CAPWAP Access Controller DHCPv6 Option

The Control And Provisioning of Wireless Access Points (CAPWAP) protocol allows lightweight access points to use DHCPv6 to discover a wireless controller to which it can connect. CAPWAP is a standard, interoperable protocol that enables a controller to manage a collection of wireless access points.

Wireless access points use the DHCPv6 option 52 (RFC 5417) to supply the IPv6 management interface addresses of the primary, secondary, and tertiary wireless controllers.

Both stateless and stateful DHCPv6 addressing modes are supported. In stateless mode, access points obtain IPv6 address using the Stateless Address AutoConfiguration (SLAAC), while additional network information (not obtained from router advertisements) is obtained from a DHCPv6 server. In stateful mode, access points obtain both IPv6 addressing and additional network information exclusively from the DHCPv6 server. In both modes, a DHCPv6 server is required to provide option 52 if Wireless Controller discovery using DHCPv6 is required.

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Information About DHCPv6 Options Support

DNS Search List Option

DNS Search List (DNSSL) is a list of Domain Name System (DNS) suffix domain names used by IPv6 hosts when they perform DNS query searches for short, unqualified domain names. The DNSSL option contains one or more domain names. All domain names share the same lifetime value, which is the maximum time in seconds over which this DNSSL may be used. If different lifetime values are required, multiple DNSSL options can be used. There can be a maximum of 5 DNSSLs.

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If DNS information is available from multiple Router Advertisements (RAs) and/or from DHCP, the host must maintain an ordered list of this DNS information.

RFC 6106 specifies IPv6 Router Advertisement (RA) options to allow IPv6 routers to advertise a DNS Search List (DNSSL) to IPv6 hosts for an enhanced DNS configuration.
The DNS lifetime range should be between the maximum RA interval and twice the maximum RA interval, as displayed in the following example:

\[(\text{max ra interval}) \leq \text{dns lifetime} \leq (2 \times \text{max ra interval})\]

The maximum RA interval can have a value between 4 and 1800 seconds (the default is 240 seconds). The following example shows an out-of-range lifetime:

```
Device(config-if)# ipv6 nd ra dns search list sss.com 3600
! Lifetime configured out of range for the interface that has the default maximum RA interval.!
```

**DHCPv6 Client Link-Layer Address Option**

Cisco IOS XE supports DHCPv6 Client Link-Layer Address Option (RFC 6939). It defines an optional mechanism and the related DHCPv6 option to allow first-hop DHCPv6 relay agents (relay agents that are connected to the same link as the client) to provide the client's link-layer address in DHCPv6 messages that are sent towards the server.

The Client Link-Layer Address option is only exchanged between relay agents and servers. DHCPv6 clients are not aware of the use of the Client Link-Layer Address option. The DHCPv6 client must not send the Client Link-Layer Address option, and must ignore the Client Link-Layer Address option if received.

Each DHCPv6 client and server is identified by a DHCP unique identifier (DUID). The DUID is carried in the client identifier and server identifier options. The DUID is unique across all DHCP clients and servers, and it is stable for any specific client or server. DHCPv6 uses DUIDs based on link-layer addresses for both the client and server identifier. The device uses the MAC address from the lowest-numbered interface to form the DUID. The network interface is assumed to be permanently attached to the device.

**DHCPv6 Relay Agent**

A DHCPv6 relay agent, which may reside on a client link, is used to relay messages between the client and the server. The DHCPv6 relay agent operation is transparent to the client. The DHCPv6 client locates a DHCPv6 server using a reserved, link-scoped multicast address. For direct communication between the DHCPv6 client and the DHCPv6 server, both of them must be attached to the same link. However, in some situations where ease of management, economy, or scalability is a concern, it is desirable to allow a DHCPv6 client to send messages to a DHCPv6 server that is not connected to the same link. IPv6 enable is required for IPv6 DHCP relay, even if the IPv6 address is configured.

**How to Configure DHCPv6 Options Support**

**Configuring CAPWAP Access Points**

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ipv6 dhcp pool poolname`
4. `capwap-ac address ipv6-address`
5. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>ipv6 dhcp pool poolname</code></td>
<td>Configures a DHCPv6 server configuration information pool and enters DHCPv6 pool configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# ipv6 dhcp pool pool1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>capwap-ac address ipv6-address</code></td>
<td>Configures CAPWAP access controller address.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-dhcpv6)# capwap-ac address 2001:DB8::1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>end</code></td>
<td>Exits DHCPv6 pool configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-dhcpv6)# end</td>
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</tbody>
</table>

**Configuring DNS Search List Using IPv6 Router Advertisement Options**

*Note*

The domain name configuration should follow RFC 1035. If not, the configuration will be rejected. For example, the following domain name configuration will result in an error:

```
Device(config-if)# ipv6 nd ra dns search list .example.example.com infinite-lifetime
```

Use the `no ipv6 nd ra dns search list name` command to delete a single DNS search list under an interface. Use the `no ipv6 nd ra dns search list` command to delete all DNS search lists under an interface.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `interface interface-type interface-number`
4. `ipv6 nd prefix ipv6-prefix/prefix-length`
5. `ipv6 nd ra lifetime seconds`
6. `ipv6 nd ra dns search list list-name [infinite-lifetime]`
7. `end`

### DETAILED STEPS

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<tr>
<th>Command or Action</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
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<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
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<tr>
<td><strong>Example:</strong></td>
<td></td>
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<tr>
<td>Device# configure terminal</td>
<td></td>
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<tr>
<td><strong>Step 3</strong></td>
<td>Configures an interface and enters interface configuration mode.</td>
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<tr>
<td><code>interface interface-type interface-number</code></td>
<td></td>
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<tr>
<td><strong>Example:</strong></td>
<td></td>
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<tr>
<td>Device(config)# interface GigabitEthernet 0/2/0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Configures IPv6 prefixes that are included in IPv6 Neighbor Discovery (ND) router advertisements,</td>
</tr>
<tr>
<td><code>ipv6 nd prefix ipv6-prefix/prefix-length</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# ipv6 nd prefix 2001:DB8::1/64</td>
<td></td>
</tr>
<tr>
<td>1111 222</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Configures the device lifetime value in IPv6 router advertisements on an interface.</td>
</tr>
<tr>
<td><code>ipv6 nd ra lifetime seconds</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# ipv6 nd ra lifetime 9000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Configures the DNS search list. You can specify the lifetime of the search list.</td>
</tr>
<tr>
<td><code>ipv6 nd ra dns search list list-name [infinite-lifetime]</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# ipv6 nd ra dns search list example.example.com infinite-lifetime</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Exits interface configuration mode and returns to privileged EXEC mode.</td>
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<tr>
<td><code>end</code></td>
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<tr>
<td><strong>Example:</strong></td>
<td></td>
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<tr>
<td>Device(config-if)# end</td>
<td></td>
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</table>

**What to do next**

Use the `show ipv6 nd idb interface` command to verify the DNS search list configuration based on IPv6 RA options:

```
Device# show ipv6 nd idb interface gigabitEthernet 0/2/0/0 detail location 0/2/CPU0

Mon Jul 4 14:28:53.422 IST
ifname: Gi0/2/0/0, ifh: 0x01000300, iftype: 15, VI-type: 0, Pseudo IDB: FALSE
vrf-id: 0x60000000, table-id: 0xe0800000
```
Mac Addr: 02d1.1e2b.0baf, size: 6, VLAN tag set: FALSE

Media Name: ether, Media Encap: 0x1 (ARPA)
Mac Length: 6, Media Header Len: 14, Media Proto: 0xdd86
Current Encap: 0x1 (ARPA), Mcast Encap: 0x1 (ARPA)

IPV6 Interface: Enabled, IPV6: Enabled, MPLS: Disabled
Link local address: 2001::d1:1eff:fe2b:baf, Global Addr count: 1
Global Addresses: 1::1{(0x2)
Default Prefix Address: ::, Prefix Addr Count: 3,
Prefix addresses: 1::(0x401), 2001:db8:e8:1011::(0x4), 2001:db8:e8:1011::(0x4)

RA Specific Route Count: 1,
RA Specific Route : Address 3:: Prefix Length 116 Lifetime 1112 Preference Low

RA DNS Search List Count: 3,
RA DNS Search List : Name example.example.com Lifetime 240
RA DNS Search List : Name example1.example1.com Lifetime 240
RA DNS Search List : Name example2.example2.com Lifetime 4294967295

Configuration Examples for DHCPv6 Options Support

Example: Configuring CAPWAP Access Points

The following example shows how to configure a CAPWAP access point:

Device> enable
Device# configure terminal
Device(config)# ipv6 dhcp pool pool1
Device(config-dhcpv6)# capwap-ac address 2001:DB8::1
Device(config-dhcpv6)# end
Device#

Verifying DHCPv6 Options Support

Verifying Option 52 Support

The following sample output from the show ipv6 dhcp pool command displays the DHCPv6 configuration pool information:

Device# show ipv6 dhcp pool

DHCPv6 pool: svr-p1
Static bindings:
Binding for client 000300010002FC01C
IA PD: IA ID 00040002,
  Prefix: 2001:db8::3/72
  preferred lifetime 604800, valid lifetime 2592000
IA PD: IA ID not specified; being used by 00040001
  Prefix: 2001:db8::1/72
  preferred lifetime 240, valid lifetime 54321
  Prefix: 2001:db8::2/72
The following example shows how to enable debugging for DHCPv6:

Device# debug ipv6 dhcp detail
IPv6 DHCP debugging is on (detailed)

**Troubleshooting DNS Search Lists**

Recursive DNS servers and DNS search lists are sent as part of RA messages. Run the IPv6 ND traces to debug any particular issue related to a DNS servers and DNS search lists:

Device# show ipv6 nd trace location 0/2/CPU0

Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 Sending RA to ff02::1 on GigabitEthernet0/2/0/0 (0x1000300)
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 hoplimit 64 lifetime 9000 reachable 0 retrans 0
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 1::/64 Onlink Auto
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 valid 2592000 pref 604800
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 2002:4898:e8:1011::/64 Onlink Auto
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 valid 1111 pref 222
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 2002:4899:e8:1011::/64 Onlink Auto
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 valid 1111 pref 222
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra specific route address 3:: lifetime 1112 preference Low
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns servers address 5::6 lifetime 240 first
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns servers address 5::5 lifetime 240 part
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns servers address 4::4 lifetime 4294967295
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns search list name example.example.com lifetime 240 first
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns search list name example1.example1.com lifetime 240 part
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns search list name example2.example2.com
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns search list name example3.example3.com
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 ra dns send ra: sending RA paksize=320, plen=280
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 nd_pak_send: size=320, ifh GigabitEthernet0/2/0/0 (0x1000300)
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 nd_pak_send: sending pak=0x60c07d8b with NO FVS set, size=320,
Jun 30 20:07:03.508 nd/event 0/2/CPU0 t26702 nd_pak_send: sending pak=0x60c07d8b with NO FVS set, size=320,