Chapter 10: DHCP

Routing & Switching

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Why use DHCP?

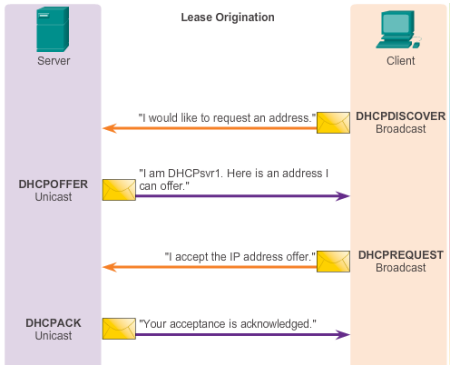
- Why would a router usually be configured as a DHCPv4 client?
  - The router is intended to be used as a SOHO gateway
  - An ISP requirement
  - No server available

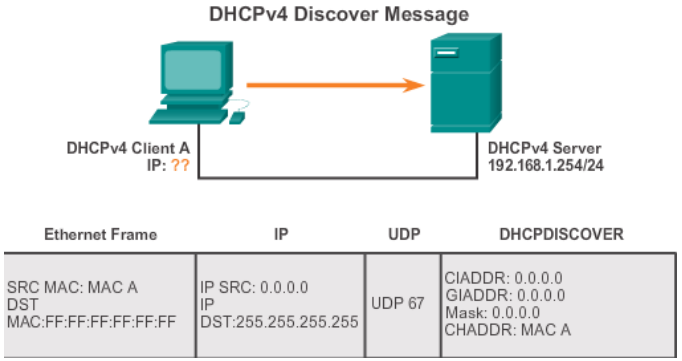
Introducing DHCPv4

- 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

- Message types:
  - Broadcast DHCPDISCOVER
    (MAC- FF:FF:FF:FF:FF:FF and IP- 255.255.255.255)
  - Unicast DHCPOFFER
    (MAC of Client and IP address of client)
  - Broadcast DHCPREQUEST
    (MAC- FF:FF:FF:FF:FF:FF and IP- 255.255.255.255)
  - Unicast DHCPACK
    (MAC of Client and IP address of client)





DHCPv4 Message Format

- What is the reason why the DHCPREQUEST message is sent as a broadcast during the DHCPv4 process?

  to notify other DHCP servers on the subnet that the IP address was leased

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			

Configuring 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

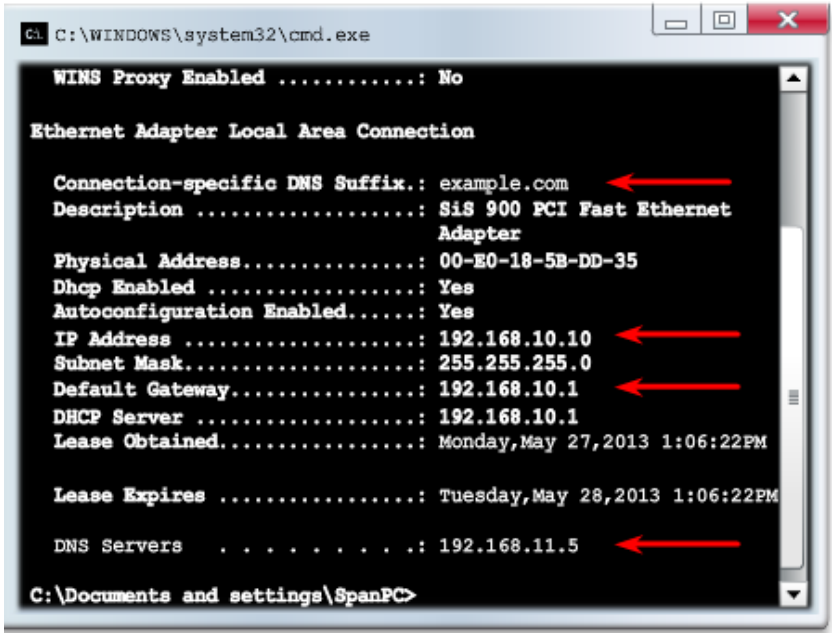
Configuring a DHCPv4 Server

- Which set of commands will configure a router (192.168.100.1) as a DHCP server that will assign IPv4 addresses to the 192.168.100.0/23 LAN while reserving the first 10 and the last addresses for static assignment?

ip dhcp excluded-address 192.168.100.1 192.168.100.10
ip dhcp excluded-address 192.168.101.254
ip dhcp pool LAN-POOL-100
network 192.168.100.0 255.255.254.0
default-router 192.168.100.1

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



DHCPv4 Relay

- Using the **ip helper-address** command 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>
```

- A host on the 10.10.100.0/24 LAN is not being assigned an IPv4 address by an enterprise DHCP server with the address 10.10.200.10/24. What is the best way for the network engineer to resolve this problem?

Issue the command ip helper-address 10.10.200.10 on the router interface that is the 10.10.100.0/24 gateway

Configuring a Router as a DHCPv4 Client

- Configuring the router to obtain IP parameters from a DHCPv4 server


```
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>
```

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#
```

Debugging DHCPv4

Verifying DHCPv4 Using Router debug Commands

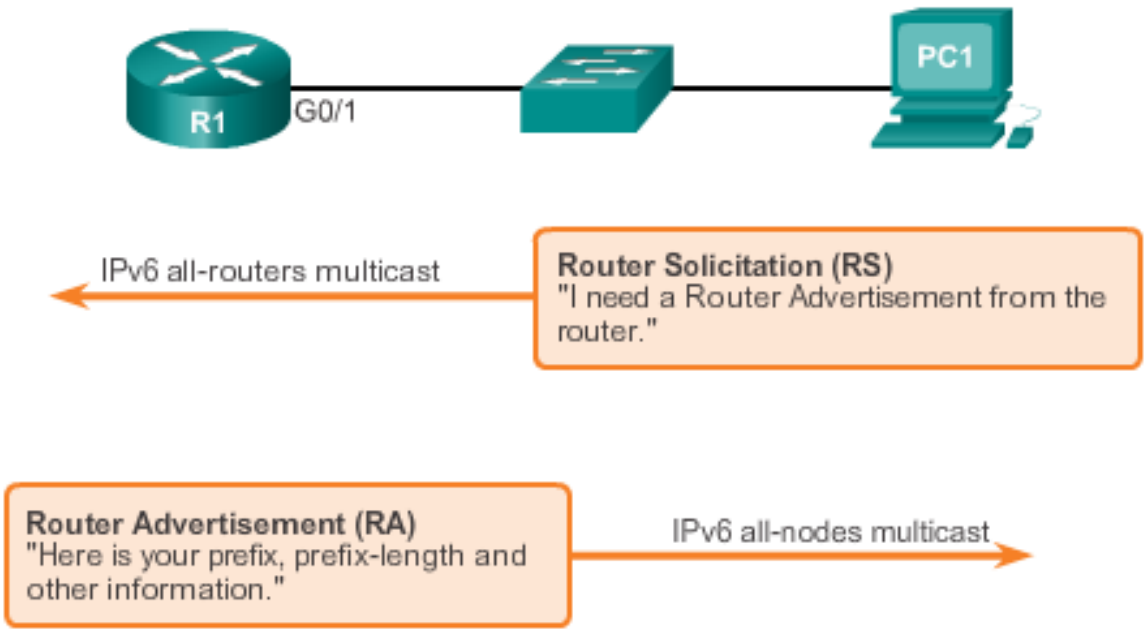
```
R1(config)# access-list 100 permit udp any any eq 67
R1(config)# access-list 100 permit udp any any eq 68
R1(config)# end
R1# debug ip packet 100
IP packet debugging is on for access list 100
*IP: s=0.0.0.0 (GigabitEthernet0/1), d=255.255.255.255, len 333,
rcvd 2
*IP: s=0.0.0.0 (GigabitEthernet0/1),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

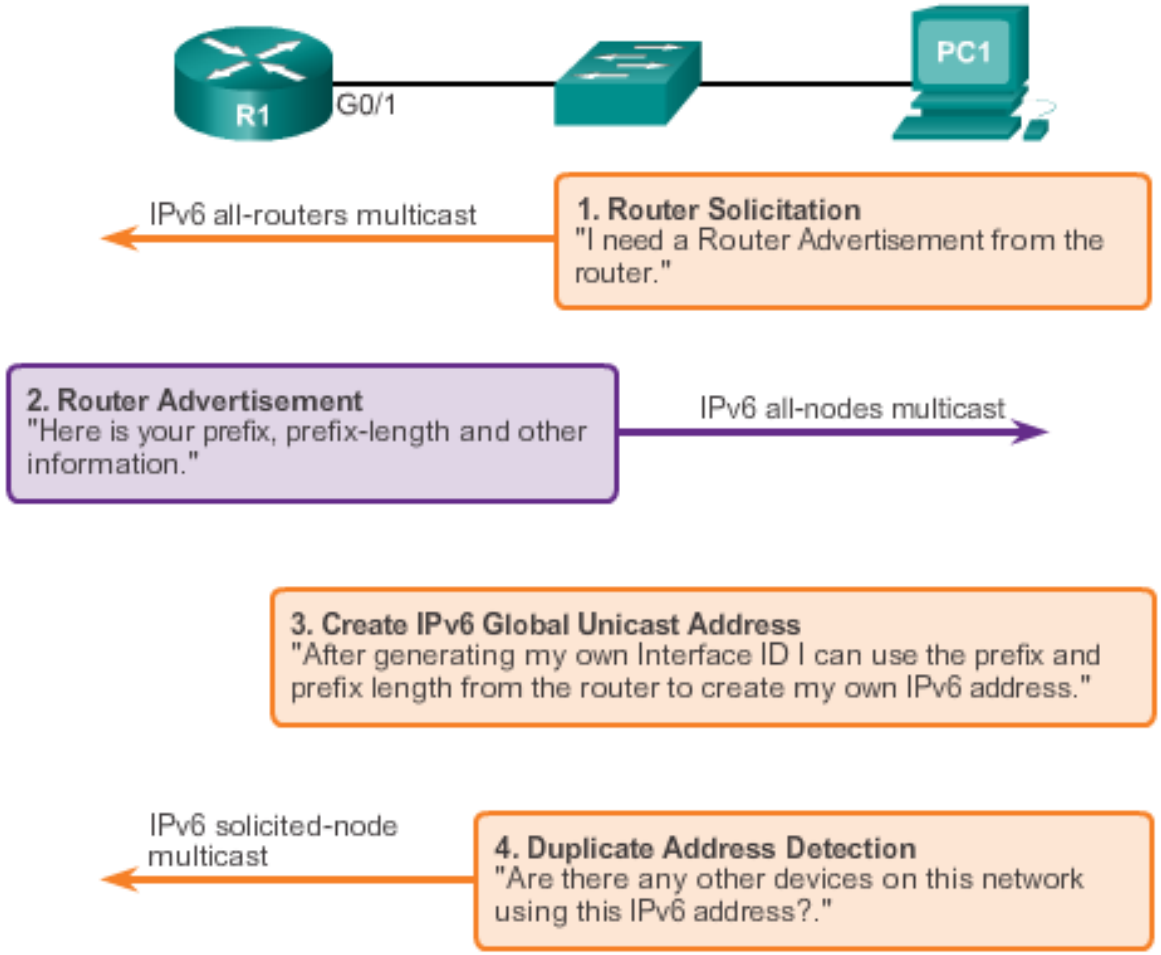
IPv6 Stateless Address Autoconfiguration

- 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.
- Used by ICMPv6

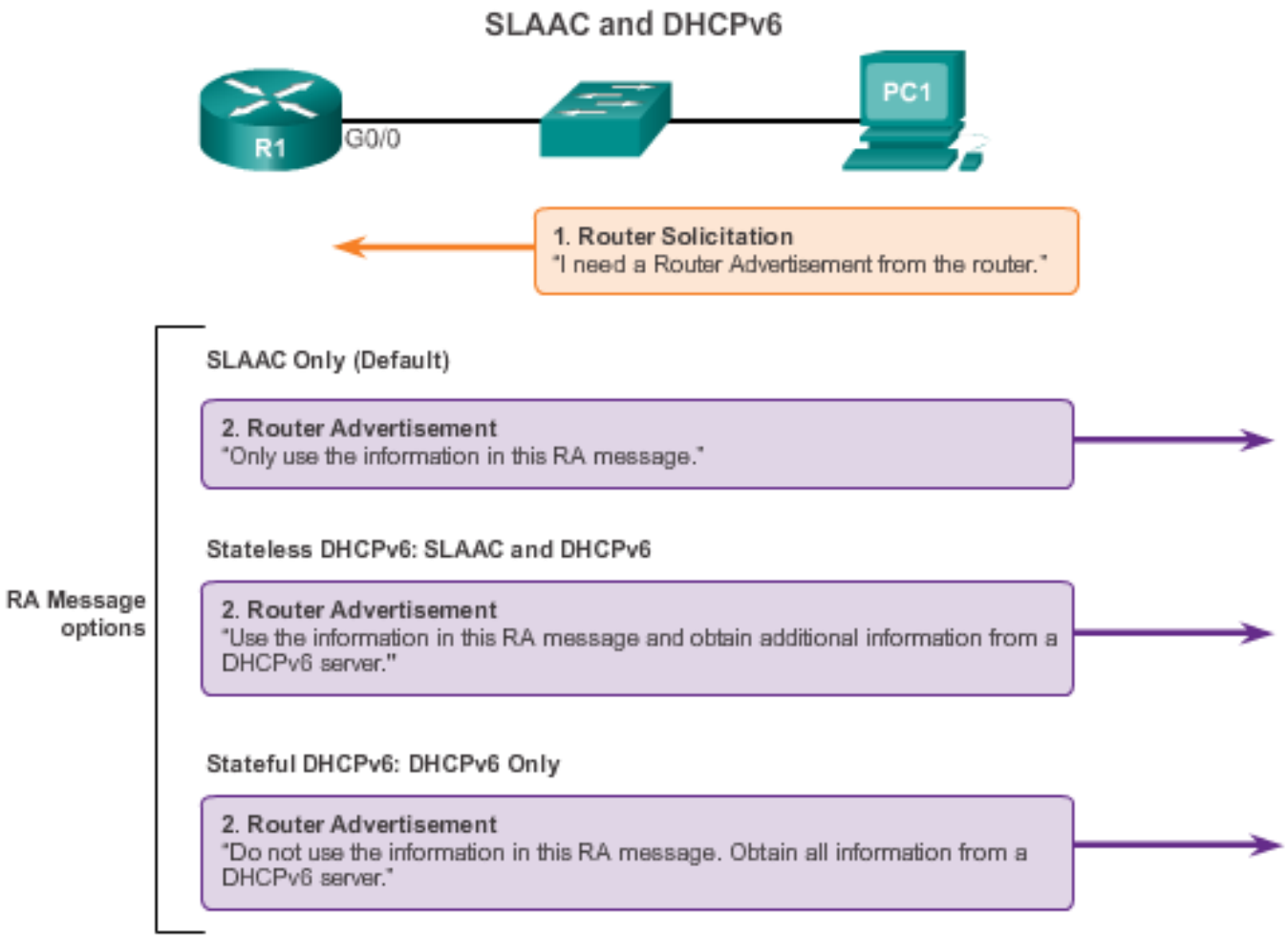


SLAAC Operation

- Client performs Duplicate Address Detection



SLAAC and DHCPv6



IPv6 Router Advertisement

- ICMPv6 RA messages contain two flags to indicate which option the client should use:
  - **Managed Address Configuration flag (M flag)**
  - **Other Configuration flag (O flag)**
- Using different combinations of the M and O flags, RA messages have one of three addressing options:
  - **SLAAC** (Router Advertisement only) – M=0 O=0
  - **Stateless DHCPv6** (Router Advertisement and DHCPv6) – M=0 O=1
    Client sends a DHCPv6 INFORMATION-REQUEST
  - **Stateful DHCPv6** (DHCPv6 only) – M=1 O=0
    Clients sends a DHCPv6 REQUEST

Configuring IPv6

- A company uses the SLAAC method to configure IPv6 addresses for the employee workstations. Which address will a client use as its default gateway?

  The link-local address of the router interface that is attached to the network

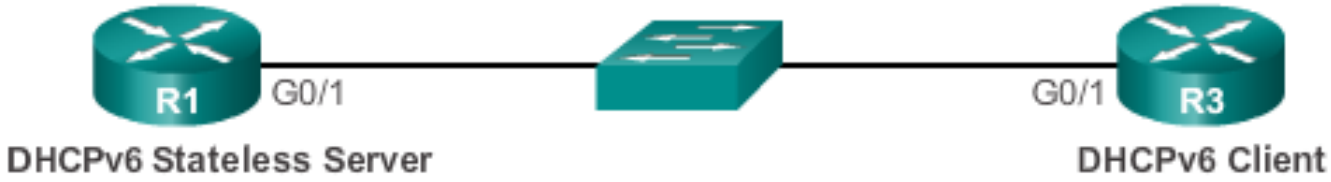
DHCPv6 Operations

```
R1# show running-config
<output omitted>
!
ipv6 dhcp pool IPV6
 dns-server 2001:DB8:1234:5678::100
 domain-name netacad.com
!
interface FastEthernet0/0
 <output omitted>
!
 ipv6 nd other-config-flag
 ipv6 dhcp server IPV6
!
<output omitted>
```

- Based on the output that is shown, what kind of IPv6 addressing is being configured?

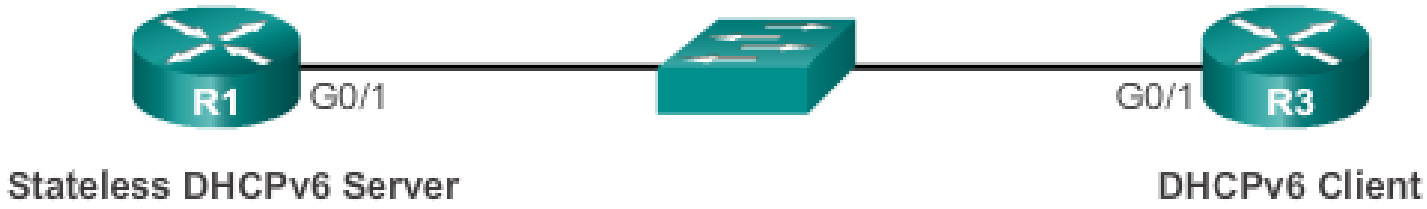
  Stateless DHCPv6

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
```

Configuring a Router as a Stateless DHCPv6 Client



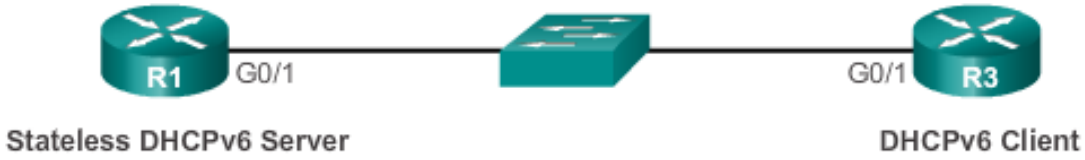
Configuring a Router as Stateless DHCPv6 Client

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

Verifying Stateless DHCPv6

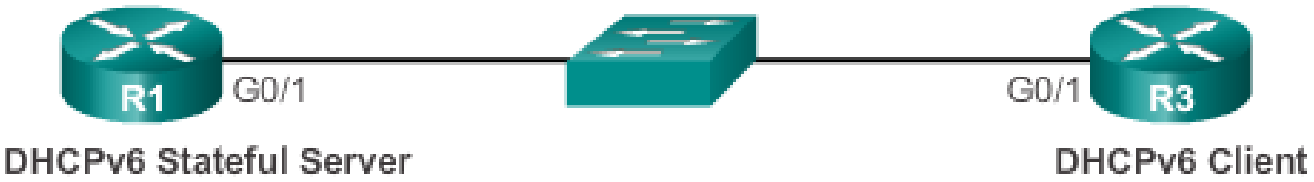
- Verify the stateless DHCP client using the following commands:
  - show IPv6 interface
  - debug ipv6 dhcp detail

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




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

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
```

Enabling IPv6

- A company uses the method SLAAC to configure IPv6 addresses for the workstations of the employees. A network administrator configured the IPv6 address on the LAN interface of the router. The interface status is UP. However, the workstations on the LAN segment did not obtain the correct prefix and prefix length. What else should be configured on the router that is attached to the LAN segment for the workstations to obtain the information?

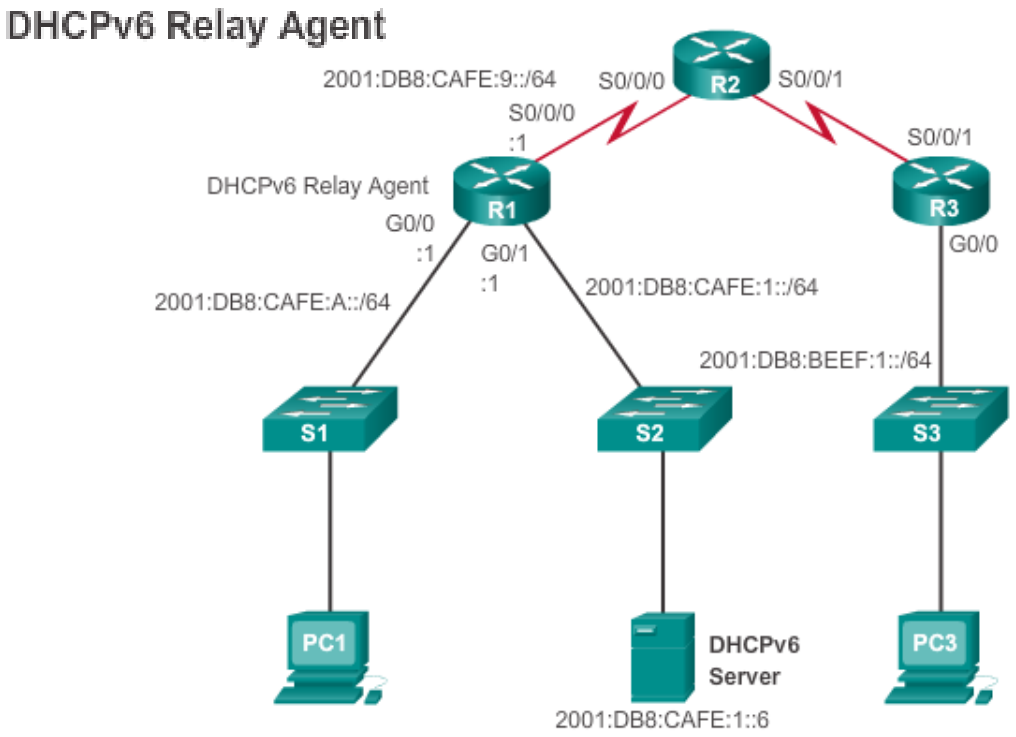
  R1(config)# ipv6 unicast-routing

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:DFF: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 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
```

Configuring 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#
```

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
```

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>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