C H A P T E R 31

Configuring IPv6 Neighbor Discovery

This chapter describes how to enable and configure IPv6 neighbor discovery on the ASA and includes the following sections:

Information About IPv6 Neighbor Discovery

The IPv6 neighbor discovery process uses ICMPv6 messages and solicited-node multicast addresses to determine the link-layer address of a neighbor on the same network (local link), verify the readability of a neighbor, and keep track of neighboring routers.

Nodes (hosts) use neighbor discovery to determine the link-layer addresses for neighbors known to reside on attached links and to quickly purge cashed values that become invalid. Hosts also use neighbor discovery to find neighboring routers that are willing to forward packets on their behalf. In addition, nodes use the protocol to actively keep track of which neighbors are reachable and which are not, and to detect changed link-layer addresses. When a router or the path to a router fails, a host actively searches for functioning alternates.

This section includes the following topics:

Neighbor Solicitation Messages

Neighbor solicitation messages (ICMPv6 Type 135) are sent on the local link by nodes attempting to discover the link-layer addresses of other nodes on the local link. The neighbor solicitation message is sent to the solicited-node multicast address. The source address in the neighbor solicitation message is the IPv6 address of the node sending the neighbor solicitation message. The neighbor solicitation message also includes the link-layer address of the source node.

After receiving a neighbor solicitation message, the destination node replies by sending a neighbor advertisement message (ICPMv6 Type 136) on the local link. The source address in the neighbor advertisement message is the IPv6 address of the node sending the neighbor advertisement message; the destination address is the IPv6 address of the node that sent the neighbor solicitation message. The data portion of the neighbor advertisement message includes the link-layer address of the node sending the neighbor advertisement message.

After the source node receives the neighbor advertisement, the source node and destination node can communicate.

Neighbor solicitation messages are also used to verify the reachability of a neighbor after the link-layer address of a neighbor is identified. When a node wants to verifying the reachability of a neighbor, the destination address in a neighbor solicitation message is the unicast address of the neighbor.

Neighbor advertisement messages are also sent when there is a change in the link-layer address of a node on a local link. When there is such a change, the destination address for the neighbor advertisement is the all-nodes multicast address.

Neighbor Reachable Time

The neighbor reachable time enables detecting unavailable neighbors. Shorter configured times enable detecting unavailable neighbors more quickly, however, shorter times consume more IPv6 network bandwidth and processing resources in all IPv6 network devices. Very short configured times are not recommended in normal IPv6 operation.

Duplicate Address Detection

During the stateless autoconfiguration process, Duplicate Address Detection verifies the uniqueness of new unicast IPv6 addresses before the addresses are assigned to interfaces (the new addresses remain in a tentative state while Duplicate Address Detection is performed). Duplicate Address Detection is performed first on the new link-local address. When the link-local address is verified as unique, then Duplicate Address Detection is performed all the other IPv6 unicast addresses on the interface.

Duplicate Address Detection is suspended on interfaces that are administratively down. While an interface is administratively down, the unicast IPv6 addresses assigned to the interface are set to a pending state. An interface returning to an administratively up state restarts Duplicate Address Detection for all of the unicast IPv6 addresses on the interface.

When a duplicate address is identified, the state of the address is set to DUPLICATE, the address is not used, and the following error message is generated:

```
%ASA-4-325002: Duplicate address ipv6_address/MAC_address on interface
```

If the duplicate address is the link-local address of the interface, the processing of IPv6 packets is disabled on the interface. If the duplicate address is a global address, the address is not used. However, all configuration commands associated with the duplicate address remain as configured while the state of the address is set to DUPLICATE.

If the link-local address for an interface changes, Duplicate Address Detection is performed on the new link-local address and all of the other IPv6 address associated with the interface are regenerated (Duplicate Address Detection is performed only on the new link-local address).

The ASA uses neighbor solicitation messages to perform Duplicate Address Detection. By default, the number of times an interface performs Duplicate Address Detection is 1.

Router Advertisement Messages

An ASA can participate in router advertisements so that neighboring devices can dynamically learn a default router address. Router advertisement messages (ICMPv6 Type 134) are periodically sent out each IPv6 configured interface of the ASA. The router advertisement messages are sent to the all-nodes multicast address.

Router advertisement messages typically include the following information:

- One or more IPv6 prefix that nodes on the local link can use to automatically configure their IPv6 addresses.
- Lifetime information for each prefix included in the advertisement.
- Sets of flags that indicate the type of autoconfiguration (stateless or stateful) that can be completed.
- Default router information (whether the router sending the advertisement should be used as a default router and, if so, the amount of time (in seconds) the router should be used as a default router).
- Additional information for hosts, such as the hop limit and MTU a host should use in packets that it originates.
- The amount of time between neighbor solicitation message retransmissions on a given link.
- The amount of time a node considers a neighbor reachable.

Router advertisements are also sent in response to router solicitation messages (ICMPv6 Type 133). Router solicitation messages are sent by hosts at system startup so that the host can immediately autoconfigure without needing to wait for the next scheduled router advertisement message. Because router solicitation messages are usually sent by hosts at system startup, and the host does not have a configured unicast address, the source address in router solicitation messages is usually the unspecified IPv6 address (0:0:0:0:0:0:0:0). If the host has a configured unicast address, the unicast address of the interface sending the router solicitation message is used as the source address in the message. The destination address in router solicitation messages is the all-routers multicast address with a scope of the link. When a router advertisement is sent in response to a router solicitation, the destination address in the router advertisement message is the unicast address of the source of the router solicitation message.

You can configure the following settings for router advertisement messages:

- The time interval between periodic router advertisement messages.
- The router lifetime value, which indicates the amount of time IPv6 nodes should consider the ASA to be the default router.
- The IPv6 network prefixes in use on the link.
- Whether or not an interface transmits router advertisement messages.

Unless otherwise noted, the router advertisement message settings are specific to an interface and are entered in interface configuration mode.

Static IPv6 Neighbors

You can manually define a neighbor in the IPv6 neighbor cache. If an entry for the specified IPv6 address already exists in the neighbor discovery cache—learned through the IPv6 neighbor discovery process—the entry is automatically converted to a static entry. Static entries in the IPv6 neighbor discovery cache are not modified by the neighbor discovery process.

Licensing Requirements for IPv6 Neighbor Discovery

The following table shows the licensing requirements for this feature:

Model	License Requirement
All models	Base License.

Prerequisites for IPv6 Neighbor Discovery

Configure IPv6 addressing according to the "Configuring IPv6 Addressing" section on page 11-12.

Guidelines and Limitations

This section includes the guidelines and limitations for this feature.

Context Mode Guidelines

Supported in single and multiple context mode.

Firewall Mode Guidelines

Supported in routed mode only. Transparent mode is not supported.

Additional Guidelines and Limitations

*   The interval value is included in all IPv6 router advertisements that are sent out of this interface.
*   The configured time enables detecting unavailable neighbors. Shorter configured times enable detecting unavailable neighbors more quickly; however, shorter times consume more IPv6 network bandwidth and processing resources in all IPv6 network devices. Very short configured times are not recommended in normal IPv6 operation.
*   The interval between transmissions should be less than or equal to the IPv6 router advertisement lifetime if the ASA is configured as a default router by using the **ipv6 nd ra-lifetime** command. To prevent synchronization with other IPv6 nodes, randomly adjust the actual value used to within 20 percent of the specified value.
*   The **ipv6 nd prefix** command allows control over the individual parameters per prefix, including whether or not the prefix should be advertised.

- By default, prefixes configured as addresses on an interface using the **ipv6 address** command are advertised in router advertisements. If you configure prefixes for advertisement using the **ipv6 nd prefix** command, then only these prefixes are advertised.

- The **default** keyword can be used to set default parameters for all prefixes.

- A date can be set to specify the expiration of a prefix. The valid and preferred lifetimes are counted down in real time. When the expiration date is reached, the prefix will no longer be advertised.

- When onlink is on (by default), the specified prefix is assigned to the link. Nodes sending traffic to such addresses that contain the specified prefix consider the destination to be locally reachable on the link.

- When autoconfig is on (by default), it indicates to hosts on the local link that the specified prefix can be used for IPv6 autoconfiguration.

- For stateless autoconfiguration to work correctly, the advertised prefix length in router advertisement messages must always be 64 bits.

- The router lifetime value is included in all IPv6 router advertisements sent out of the interface. The value indicates the usefulness of the ASA as a default router on this interface.

- Setting the value to a non-zero value indicates that the ASA should be considered a default router on this interface. The non-zero value for the router lifetime value should not be less than the router advertisement interval.

The following guidelines and limitations apply for configuring a static IPv6 neighbor:

- The **ipv6 neighbor** command is similar to the **arp** command. If an entry for the specified IPv6 address already exists in the neighbor discovery cache—learned through the IPv6 neighbor discovery process—the entry is automatically converted to a static entry. These entries are stored in the configuration when the copy command is used to store the configuration.

- Use the **show ipv6 neighbor** command to view static entries in the IPv6 neighbor discovery cache.

- The **clear ipv6 neighbor** command deletes all entries in the IPv6 neighbor discovery cache except static entries. The **no ipv6 neighbor** command deletes a specified static entry from the neighbor discovery cache; the command does not remove dynamic entries—entries learned from the IPv6 neighbor discovery process—from the cache. Disabling IPv6 on an interface by using the **no ipv6 enable** command deletes all IPv6 neighbor discovery cache entries configured for that interface except static entries (the state of the entry changes to INCMP [Incomplete]).

- Static entries in the IPv6 neighbor discovery cache are not modified by the neighbor discovery process.

- The **clear ipv6 neighbor** command does not remove static entries from the IPv6 neighbor discovery cache; it only clears the dynamic entries.

- The ICMP syslogs generated are caused by a regular refresh of IPv6 neighbor entries. The ASA default timer for IPv6 neighbor entry is 30 seconds, so the ASA would generate ICMPv6 neighbor discovery and response packets about every 30 seconds. If the ASA has both failover LAN and state interfaces configured with IPv6 addresses, then every 30 seconds, ICMPv6 neighbor discovery and response packets will be generated by both ASAs for both configured and link-local IPv6 addresses. In addition, each packet will generate several syslogs (ICMP connection and local-host creation or teardown), so it may appear that constant ICMP syslogs are being generated. The refresh time for IPV6 neighbor entry is configurable on the regular data interface, but not configurable on the failover interface. However, the CPU impact for this ICMP neighbor discovery traffic is minimal.

Default Settings for IPv6 Neighbor Discovery

Table 31-1 lists the default settings for IPv6 Neighbor Discovery.

Table 31-1   Default IPv6 Neighbor Discovery Parameters

Parameters	Default
value for the neighbor solicitation transmission message interval	1000 seconds between neighbor solicitation transmissions.
value for the neighbor reachable time	The default is 0.
value for the router advertisement transmission interval	The default is 200 seconds.
value for the router lifetime	The default is 1800 seconds.
value for the number of consecutive neighbor solicitation messages sent during DAD	The default is one message.
prefix lifetime	The default lifetime is 2592000 seconds (30 days), and a preferred lifetime is 604800 seconds (7 days).
on-link flag	The flag is on by default, which means that the prefix is used on the advertising interface.
autoconfig flag	The flag is on by default, which means that the prefix is used for autoconfiguration.
static IPv6 neighbor	Static entries are not configured in the IPv6 neighbor discovery cache.

Configuring IPv6 Neighbor Discovery

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- Configuring the Neighbor Solicitation Message Interval, page 31-7
- Configuring the Neighbor Reachable Time, page 31-8
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- Configuring the Router Lifetime Value, page 31-9
- Configuring DAD Settings, page 31-9
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- Configuring Address Config Flags for IPv6 DHCP Relay, page 31-11
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- Configuring a Static IPv6 Neighbor, page 31-13

Entering Interface Configuration Mode

Configure neighbor discovery settings per interface. To enter interface configuration mode, perform the following steps.

Detailed Steps

Command	Purpose
interface *name* **Example:** hostname(config)# interface gigabitethernet 0/0 hostname(config-if)#	Enters interface configuration mode.

Configuring the Neighbor Solicitation Message Interval

To configure the interval between IPv6 neighbor solicitation retransmissions on an interface, enter the following command.

Detailed Steps

Command	Purpose
ipv6 nd ns-interval *value* **Example:** hostname (config-if)# ipv6 nd ns-interval 9000	Sets the interval between IPv6 neighbor solicitation retransmissions on an interface. Valid values for the value argument range from 1000 to 3600000 milliseconds. This information is also sent in router advertisement messages.

Examples

The following example configures an IPv6 neighbor solicitation transmission interval of 9000 milliseconds for GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd ns-interval 9000
```

Configuring the Neighbor Reachable Time

To configure the amount of time that a remote IPv6 node is considered reachable after a reachability confirmation event has occurred, enter the following command.

Detailed Steps

Command	Purpose

`ipv6 nd reachable-time` *value*
 	
Example:
`hostname (config-if)# ipv6 nd`
`reachable-time 1700000`
	Sets the amount of time that a remote IPv6 node is reachable.
	
	Valid values for the *value* argument range from 0 to 3600000 milliseconds.
	
	When 0 is used for the value, the reachable time is sent as undetermined. It is up to the receiving devices to set and track the reachable time value.

Examples

The following example configures an IPv6 reachable time of 1700000 milliseconds for the selected interface, GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd reachable-time 1700000
```

Configuring the Router Advertisement Transmission Interval

To configure the interval between IPv6 router advertisement transmissions on an interface, enter the following command.

Detailed Steps

Command	Purpose

`ipv6 nd ra-interval` [**msec**] *value*
 	
Example:
`hostname (config-if)# ipv6 nd ra-interval`
`201`
	Sets the interval between IPv6 router advertisement transmissions.
	
	The optional **msec** keyword indicates that the value provided is in milliseconds. If this keyword is not present, the value provided is in seconds.
	
	Valid values for the *value* argument range from 3 to 1800 seconds or from 500 to 1800000 milliseconds if the **msec** keyword is provided.
	
	The interval between transmissions should be less than or equal to the IPv6 router advertisement lifetime if the ASA is configured as a default router. For more information, see the "Configuring the Router Lifetime Value" section on page 31-9. To prevent synchronization with other IPv6 nodes, randomly adjust the actual value used to within 20 percent of the desired value.

Examples

The following example configures an IPv6 router advertisement interval of 201 seconds for the selected interface, GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd ra-interval 201
```

Configuring the Router Lifetime Value

To configure the router lifetime value in IPv6 router advertisements on an interface, enter the following command.

Detailed Steps

Command	Purpose
`ipv6 nd ra-lifetime` [**msec**] *value*	Specifies the length of time that nodes on the local link should consider the ASA as the default router on the link.
Example: hostname (config-if)# ipv6 nd ra-lifetime 2000	The optional **msec** keyword indicates that the value provided is in milliseconds. If this keyword is not present, the value provided is in seconds.
	Valid values for the *value* argument range from 0 to 9000 seconds.
	Entering 0 indicates that the ASA should not be considered a default router on the selected interface.

Examples

The following example configures an IPv6 router lifetime value of 2000 seconds for the selected interface, GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd ra-lifetime 2000
```

Configuring DAD Settings

To specify DAD settings on the interface, enter the following command.

Detailed Steps

Command	Purpose
`ipv6 nd dad attempts` *value* **Example:** hostname (config-if)# ipv6 nd dad attempts 20	Specifies the uniqueness of new unicast IPv6 addresses before they are assigned and ensures that duplicate IPv6 addresses are detected in the network on a link basis.
	Valid values for the *value* argument range from 0 to 600. A zero value disables DAD processing on the specified interface.

Examples

The following example configures a DAD attempt value of 20 for the selected interface, GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd dad attempts 20
```

Suppressing Router Advertisement Messages

Router advertisement messages are automatically sent in response to router solicitation messages. You may want to disable these messages on any interface for which you do not want the ASA to supply the IPv6 prefix (for example, the outside interface).

To suppress the router lifetime value in IPv6 router advertisements on an interface, enter the following command.

Detailed Steps

Command	Purpose
`ipv6 nd suppress-ra` **Example:** hostname (config-if)# ipv6 nd suppress-ra	Suppresses IPv6 router advertisement transmissions on a LAN interface. Entering this command causes the ASA to appear as a regular IPv6 neighbor on the link and not as an IPv6 router.

Examples

The following example suppresses an IPv6 router advertisement transmission for the specified interface, which is GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd suppress-ra
```

Configuring Address Config Flags for IPv6 DHCP Relay

You can add a flag to IPv6 router advertisements to inform IPv6 autoconfiguration clients to use DHCPv6 to obtain an IPv6 address and/or additional information such as the DNS server address.

Detailed Steps

Command	Purpose

`ipv6 nd managed-config-flag`
 	
Example:
`hostname (config-if)# ipv6 nd`
`managed-config-flag`
	Sets the Managed Address Config flag in the IPv6 router advertisement packet. This flag informs IPv6 autoconfiguration clients that they should use DHCPv6 to obtain addresses, in addition to the derived stateless autoconfiguration address.

`ipv6 nd other-config-flag`
 	
Example:
`hostname (config-if)# ipv6 nd`
`other-config-flag`
	Sets the Other Address Config flag in the IPv6 router advertisement packet. This flag informs IPv6 autoconfiguration clients that they should use DHCPv6 to obtain additional information from DHCPv6, such as the DNS server address.

Configuring the IPv6 Prefix in Router Advertisements

To configure the which IPv6 prefixes are included in IPv6 router advertisements, enter the following command.

Detailed Steps

Command	Purpose
`ipv6 nd prefix` *ipv6-prefix/prefix-length* | `default` [[*valid-lifetime preferred-lifetime*] | [`at` *valid-date preferred-date*] | `infinite` | `no-advertise` | `off-link` | `no-autoconfig`] **Example:** `hostname (config-if)# ipv6 nd prefix 2001:DB8::/32 1000 900`	Configures which IPv6 prefixes are included in IPv6 router advertisements. The prefix advertisement can be used by neighboring devices to autoconfigure their interface addresses. Stateless autoconfiguration uses IPv6 prefixes provided in router advertisement messages to create the global unicast address from the link-local address. The **at** *valid-date preferred-date* syntax indicates the date and time at which the lifetime and preference expire. The prefix is valid until this specified date and time are reached. Dates are expressed in the form *date-valid-expire month-valid-expire hh:mm-valid-expire date-prefer-expire month-prefer-expire hh:mm-prefer-expire*. The **default** keyword indicates that default values are used. The optional **infinite** keyword specifies that the valid lifetime does not expire. The *ipv6-prefix* argument specifies the IPv6 network number to include in router advertisements. This argument must be in the form documented in RFC 2373 where the address is specified in hexadecimal using 16-bit values between colons. The optional **no-advertise** keyword indicates to hosts on the local link that the specified prefix is not to be used for IPv6 autoconfiguration. The optional **no-autoconfig** keyword indicates to hosts on the local link that the specified prefix cannot be used for IPv6 autoconfiguration. The optional **off-link** keyword indicates that the specified prefix is not used for on-link determination. The *preferred-lifetime* argument specifies the amount of time (in seconds) that the specified IPv6 prefix is advertised as being preferred. Valid values range from 0 to 4294967295 seconds. The maximum value represents infinity, which can also be specified with infinite. The default is 604800 (7 days). The *prefix-length* argument specifies the length of the IPv6 prefix. This value indicates how many of the high-order, contiguous bits of the address comprise the network portion of the prefix. The slash (/) must precede the prefix length. The *valid-lifetime* argument specifies the amount of time that the specified IPv6 prefix is advertised as being valid. Valid values range from 0 to 4294967295 seconds. The maximum value represents infinity, which can also be specified with infinite. The default is 2592000 (30 days).

Examples

The following example includes the IPv6 prefix 2001:DB8::/32, with a valid lifetime of 1000 seconds and a preferred lifetime of 900 seconds, in router advertisements sent out on the specified interface, which is GigabitEthernet 0/0:

```
hostname (config)# interface gigabitethernet 0/0
hostname (config-if)# ipv6 nd prefix 2001:DB8::/32 1000 900
```

Configuring a Static IPv6 Neighbor

To configure a static entry in the IPv6 neighbor discovery cache, enter the following command.

Detailed Steps

Command	Purpose
ipv6 neighbor *ipv6_address if_name mac_address* **Example:** hostname(config-if)# ipv6 neighbor 3001:1::45A inside 002.7D1A.9472	Configures a static entry in the IPv6 neighbor discovery cache. The *ipv6_address* argument is the link-local IPv6 address of the neighbor, the *if_name* argument is the interface through which the neighbor is available, and the *mac_address* argument is the MAC address of the neighbor interface.

Examples

The following example adds a static entry for an inside host with an IPv6 address of 3001:1::45A and a MAC address of 002.7D1a.9472 to the neighbor discovery cache:

```
hostname(config-if)# ipv6 neighbor 3001:1::45A inside 002.7D1A.9472
```

Monitoring IPv6 Neighbor Discovery

To monitor IPv6 neighbor discovery parameters, enter the following command:

Command	Purpose
`show ipv6 interface`	Displays the usability status of interfaces configured for IPv6. Including the interface name, such as "outside" and displays the settings for the specified interface. Excludes the name from the command and displays the settings for all interfaces that have IPv6 enabled on them. Output for the command shows the following: • The name and status of the interface. • The link-local and global unicast addresses. • The multicast groups to which the interface belongs. • ICMP redirect and error message settings. • Neighbor discovery settings. • The actual time when the command is set to 0. • The neighbor discovery reachable time that is being used.

Additional References

For additional information related to implementing IPv6 prefixes, see the following topics:

- Related Documents for IPv6 Prefixes, page 31-15
- RFCs for IPv6 Prefixes and Documentation, page 31-15

Related Documents for IPv6 Prefixes

Related Topic	Document Title
ipv6 commands	*command reference*

RFCs for IPv6 Prefixes and Documentation

RFC	Title
RFC 2373 includes complete documentation to show how IPv6 network address numbers must be shown in router advertisements. The command argument *ipv6-prefix* indicates this network number, in which the address must be specified in hexadecimal format using 16-bit values between colons.	IP Version 6 Addressing Architecture
RFC 3849 specifies the requirements for using IPv6 address prefixes in documentation. The IPv6 unicast address prefix that has been reserved for use in documentation is 2001:DB8::/32.	IPv6 Address Prefix Reserved for Documentation

Feature History for IPv6 Neighbor Discovery

Table 31-2 lists each feature change and the platform release in which it was implemented.

Table 31-2   Feature History for IPv6 Neighbor Discovery

Feature Name	Releases	Feature Information
IPv6 Neighbor Discovery	7.0(1)	We introduced this feature. We introduced the following commands: **ipv6 nd ns-interval**, **ipv6 nd ra-lifetime**, **ipv6 nd suppress-ra**, **ipv6 neighbor**, **ipv6 nd prefix**, **ipv6 nd dad-attempts**, **ipv6 nd reachable-time**, **ipv6 address**, **ipv6 enforce-eui64**.
Address Config Flags for IPv6 DHCP Relay	9.0(1)	We introduced the following commands: **ipv6 nd managed-config-flag**, **ipv6 nd other-config-flag**.