broadband Router

Firmware Version: v0.93.3

Setup

Wireless Security
Access Restrictions
Applications & Gaming
Administration
Status

Internet Setup

Internet Connection type
Optional Settings
(required by some internet service providers)

Automatic Configuration - DHCP

Host Name:

Domain Name:

MTU:

Size: 1500

Help...



Troubleshooting DHCPv4

Troubleshooting Tasks

Troubleshooting Task 1:	Resolve address 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.



Troubleshooting DHCPv4

Verify 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#
```



Troubleshooting 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>

R1# 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
```

- The figure shows an extended ACL permitting only packets with UDP destination ports of 67 or 68. These are the typical ports used by DHCPv4 clients and servers when sending DHCPv4 messages. The extended ACL is used with the `debug ip packet` command to display only DHCPv4 messages.



8.2 DHCPv6



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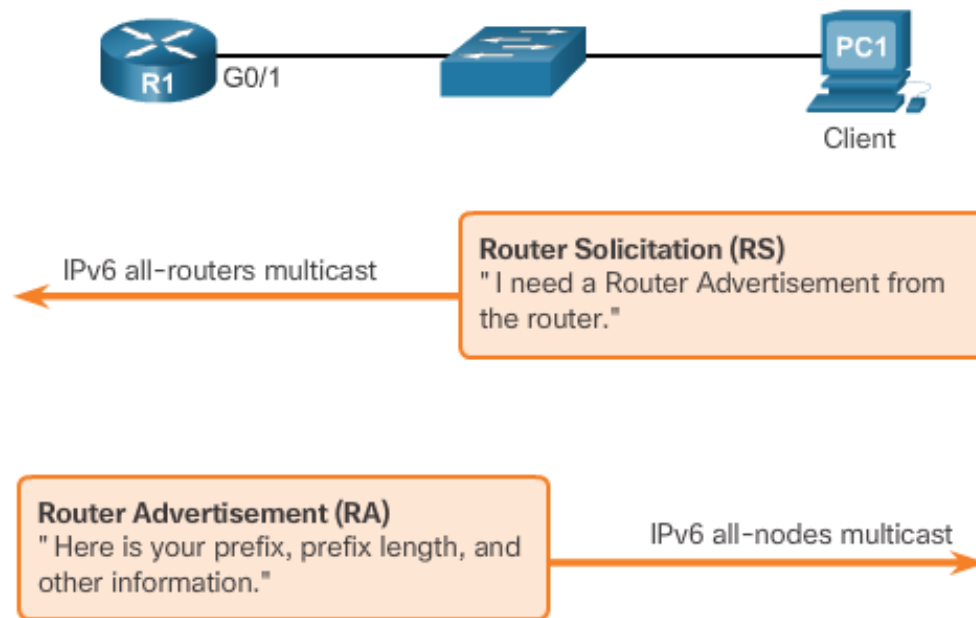


SLAAC and DHCPv6

Stateless Address Autoconfiguration (SLAAC)

- SLAAC uses ICMPv6 Router Solicitation and Router Advertisement messages to provide addressing and other configuration information that would normally be provided by a DHCP server:

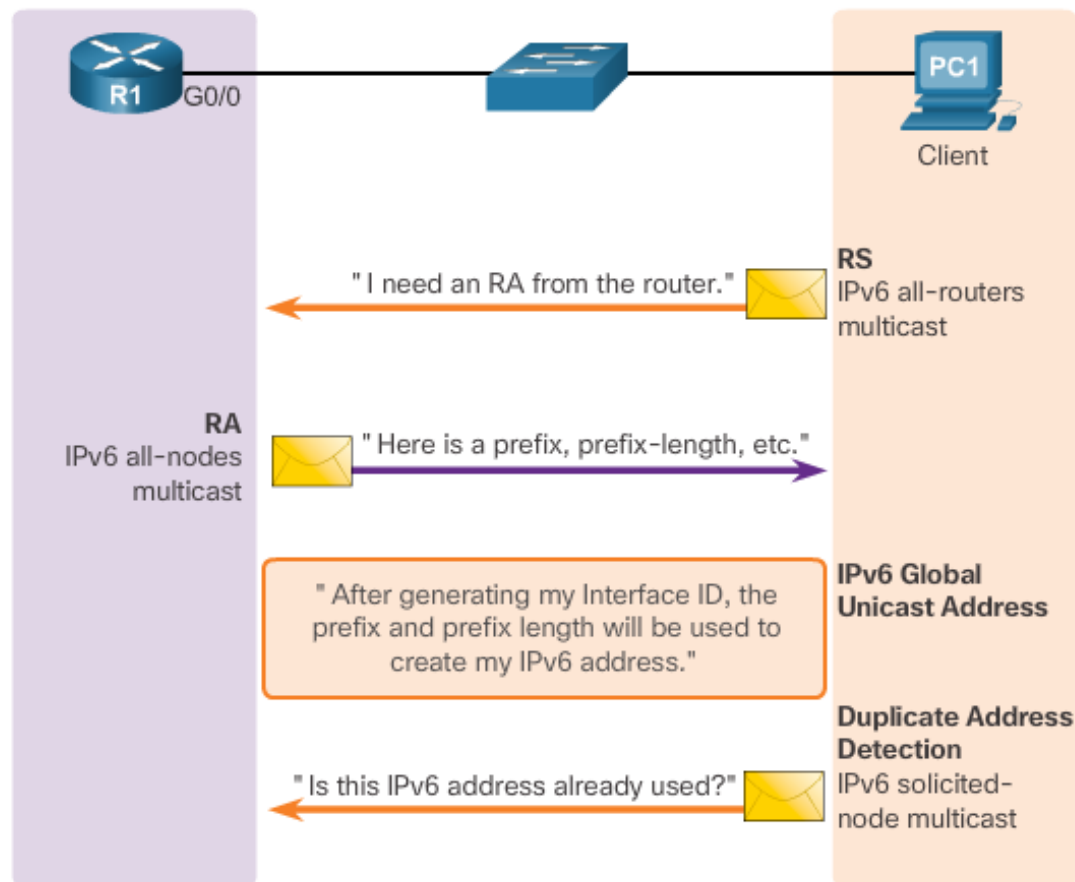
ICMPv6 Stateless Address Autoconfiguration



SLAAC and DHCPv6

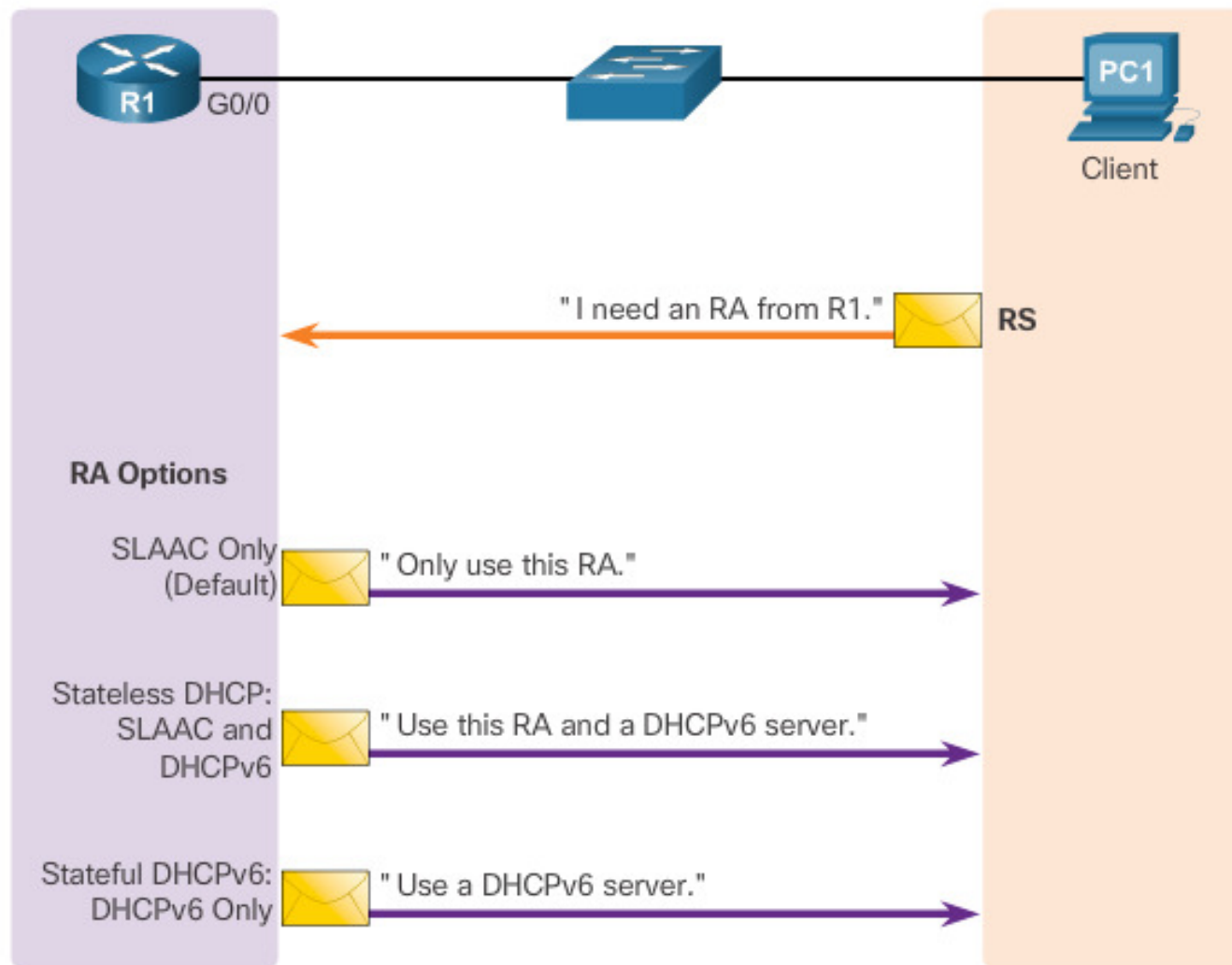
SLAAC Operation

- A router must have IPv6 routing enabled before it can send RA messages: Router(config)# **ipv6 unicast-routing**



SLAAC and DHCPv6

SLAAC and DHCPv6

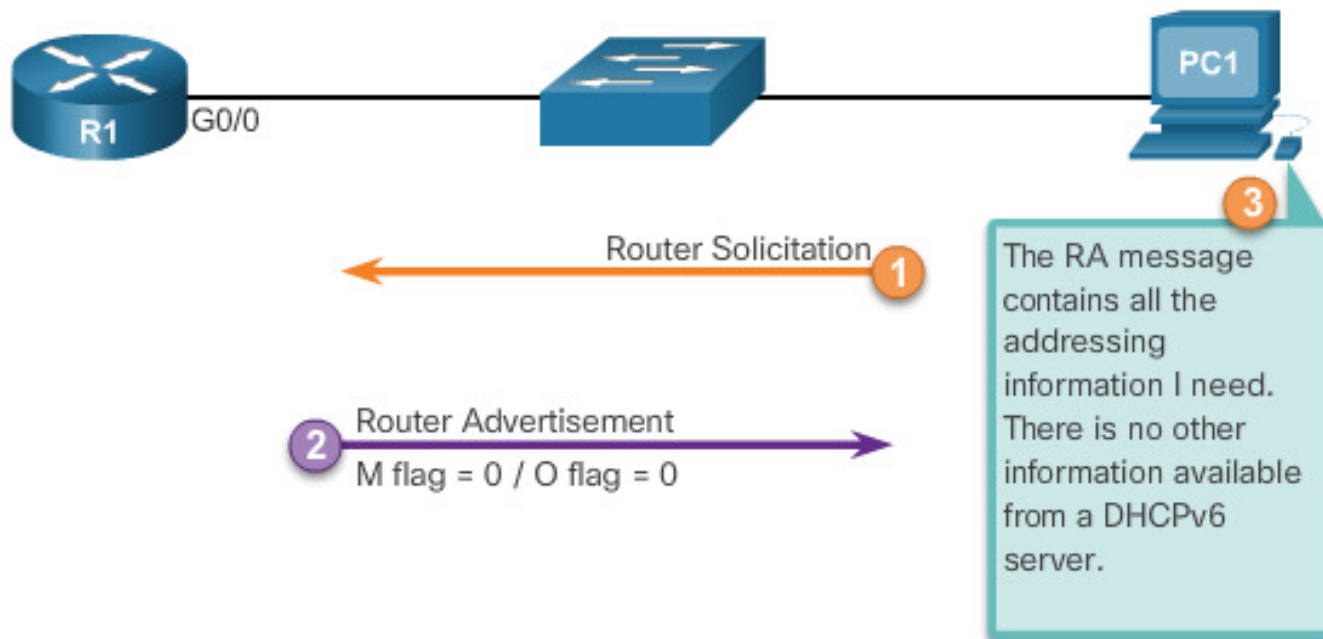




SLAAC and DHCPv6

SLAAC Option

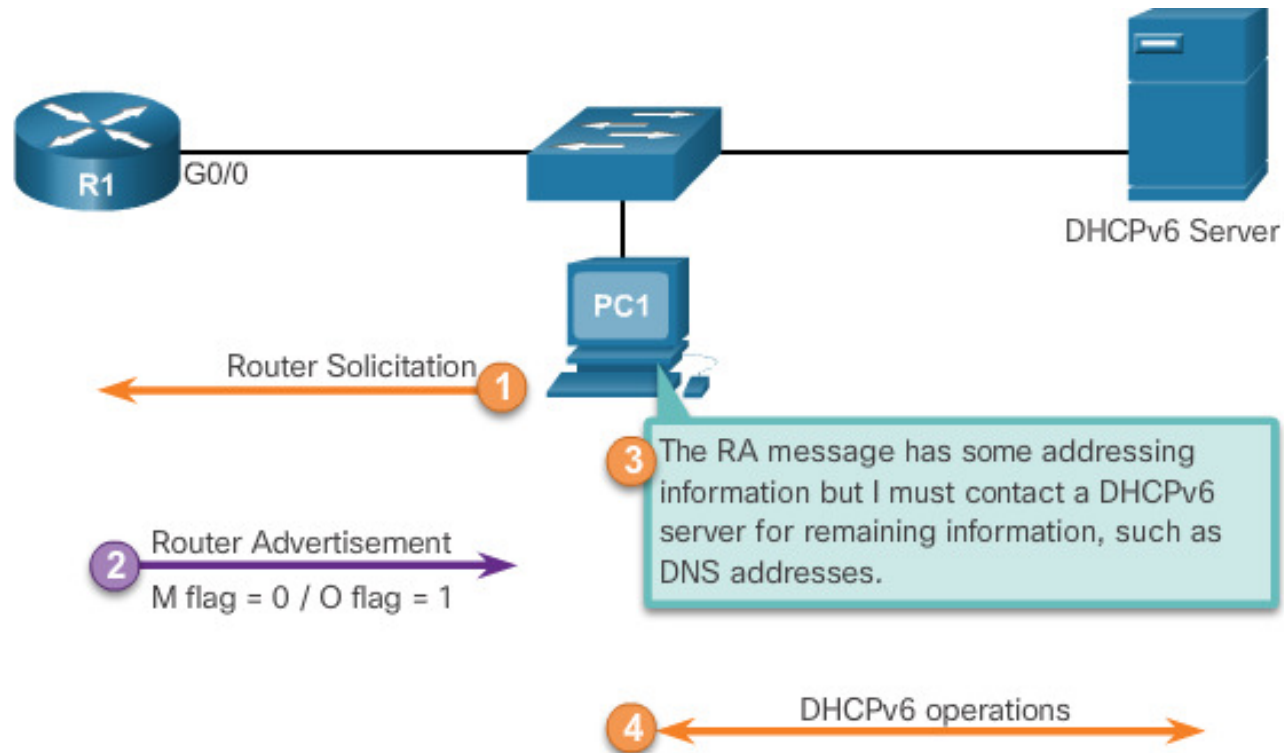
- SLAAC is the default option on Cisco routers. Both the M flag and the O flag are set to 0 in the RA, as shown in the figure.



SLAAC and DHCPv6

Stateless DHCPv6 Option

- To modify the RA message sent on the interface of a router to indicate stateless DHCPv6, use the following command: **Router(config-if)# ipv6 nd other-config-flag**

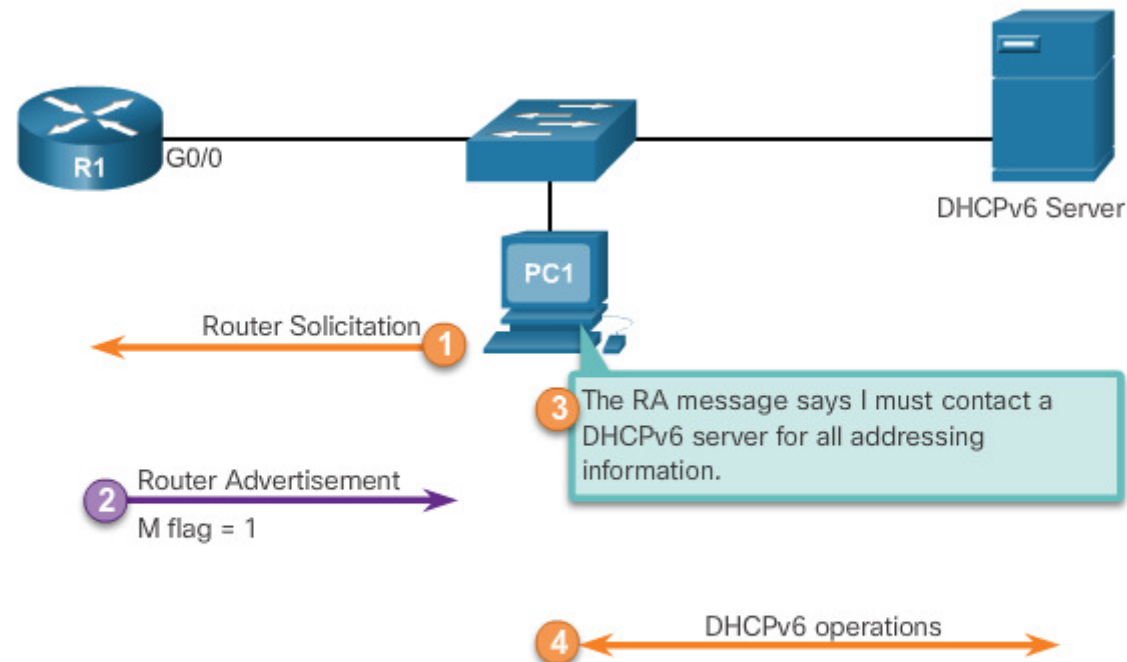




SLAAC and DHCPv6

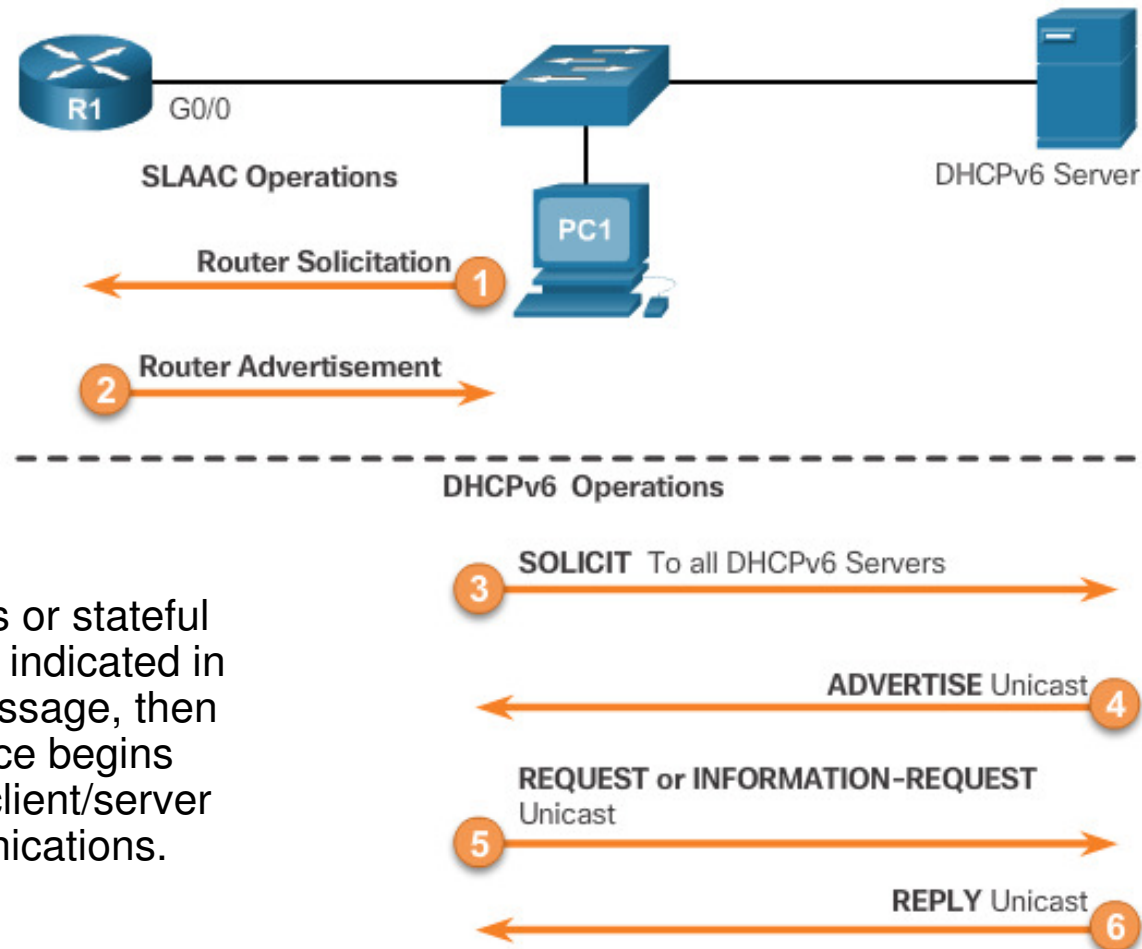
Stateful DHCPv6 Option

- This option is the most similar to DHCPv4. In this case, the RA message informs the client not to use the information in the RA message. All addressing information and configuration information must be obtained from a stateful DHCPv6 server. **Router(config-if)# ipv6 nd managed-config-flag**



SLAAC and DHCPv6

DHCPv6 Operations

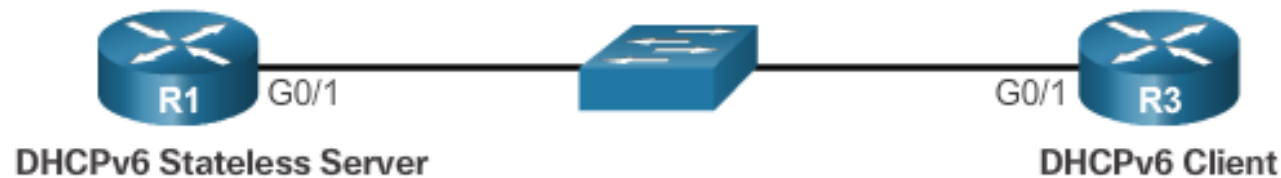


If stateless or stateful DHCPv6 is indicated in the RA message, then the device begins DHCPv6 client/server communications.



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



```

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



Stateless DHCPv6

Verifying Stateless DHCPv6



```

R1# show ipv6 dhcp pool
DHCPv6 pool: IPV6-STATELESS
  DNS server: 2001:DB8:CAFE:AAAA::5
  Domain name: example.com
  Active clients: 0
R1#
  
```

Verify the stateless DHCP client using the following commands:

- `show ipv6 interface`
- `debug ipv6 dhcp detail`



Stateful DHCPv6 Server

Configuring a Router as a Stateful DHCPv6 Server

Step 1. Enable IPv6 Routing

```
Router(config)# ipv6 unicast-routing
```

Step 2. Configure a DHCPv6 Pool

```
Router(config)# ipv6 dhcp pool pool-name  
Router(config-dhcpv6)#
```

Step 3. Configure Pool Parameters

```
Router(config-dhcpv6)# address prefix/length [lifetime  
                        {valid-lifetime preferred-lifetime  
                        | infinite}]  
Router(config-dhcpv6)# dns-server dns-server-address  
Router(config-dhcpv6)# domain-name domain-name
```

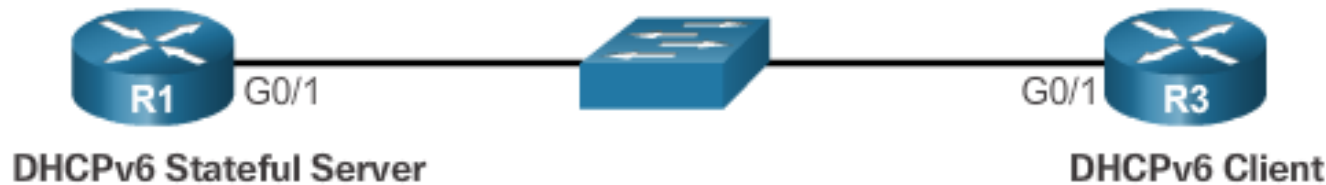
Step 4. Configure the DHCPv6 Interface

```
Router(config)# interface type number  
Router(config-if)# ipv6 dhcp server pool-name  
Router(config-if)# ipv6 nd managed-config-flag
```



Stateful DHCPv6 Server

Configuring a Router as a Stateful DHCPv6 Server (cont.)



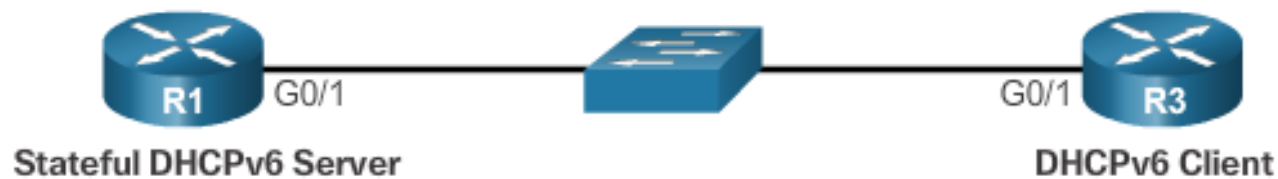
```

R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATEFUL
R1(config-dhcpv6)# address prefix 2001:DB8:CAFE:1::/64
                        lifetime 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
  
```



Stateful DHCPv6 Server

Configuring a Router as a Stateful DHCPv6 Client



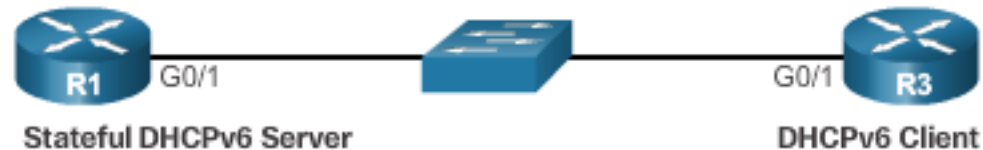
```

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




Stateful DHCPv6 Server

Verifying Stateful DHCPv6



```

R1# show ipv6 dhcp pool
DHCPv6 pool: IPV6-STATEFUL
  Address allocation prefix: 2001:DB8:CAFE:1::/64 valid
  4294967295 preferred 4294967295 (1 in use, 0 conflicts)
  DNS server: 2001:DB8:CAFE:AAAA::5
  Domain name: example.com
  Active clients: 1
R1#
  
```

```

R1# show ipv6 dhcp binding
Client: FE80::32F7:DFF:FE25:2DE1
  DUID: 0003000130F70D252DE0
  Username : unassigned
  IA NA: IA ID 0x00040001, T1 43200, T2 69120
  Address: 2001:DB8:CAFE:1:5844:47B2:2603:C171
           preferred lifetime INFINITY, , valid lifetime
INFINITY,
R1#
  
```



Stateful DHCPv6 Server

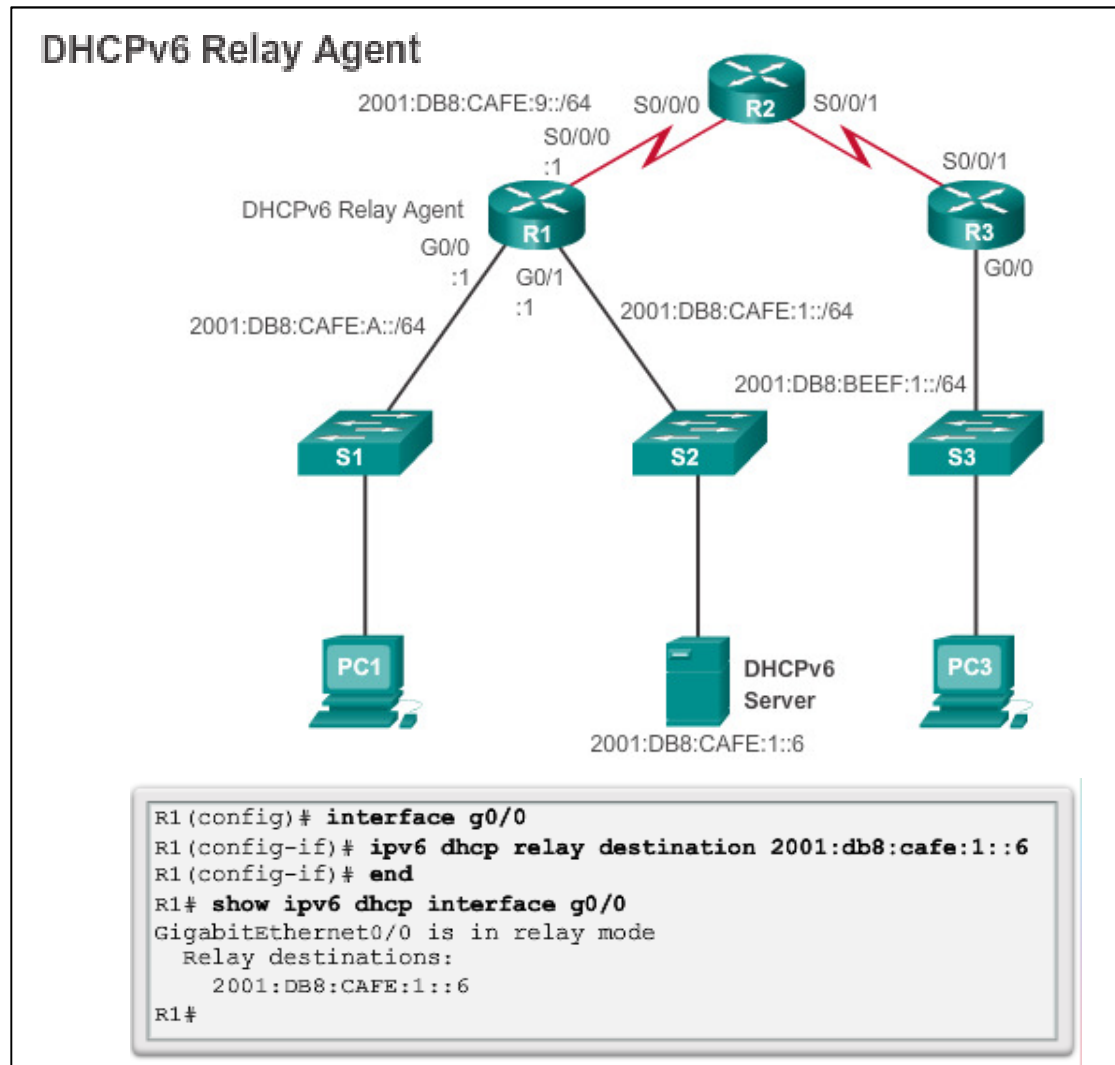
Verifying Stateful DHCPv6 (cont.)

```
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):
    FE02::1
    FE02::1:FE03:C171
    FE02::1:FE25:2DE1
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables 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
GigabitEthernet0/1
R3#
```



Stateful DHCPv6

Configuring a Router as a DHCPv6 Relay Agent





Troubleshooting DHCPv6

Troubleshooting Tasks

Troubleshooting Task 1:	Resolve address 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

Verify Router DHCPv6 Configuration

Stateful DHCPv6 Services

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATEFUL
R1(config-dhcpv6)# address prefix 2001:DB8:CAFE:1::/64 lifetime
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: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>
```



8.3 Summary



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Chapter Summary

Summary

- Explain how DHCPv4 operates 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 stateless DHCPv6 for a small to medium-sized business.
- Configure stateful DHCPv6 for a small to medium-sized business.
- Troubleshoot a DHCP configuration for IPv6 in a switched network.

