CHAPTER 15

Configuring Dynamic ARP Inspection

This chapter describes how to configure dynamic Address Resolution Protocol (ARP) inspection (DAI) on an NX-OS device.

This chapter includes the following sections:

Information About DAI

This section includes the following topics:

Understanding ARP

ARP provides IP communication within a Layer 2 broadcast domain by mapping an IP address to a MAC address. For example, host B wants to send information to host A but does not have the MAC address of host A in its ARP cache. In ARP terms, host B is the sender and host A is the target.

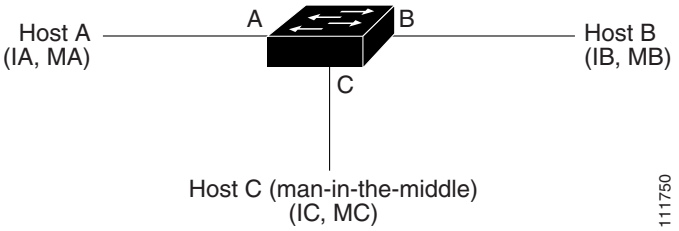
To get the MAC address of host A, host B generates a broadcast message for all hosts within the broadcast domain to obtain the MAC address associated with the IP address of host A. All hosts within the broadcast domain receive the ARP request, and host A responds with its MAC address.

Understanding ARP Spoofing Attacks

ARP spoofing attacks and ARP cache poisoning can occur because ARP allows a reply from a host even if an ARP request was not received. After the attack, all traffic from the device under attack flows through the attacker's computer and then to the router, switch, or host.

An ARP spoofing attack can affect hosts, switches, and routers connected to your Layer 2 network by sending false information to the ARP caches of the devices connected to the subnet. Sending false information to an ARP cache is known as ARP cache poisoning. Spoof attacks can also intercept traffic intended for other hosts on the subnet. Figure 15-1 shows an example of ARP cache poisoning.

Figure 15-1 ARP Cache Poisoning



Hosts A, B, and C are connected to the device on interfaces A, B, and C, all of which are on the same subnet. Their IP and MAC addresses are shown in parentheses; for example, host A uses IP address IA and MAC address MA. When host A needs to send IP data to host B, it broadcasts an ARP request for the MAC address associated with IP address IB. When the device and host B receive the ARP request, they populate their ARP caches with an ARP binding for a host with the IP address IA and a MAC address MA; for example, IP address IA is bound to MAC address MA. When host B responds, the device and host A populate their ARP caches with a binding for a host with the IP address IB and the MAC address MB.

Host C can poison the ARP caches of the device, host A, and host B by broadcasting two forged ARP responses with bindings: one for a host with an IP address of IA and a MAC address of MC and another for a host with the IP address of IB and a MAC address of MC. Host B and the device then use the MAC address MC as the destination MAC address for traffic intended for IA, which means that host C intercepts that traffic. Likewise, host A and the device use the MAC address MC as the destination MAC address for traffic intended for IB.

Because host C knows the true MAC addresses associated with IA and IB, it can forward the intercepted traffic to those hosts by using the correct MAC address as the destination. This topology, in which host C has inserted itself into the traffic stream from host A to host B, is an example of a *man-in-the middle* attack.

Understanding DAI and ARP Spoofing Attacks

DAI ensures that only valid ARP requests and responses are relayed. When DAI is enabled and properly configured, an NX-OS device performs these activities:

- Intercepts all ARP requests and responses on untrusted ports
- Verifies that each of these intercepted packets has a valid IP-to-MAC address binding before updating the local ARP cache or before forwarding the packet to the appropriate destination
- Drops invalid ARP packets

DAI can determine the validity of an ARP packet based on valid IP-to-MAC address bindings stored in a Dynamic Host Configuration Protocol (DHCP) snooping binding database. This database is built by DHCP snooping if DHCP snooping is enabled on the VLANs and on the device. It can also contain static entries that you create. If the ARP packet is received on a trusted interface, the device forwards the packet without any checks. On untrusted interfaces, the device forwards the packet only if it is valid.

DAI can validate ARP packets against user-configured ARP access control lists (ACLs) for hosts with statically configured IP addresses (see the "Applying ARP ACLs to VLANs for DAI Filtering" section on page 15-9). The device logs dropped packets (see the "Logging DAI Packets" section on page 15-5).

You can configure DAI to drop ARP packets when the IP addresses in the packets are invalid or when the MAC addresses in the body of the ARP packets do not match the addresses specified in the Ethernet header (see the "Enabling or Disabling Additional Validation" section on page 15-11).

Interface Trust States and Network Security

DAI associates a trust state with each interface on the device. Packets that arrive on trusted interfaces bypass all DAI validation checks, and packets that arrive on untrusted interfaces go through the DAI validation process.

In a typical network configuration, the guidelines for configuring the trust state of interfaces as follows:

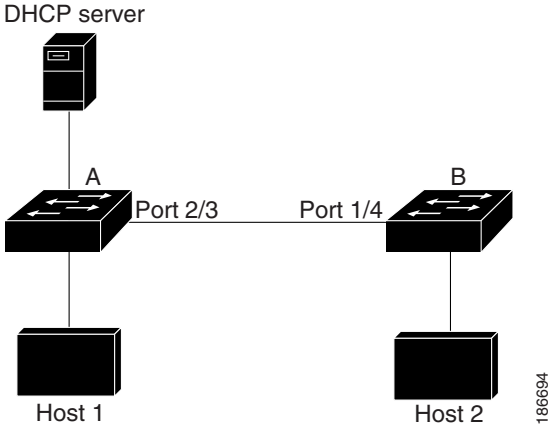
- Untrusted—Interfaces that are connected to hosts
- Trusted—Interfaces that are connected to devices

With this configuration, all ARP packets that enter the network from a device bypass the security check. No other validation is needed at any other place in the VLAN or in the network. For information about configuring the trust state of an interface, see the "Configuring the DAI Trust State of a Layer 2 Interface" section on page 15-8.

Caution Use the trust state configuration carefully. Configuring interfaces as untrusted when they should be trusted can result in a loss of connectivity.

In Figure 15-2, assume that both device A and device B are running DAI on the VLAN that includes host 1 and host 2. If host 1 and host 2 acquire their IP addresses from the DHCP server connected to device A, only device A binds the IP-to-MAC address of host 1. If the interface between device A and device B is untrusted, the ARP packets from host 1 are dropped by device B and connectivity between host 1 and host 2 is lost.

Figure 15-2 ARP Packet Validation on a VLAN Enabled for DAI



If you configure interfaces as trusted when they should be untrusted, you may open a security hole in a network. If device A is not running DAI, host 1 can easily poison the ARP cache of device B (and host 2, if you configured the link between the devices as trusted). This condition can occur even though device B is running DAI.

DAI ensures that hosts (on untrusted interfaces) connected to a device that runs DAI do not poison the ARP caches of other hosts in the network; however, DAI does not prevent hosts in other portions of the network from poisoning the caches of the hosts that are connected to a device that runs DAI.

If some devices in a VLAN run DAI and other devices do not, then the guidelines for configuring the trust state of interfaces on a device running DAI becomes the following:

- Untrusted—Interfaces that are connected to hosts or to devices that *are not* running DAI
- Trusted—Interfaces that are connected to devices that *are* running DAI

To validate the bindings of packets from devices that are not running DAI, configure ARP ACLs on the device running DAI. When you cannot determine the bindings, isolate at Layer 3 the devices that run DAI from devices that do not run DAI. For configuration information, see the "Example 2: One Device Supports DAI" section on page 15-19.

Note Depending on your network setup, you may not be able to validate a given ARP packet on all devices in the VLAN.

Prioritizing ARP ACLs and DHCP Snooping Entries

By default, DAI filters DAI traffic by comparing DAI packets to IP-MAC address bindings in the DHCP snooping database.

When you apply an ARP ACL to traffic, the ARP ACLs take precedence over the default filtering behavior. The device first compares ARP packets to user-configured ARP ACLs. If the ARP ACL denies the ARP packet, the device denies the packet regardless of whether a valid IP-MAC binding exists in the DHCP snooping database.

Note VLAN ACLs (VACLs) take precedence over both ARP ACLs and DHCP snooping entries. For example, if you apply a VACL and an ARP ACL to a VLAN and you configured the VACL to act on ARP traffic, the device permits or denies ARP traffic as determined by the VACL, not the ARP ACL or DHCP snooping entries.

For information about configuring ARP ACLs, see the "Configuring ARP ACLs" section on page 15-21. For information about applying an ARP ACL, see the "Applying ARP ACLs to VLANs for DAI Filtering" section on page 15-9.

Logging DAI Packets

NX-OS maintains a buffer of log entries about DAI packets processed. Each log entry contains flow information, such as the receiving VLAN, the port number, the source and destination IP addresses, and the source and destination MAC addresses.

You can also specify the type of packets that are logged. By default, an NX-OS device logs only packets that DAI drops. For configuration information, see the "Configuring DAI Log Filtering" section on page 15-13.

If the log buffer overflows, the device overwrites the oldest DAI log entries with newer entries. You can configure the maximum number of entries in the buffer. For more information, see the "Configuring the DAI Logging Buffer Size" section on page 15-12.

Note NX-OS does not generate system messages about DAI packets that are logged.

Virtualization Support

The following information applies to DAI used in Virtual Device Contexts (VDCs):

- IP-MAC address bindings are unique per VDC.
- ARP ACLs are unique per VDC. You cannot use an ACL that you created in one VDC in a different VDC.
- Because ACLs are not shared by VDCs, you can reuse ACL names in different VDCs.
- The system does not limit ARP ACLs or rules on a per-VDC basis.

Licensing Requirements for DAI

The following table shows the licensing requirements for this feature:

Product	License Requirement
NX-OS	DAI requires no license. Any feature not included in a license package is bundled with the Cisco NX-OS system images and is provided at no extra charge to you. For a complete explanation of the NX-OS licensing scheme, see the *Cisco Nexus 7000 Series NX-OS Licensing Guide, Release 4.0*.

Prerequisites for DAI

You should be familiar with the following before you configure DAI:

- ARP
- DHCP snooping

Guidelines and Limitations

DAI has the following configuration guidelines and limitations:

- DAI is an ingress security feature; it does not perform any egress checking.
- DAI is not effective for hosts connected to devices that do not support DAI or that do not have this feature enabled. Because man-in-the-middle attacks are limited to a single Layer 2 broadcast domain, you should separate the domain with DAI from domains without DAI. This separation secures the ARP caches of hosts in the domain with DAI.
- DAI depends on the entries in the DHCP snooping binding database to verify IP-to-MAC address bindings in incoming ARP requests and ARP responses. If you want DAI to use static IP-MAC address bindings to determine if ARP packets are valid, DHCP snooping needs only to be enabled. If you want DAI to use dynamic IP-MAC address bindings to determine if ARP packets are valid, DHCP snooping must configured on the same VLANs on which you configure DAI. For configuration information, see the "Configuring DHCP Snooping" section on page 14-6.
- When you use the **feature dhcp** command to enable the DHCP snooping feature, there is a delay of approximately 30 seconds before the I/O modules receive DHCP snooping or DAI configuration. This delay occurs regardless of the method that you use to change from a configuration with DHCP snooping disabled to a configuration with DHCP snooping enabled. For example, if you use the Rollback feature to revert to a configuration that enables DHCP snooping, the I/O modules receive DHCP snooping and DAI configuration approximately 30 seconds after you complete the rollback.
- When DHCP snooping is disabled or used in a non-DHCP environment, you should use ARP ACLs to permit or to deny packets.
- DAI is supported on access ports, trunk ports, port-channel ports, and private VLAN ports.
- The DAI trust configuration of a port channel determines the trust state of all physical ports that you assign to the port channel. For example, if you have configured a physical port as a trusted interface and then you add that physical port to a port channel that is an untrusted interface, the physical port becomes untrusted.
- When you remove a physical port from a port channel, the physical port retains the DAI trust state configuration of the port channel.
- When you change the trust state on the port channel, the device configures a new trust state on all the physical ports that comprise the channel.
- If you want DAI to use static IP-MAC address bindings to determine if ARP packets are valid, ensure that the DHCP snooping feature is enabled and that you have configured the static IP-MAC address bindings. For configuration information, see the "Configuring DHCP Snooping" section on page 14-6.
- If you want DAI to use dynamic IP-MAC address bindings to determine if ARP packets are valid, ensure that DHCP snooping is configured (see the "Configuring DHCP Snooping" section on page 14-6).

Configuring DAI

This section includes the following topics:

Enabling or Disabling DAI on VLANs

You can enable or disable DAI on VLANs.

BEFORE YOU BEGIN

By default, DAI is disabled on all VLANs.

If you are enabling DAI, ensure the following:

- DHCP snooping is enabled. For more information, see the "Enabling or Disabling the DHCP Snooping Feature" section on page 14-7.
- The VLANs on which you want to enable DAI are configured.

SUMMARY STEPS

1. **config t**
2. **[no] ip arp inspection vlan** *list*
3. **show ip arp inspection vlan** *list*
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	[**no**] **ip arp inspection vlan** *list* **Example:** switch(config)# ip arp inspection vlan 13	Enables DAI for the specified list of VLANs. The **no** option disables DAI for the specified VLANs.
Step 3	**show ip arp inspection vlan** *list* **Example:** switch(config)# show ip arp inspection vlan 13	(Optional) Shows the DAI status for the specified list of VLANs.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Configuring the DAI Trust State of a Layer 2 Interface

You can configure the DAI interface trust state of a Layer 2 interface.

A device forwards ARP packets that it receives on a trusted Layer 2 interface but does not check them.

On untrusted interfaces, the device intercepts all ARP requests and responses, verifies that the intercepted packets have valid IP-MAC address bindings before updating the local cache and forwarding the packet to the appropriate destination. If the device determines that packets have invalid bindings, it drops the packets and logs them according to the logging configuration. For more information, see the "Configuring DAI Log Filtering" section on page 15-13.

BEFORE YOU BEGIN

By default, all interfaces are untrusted.

If you are enabling DAI, ensure that DHCP snooping is enabled. For more information, see the "Enabling or Disabling the DHCP Snooping Feature" section on page 14-7.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/number*
3. [**no**] **ip arp inspection trust**
4. **show ip arp inspection interface** *type slot/number*
5. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	**interface** *type slot/number* **Example:** switch(config)# interface ethernet 2/1 switch(config-if)#	Enters interface configuration mode.
Step 3	[**no**] **ip arp inspection trust** **Example:** switch(config-if)# ip arp inspection trust	Configures the interface as a trusted ARP interface. The **no** option configures the interface as an untrusted ARP interface.
Step 4	**show ip arp inspection interface** *type slot/number* **Example:** switch(config-if)# show ip arp inspection interface ethernet 2/1	(Optional) Displays the trust state and the ARP packet rate for the specified interface.
Step 5	**copy running-config startup-config** **Example:** switch(config-if)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Applying ARP ACLs to VLANs for DAI Filtering

You can apply an ARP ACL to one or more VLANs. The device permits packets only if the ACL permits them.

BEFORE YOU BEGIN

By default, no VLANs have an ARP ACL applied.

Ensure that the ARP ACL that you want to apply is correctly configured. For information about configuring an ARP ACL, see the "Configuring ARP ACLs" section on page 15-21.

SUMMARY STEPS

1. **config t**
2. [**no**] **ip arp inspection filter** *acl-name* **vlan** *list*
3. **show ip arp inspection vlan** *list*
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	[**no**] **ip arp inspection filter** *acl-name* **vlan** *list* **Example:** switch(config)# ip arp inspection filter arp-acl-01 vlan 100	Applies the ARP ACL to the list of VLANs, or if you use the **no** option, removes the ARP ACL from the list of VLANs.
Step 3	**show ip arp inspection vlan** *list* **Example:** switch(config)# show ip arp inspection vlan 100	(Optional) Shows the DAI status for the specified list of VLANs, including whether an ARP ACL is applied.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Enabling or Disabling DAI Error-Disabled Recovery

You can enable or disable DAI error-disabled recovery on a device.

BEFORE YOU BEGIN

By default, DAI error-disabled recovery is disabled.

SUMMARY STEPS

1. **config t**
2. [**no**] **errdisable recovery cause arp-inspection**
3. **show running-config | include errdisable**
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	[**no**] **errdisable recovery cause arp-inspection** **Example:** switch(config)# errdisable recovery cause arp-inspection	Enables DAI error-disabled recovery. The **no** option disables DAI error-disabled recovery.
Step 3	**show running-config | include errdisable** **Example:** switch(config)# show running-config | include errdisable	(Optional) Displays the errdisable configuration.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Enabling or Disabling Additional Validation

You can enable or disable additional validation of ARP packets.

DAI intercepts, logs, and discards ARP packets with invalid IP-to-MAC address bindings. You can enable additional validation on the destination MAC address, the sender and target IP addresses, and the source MAC address.

BEFORE YOU BEGIN

By default, no additional validation of ARP packets is enabled.

SUMMARY STEPS

1. **config t**
2. [**no**] **ip arp inspection validate** {[**src-mac**] [**dst-mac**] [**ip**]}
3. **show running-config dhcp**
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	[**no**] **ip arp inspection validate** {[**src-mac**] [**dst-mac**] [**ip**]} **Example:** switch(config)# ip arp inspection validate src-mac dst-mac ip	Enables additional DAI validation, or if you use the **no** option, disables additional DAI validation.
Step 3	**show running-config dhcp** **Example:** switch(config)# show running-config dhcp	(Optional) Displays the DHCP snooping configuration, including the DAI configuration.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

The additional validations do the following:

- **dst-mac**—Checks the destination MAC address in the Ethernet header against the target MAC address in the ARP body for ARP responses. When enabled, packets with different MAC addresses are classified as invalid and are dropped.
- **ip**—Checks the ARP body for invalid and unexpected IP addresses. Addresses include 0.0.0.0, 255.255.255.255, and all IP multicast addresses. Sender IP addresses are checked in all ARP requests and responses, and target IP addresses are checked only in ARP responses.
- **src-mac**—Checks the source MAC address in the Ethernet header against the sender MAC address in the ARP body for ARP requests and responses. When enabled, packets with different MAC addresses are classified as invalid and are dropped.

When enabling additional validation, follow these guidelines:

- You must specify at least one of the keywords. You can specify one, two, or all three keywords.
- Each **ip arp inspection validate** command that you enter overrides the configuration from any previous commands. If you enter an **ip arp inspection validate** command to enable **src-mac** and **dst-mac** validations, and a second **ip arp inspection validate** command to enable IP validation only, the **src-mac** and **dst-mac** validations are disabled when you enter the second command.

Configuring the DAI Logging Buffer Size

You can configure the DAI logging buffer size.

BEFORE YOU BEGIN

The default buffer size is 32 messages.

SUMMARY STEPS

1. **config t**
2. **[no] ip arp inspection log-buffer entries** *number*
3. **show running-config dhcp**
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	**[no] ip arp inspection log-buffer entries** *number* **Example:** switch(config)# ip arp inspection log-buffer entries 64	Configures the DAI logging buffer size. The **no** option reverts to the default buffer size, which is 32 messages. The buffer size can be between 0 and 2048 messages.
Step 3	**show running-config dhcp** **Example:** switch(config)# show running-config dhcp	(Optional) Displays the DHCP snooping configuration, including the DAI configuration.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Configuring DAI Log Filtering

You can configure how the device determines whether to log a DAI packet.

BEFORE YOU BEGIN

By default, the device logs DAI packets that are dropped.

SUMMARY STEPS

1. **config t**
2. **[no] ip arp inspection vlan** *vlan-list* **logging dhcp-bindings {all | none | permit}**
3. **show running-config dhcp**
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	[**no**] **ip arp inspection vlan** *vlan-list* **logging dhcp-bindings** {**all** | **none** | **permit**} **Example:** switch(config)# ip arp inspection vlan 100 dhcp-bindings permit	Configures DAI log filtering. The **no** option removes DAI log filtering.
Step 3	**show running-config dhcp** **Example:** switch(config)# show running-config dhcp	(Optional) Displays the DHCP snooping configuration, including the DAI configuration.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

When configuring the DAI log filtering, follow these guidelines:

- By default, all denied packets are logged.
- **dhcp-bindings all**—Logs all packets that match DHCP bindings.
- **dhcp-bindings none**—Does not log packets that match DHCP bindings.
- **dhcp-bindings permit**—Logs DHCP-binding permitted packets.

Verifying the DAI Configuration

To display the DAI configuration information, use the following commands:

Command	Purpose
show running-config arp	Displays DAI configuration.
show ip arp inspection	Displays the status of DAI.
show ip arp inspection interface ethernet *slot/port*	Displays the trust state and ARP packet rate for a specific interface.
show ip arp inspection vlan *vlan-ID*	Displays the DAI configuration for a specific VLAN.
show arp access-lists	Displays ARP ACLs.
show ip arp inspection log	Displays the DAI log configuration.

For detailed information about the fields in the output from these commands, see the *Cisco Nexus 7000 Series NX-OS Security Command Reference, Release 4.0*.

Displaying and Clearing DAI Statistics

To display and clear DAI statistics, use the following commands:

Command	Purpose
show ip arp inspection statistics	Displays DAI statistics.
show arp ethernet *slot/port* **statistics**	Displays interface-specific DAI statistics.
clear ip arp inspection statistics	Clears DAI statistics.

For more information about these commands, see the *Cisco Nexus 7000 Series NX-OS Security Command Reference, Release 4.0*.

Example Configurations for DAI

This section includes these examples:

- Example 1: Two Devices Support DAI, page 15-15
- Example 2: One Device Supports DAI, page 15-19

Example 1: Two Devices Support DAI

This procedure shows how to configure DAI when two devices support this feature. Host 1 is connected to device A, and Host 2 is connected to device B as shown in Figure 15-2 on page 15-4. Both devices are running DAI on VLAN 1 where the hosts are located. A DHCP server is connected to device A. Both hosts acquire their IP addresses from the same DHCP server. Device A has the bindings for Host 1 and Host 2, and device B has the binding for Host 2. Device A Ethernet interface 2/3 is connected to the device B Ethernet interface 1/4.

Note

- DAI depends on the entries in the DHCP snooping binding database to verify IP-to-MAC address bindings in incoming ARP requests and ARP responses. Make sure to enable DHCP snooping to permit ARP packets that have dynamically-assigned IP addresses. For configuration information, see Chapter 14, "Configuring DHCP Snooping."
- This configuration does not work if the DHCP server is moved from device A to a different location.
- To ensure that this configuration does not compromise security, configure Ethernet interface 2/3 on device A and Ethernet interface 1/4 on device B as trusted.

Configuring Device A

To enable DAI and configure Ethernet interface 2/3 on device A as trusted, follow these steps:

Step 1 While logged into device A, verify the connection between device A and device B.

```
switchA# show cdp neighbors
Capability Codes: R - Router, T - Trans-Bridge, B - Source-Route-Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater,
                  V - VoIP-Phone, D - Remotely-Managed-Device,
                  s - Supports-STP-Dispute

Device ID              Local Intrfce   Hldtme  Capability  Platform      Port ID
switchB                Ethernet2/3     177     R S I    WS-C2960-24TC Ethernet1/4
switchA#
```

Step 2 Enable DAI on VLAN 1 and verify the configuration.

```
switchA# config t
switchA(config)# ip arp inspection vlan 1
switchA(config)# show ip arp inspection vlan 1

Source Mac Validation      : Disabled
Destination Mac Validation : Disabled
IP Address Validation      : Disabled

Vlan : 1
-----------
Configuration   : Enabled
Operation State : Active
switchA(config)#
```

Step 3 Configure Ethernet interface 2/3 as trusted.

```
switchA(config)# interface ethernet 2/3
switchA(config-if)# ip arp inspection trust
switchA(config-if)# exit
switchA(config)# exit
switchA# show ip arp inspection interface ethernet 2/3

 Interface        Trust State    Rate (pps)    Burst Interval
 -------------    -----------    ----------    --------------
 Ethernet2/3      Trusted           15             5
```

Step 4 Verify the bindings.

```
switchA# show ip dhcp snooping binding
MacAddress         IpAddress        LeaseSec  Type           VLAN  Interface
-----------------  ---------------  --------  -------------  ----  -------------
00:60:0b:00:12:89  10.0.0.1         0         dhcp-snooping  1     Ethernet2/3
switchA#
```

Step 5 Check the statistics before and after DAI processes any packets.

```
switchA# show ip arp inspection statistics vlan 1

Vlan : 1
-----------
ARP Req Forwarded  = 0
ARP Res Forwarded  = 0
ARP Req Dropped    = 0
ARP Res Dropped    = 0
DHCP Drops         = 0
DHCP Permits       = 0
```

```
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
switchA#
```

If Host 1 sends out two ARP requests with an IP address of 10.0.0.1 and a MAC address of 0002.0002.0002, both requests are permitted, shown as follows:

```
switchA# show ip arp inspection statistics vlan 1

Vlan : 1
-----------
ARP Req Forwarded  = 2
ARP Res Forwarded  = 0
ARP Req Dropped    = 0
ARP Res Dropped    = 0
DHCP Drops         = 0
DHCP Permits       = 2
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
```

If Host 1 tries to send an ARP request with an IP address of 10.0.0.3, the packet is dropped and an error message is logged.

```
00:12:08: %SW_DAI-4-DHCP_SNOOPING_DENY: 2 Invalid ARPs (Req) on Ethernet2/3, vlan
1.([0002.0002.0002/10.0.0.3/0000.0000.0000/0.0.0.0/02:42:35 UTC Fri Jul 13 2008])
```

The statistics display as follows:

```
switchA# show ip arp inspection statistics vlan 1
switchA#

Vlan : 1
-----------
ARP Req Forwarded  = 2
ARP Res Forwarded  = 0
ARP Req Dropped    = 2
ARP Res Dropped    = 0
DHCP Drops         = 2
DHCP Permits       = 2
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
switchA#
```

Configuring Device B

To enable DAI and configure Ethernet interface 1/4 on device B as trusted, follow these steps:

Step 1 While logged into device B, verify the connection between device B and device A.

```
switchB# show cdp neighbors
Capability Codes: R - Router, T - Trans-Bridge, B - Source-Route-Bridge
```

```
                    S - Switch, H - Host, I - IGMP, r - Repeater,
                    V - VoIP-Phone, D - Remotely-Managed-Device,
                    s - Supports-STP-Dispute

Device ID             Local Intrfce   Hldtme  Capability  Platform      Port ID
switchA               Ethernet1/4     120     R S I    WS-C2960-24TC Ethernet2/3
switchB#
```

Step 2 Enable DAI on VLAN 1, and verify the configuration.

```
switchB# config t
switchB(config)# ip arp inspection vlan 1
switchB(config)# show ip arp inspection vlan 1

Source Mac Validation      : Disabled
Destination Mac Validation : Disabled
IP Address Validation      : Disabled

Vlan : 1
-----------
Configuration   : Enabled
Operation State : Active
switchB(config)#
```

Step 3 Configure Ethernet interface 1/4 as trusted.

```
switchB(config)# interface ethernet 1/4
switchB(config-if)# ip arp inspection trust
switchB(config-if)# exit
switchB(config)# exit
switchB# show ip arp inspection interface ethernet 1/4

 Interface        Trust State    Rate (pps)    Burst Interval
 -------------    -----------    ----------    --------------
 Ethernet1/4      Trusted           15             5
switchB#
```

Step 4 Verify the list of DHCP snooping bindings.

```
witchB# show ip dhcp snooping binding
MacAddress          IpAddress        LeaseSec  Type           VLAN  Interface
------------------  ---------------  --------  -------------  ----  -------------
00:01:00:01:00:01   10.0.0.2         4995      dhcp-snooping  1     Ethernet1/4
switchB#
```

Step 5 Check the statistics before and after DAI processes any packets.

```
switchB# show ip arp inspection statistics vlan 1

Vlan : 1
-----------
ARP Req Forwarded  = 0
ARP Res Forwarded  = 0
ARP Req Dropped    = 0
ARP Res Dropped    = 0
DHCP Drops         = 0
DHCP Permits       = 0
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
switchB#
```

If Host 2 sends out an ARP request with the IP address 10.0.0.2 and the MAC address 0001.0001.0001, the packet is forwarded and the statistics are updated.

```
switchB# show ip arp inspection statistics vlan 1

Vlan : 1
-----------
ARP Req Forwarded  = 1
ARP Res Forwarded  = 0
ARP Req Dropped    = 0
ARP Res Dropped    = 0
DHCP Drops         = 0
DHCP Permits       = 1
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
switchB#
```

If Host 2 attempts to send an ARP request with the IP address 10.0.0.1, DAI drops the request and logs the following system message:

```
00:18:08: %SW_DAI-4-DHCP_SNOOPING_DENY: 1 Invalid ARPs (Req) on Ethernet1/4, vlan
1.([0001.0001.0001/10.0.0.1/0000.0000.0000/0.0.0.0/01:53:21 UTC Fri Jun 13 2008])
switchB#
```

The statistics display as follows:

```
switchB# show ip arp inspection statistics vlan 1

Vlan : 1
-----------
ARP Req Forwarded  = 1
ARP Res Forwarded  = 0
ARP Req Dropped    = 1
ARP Res Dropped    = 0
DHCP Drops         = 1
DHCP Permits       = 1
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
switchB#
```

Example 2: One Device Supports DAI

This procedure shows how to configure DAI when device B shown in Figure 15-2 on page 15-4 does not support DAI or DHCP snooping.

If device B does not support DAI or DHCP snooping, configuring Ethernet interface 2/3 on device A as trusted creates a security hole because both device A and Host 1 could be attacked by either device B or Host 2.

To prevent this possibility, you must configure Ethernet interface 2/3 on device A as untrusted. To permit ARP packets from Host 2, you must set up an ARP ACL and apply it to VLAN 1. If the IP address of Host 2 is not static, which would make it impossible to accurately configure the ARP ACL on device A, you must separate device A from device B at Layer 3 and use a router to route packets between them.

To set up an ARP ACL on device A, follow these steps:

Step 1 Configure the access list to permit the IP address 10.0.0.1 and the MAC address 0001.0001.0001, and verify the configuration.

```
switchA# config t
switchA(config)# arp access-list H2
switchA(config-arp-acl)# permit ip host 10.0.0.1 mac host 0001.0001.0001
switchA(config-arp-acl)# exit
switchA(config)# show arp access-lists H2

ARP access list H2
10 permit ip host 1.1.1.1 mac host 0001.0001.0001
switchA(config)#
```

Step 2 Apply the ACL to VLAN 1, and verify the configuration.

```
switchA(config)# ip arp inspection filter H2 vlan 1
switchA(config)# show ip arp inspection vlan 1

Source Mac Validation      : Disabled
Destination Mac Validation : Disabled
IP Address Validation      : Disabled

Vlan : 200
-----------
Configuration    : Enabled
Operation State  : Active
ACL Match/Static : H2 / No
```

Step 3 Configure Ethernet interface 2/3 as untrusted, and verify the configuration.

Note By default, the interface is untrusted.

```
switchA(config)# interface ethernet 2/3
switchA(config-if)# no ip arp inspection trust
switchA(config-if)# exit
switchA# show ip arp inspection interface ethernet 2/3
switchA#
```

The **show ip arp inspection interface** command has no output because the interface has the default configuration, which includes an untrusted state.

When Host 2 sends 5 ARP requests through Ethernet interface 2/3 on device A and a “get” is permitted by device A, the statistics are updated.

```
switchA# show ip arp inspection statistics vlan 1

Vlan : 1
-----------
ARP Req Forwarded  = 5
ARP Res Forwarded  = 0
ARP Req Dropped    = 0
ARP Res Dropped    = 0
DHCP Drops         = 0
DHCP Permits       = 0
SMAC Fails-ARP Req = 0
SMAC Fails-ARP Res = 0
DMAC Fails-ARP Res = 0
IP Fails-ARP Req   = 0
IP Fails-ARP Res   = 0
```

```
switchA#
```

Configuring ARP ACLs

This section includes the following topics:

Session Manager Support

Session Manager supports the configuration of ARP ACLs. This feature allows you to create a configuration session and verify your ARP ACL configuration changes prior to committing them to the running configuration. For more information about Session Manager, see the *Cisco Nexus 7000 Series NX-OS System Management Configuration Guide, Release 4.0*.

Creating an ARP ACL

You can create an ARP ACL on the device and add rules to it.

BEFORE YOU BEGIN

Ensure that you are in the correct VDC (or use the **switchto vdc** command). ACL names can be repeated in different VDCs, so we recommend that you confirm which VDC you are working in.

SUMMARY STEPS

1. **config t**
2. **arp access-list** *name*
3. [*sequence-number*] {**permit** | **deny**} **ip** {**any** | **host** *sender-IP* | *sender-IP sender-IP-mask*} **mac** {**any** | **host** *sender-MAC* | *sender-MAC sender-MAC-mask*} [**log**]

   [*sequence-number*] {**permit** | **deny**} **request ip** {**any** | **host** *sender-IP* | *sender-IP sender-IP-mask*} **mac** {**any** | **host** *sender-MAC* | *sender-MAC sender-MAC-mask*} [**log**]

   [*sequence-number*] {**permit** | **deny**} **response ip** {**any** | **host** *sender-IP* | *sender-IP sender-IP-mask*} {**any** | **host** *target-IP* | *target-IP target-IP-mask*} **mac** {**any** | **host** *sender-MAC* | *sender-MAC sender-MAC-mask*} [**any** | **host** *target-MAC* | *target-MAC target-MAC-mask*] [**log**]
4. **show arp access-lists** *acl-name*
5. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	**arp access-list** *name* **Example:** switch(config)# arp access-list arp-acl-01 switch(config-arp-acl)#	Creates the ARP ACL and enters ARP ACL configuration mode.
Step 3	[*sequence-number*] {**permit** | **deny**} **ip** {**any** | **host** *sender-IP* | *sender-IP sender-IP-mask*} **mac** {**any** | **host** *sender-MAC* | *sender-MAC sender-MAC-mask*} [**log**] **Example:** switch(config-arp-acl)# permit ip 192.168.2.0 0.0.0.255 mac 00C0.4F00.0000 ffff.ff00.0000	Creates a rule that permits or denies any ARP message based upon the IP address and MAC address of the sender of the message. Using a sequence number allows you to specify a position for the rule in the ACL. Without a sequence number, the rule is added to the end of the rules.
	[*sequence-number*] {**permit** | **deny**} **request ip** {**any** | **host** *sender-IP* | *sender-IP sender-IP-mask*} **mac** {**any** | **host** *sender-MAC* | *sender-MAC sender-MAC-mask*} [**log**] **Example:** switch(config-arp-acl)# permit request ip 192.168.102.0 0.0.0.255 mac any	Creates a rule that permits or denies ARP request messages based upon the IP address and MAC address of the sender of the message. Using a sequence number allows you to specify a position for the rule in the ACL. Without a sequence number, the rule is added to the end of the rules.
	[*sequence-number*] {**permit** | **deny**} **response ip** {**any** | **host** *sender-IP* | *sender-IP sender-IP-mask*} [**any** | **host** *target-IP* | *target-IP target-IP-mask*]] **mac** {**any** | **host** *sender-MAC* | *sender-MAC sender-MAC-mask*} [**any** | **host** *target-MAC* | *target-MAC target-MAC-mask*] [**log**] **Example:** switch(config-arp-acl)# permit response ip host 192.168.202.32 any mac host 00C0.4FA9.BCF3 any	Creates a rule that permits or denies ARP response messages based upon the IPv4 address and MAC address of the sender and the target of the message. Using a sequence number allows you to specify a position for the rule in the ACL. Without a sequence number, the rule is added to the end of the rules.
Step 4	**show arp access-lists** *acl-name* **Example:** switch(config-arp-acl)# show arp access-lists arp-acl-01	(Optional) Shows the ARP ACL configuration.
Step 5	**copy running-config startup-config** **Example:** switch(config-arp-acl)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Changing an ARP ACL

You can add and remove rules in an existing ARP ACL. You cannot change existing rules. Instead, to change a rule, you can remove it and recreate it with the desired changes.

If you need to add more rules between existing rules than the current sequence numbering allows, you can use the **resequence** command to reassign sequence numbers. For more information, see the "Changing Sequence Numbers in an ARP ACL" section on page 15-25.

BEFORE YOU BEGIN

Ensure that you are in the correct VDC (or use the **switchto vdc** command). ACL names can be repeated in different VDCs, so we recommend that you confirm which VDC you are working in.

SUMMARY STEPS

1. **config t**
2. **arp access-list** *name*
3. [*sequence-number*] {**permit** | **deny**} [**request** | **response**] **ip** *IP-data* **mac** *MAC-data*
4. **no** {*sequence-number* | {**permit** | **deny**} [**request** | **response**] **ip** *IP-data* **mac** *MAC-data*}
5. **show arp access-lists**
6. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	**arp access-list** *name* **Example:** switch(config)# arp access-list arp-acl-01 switch(config-acl)#	Enters ARP ACL configuration mode for the ACL that you specify by name.

	Command	Purpose
Step 3	[*sequence-number*] {**permit** | **deny**} [**request** | **response**] **ip** *IP-data* **mac** *MAC-data* **Example:** `switch(config-arp-acl)# 100 permit request ip 192.168.132.0 0.0.0.255 mac any`	(Optional) Creates a rule. For more information about the **permit** and **deny** commands, see the "Creating an ARP ACL" section on page 15-21. Using a sequence number allows you to specify a position for the rule in the ACL. Without a sequence number, the rule is added to the end of the rules.
Step 4	**no** {*sequence-number* | {**permit** | **deny**} [**request** | **response**] **ip** *IP-data* **mac** *MAC-data* **Example:** `switch(config-arp-acl)# no 80`	(Optional) Removes the rule that you specified from the ARP ACL. For more information about the **permit** and **deny** commands, see the "Creating an ARP ACL" section on page 15-21.
Step 5	**show arp access-lists** **Example:** `switch(config-arp-acl)# show arp access-lists`	Displays the ARP ACL configuration.
Step 6	**copy running-config startup-config** **Example:** `switch(config-arp-acl)# copy running-config startup-config`	(Optional) Copies the running configuration to the startup configuration.

Removing an ARP ACL

You can remove an ARP ACL from the device.

BEFORE YOU BEGIN

Ensure that you are in the correct VDC (or use the **switchto vdc** command). ACL names can be repeated in different VDCs, so we recommend that you confirm which VDC you are working in.

Ensure that you know whether the ACL is applied to a VLAN. The device allows you to remove ACLs that are currently applied. Removing an ACL does not affect the configuration of VLANs where you have applied the ACL. Instead, the device considers the removed ACL to be empty.

SUMMARY STEPS

1. **config t**
2. **no arp access-list** *name*
3. **show arp access-lists**
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	**no arp access-list** *name* **Example:** switch(config)# no arp access-list arp-acl-01	Removes the ARP ACL you specified by name from running configuration.
Step 3	**show arp access-lists** **Example:** switch(config)# show arp access-lists	Displays the ARP ACL configuration.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Changing Sequence Numbers in an ARP ACL

You can change all the sequence numbers assigned to rules in an ARP ACL.

BEFORE YOU BEGIN

Ensure that you are in the correct VDC (or use the **switchto vdc** command). ACL names can be repeated in different VDCs, so we recommend that you confirm which VDC you are working in.

SUMMARY STEPS

1. **config t**
2. **resequence arp access-list** *name starting-sequence-number increment*
3. **show arp access-lists** *name*
4. **copy running-config startup-config**

DETAILED STEPS

	Command	Purpose
Step 1	**config t** **Example:** switch# config t switch(config)#	Enters global configuration mode.
Step 2	**resequence arp access-list** *name starting-sequence-number increment* **Example:** switch(config)# resequence arp access-list arp-acl-01 100 10 switch(config)#	Assigns sequence numbers to the rules contained in the ACL, where the first rule receives the starting sequence number that you specify. Each subsequent rule receives a number larger than the preceding rule. The difference in numbers is determined by the increment that you specify.
Step 3	**show arp access-lists** *name* **Example:** switch(config)# show arp access-lists arp-acl-01	Displays the ARP ACL configuration for the ACL specified by the *name* argument.
Step 4	**copy running-config startup-config** **Example:** switch(config)# copy running-config startup-config	(Optional) Copies the running configuration to the startup configuration.

Verifying ARP ACL Configuration

To display ARP ACL configuration information, use one of the following commands:

Command	Purpose
show arp access-lists	Displays the ARP ACL configuration.
show running-config aclmgr	Displays ACLs in the running configuration.

For detailed information about the fields in the output from these commands, see the *Cisco Nexus 7000 Series NX-OS Security Command Reference, Release 4.0*.

Default Settings

Table 15-1 lists the default settings for DAI parameters.

Table 15-1 Default DAI Parameters

Parameters	Default
DAI	Disabled on all VLANs.
Interface trust state	All interfaces are untrusted.
ARP ACLs for non-DHCP environments	No ARP ACLs are defined.

Table 15-1 Default DAI Parameters (continued)

Parameters	Default
Validation checks	No checks are performed.
Log buffer	When DAI is enabled, all denied or dropped ARP packets are logged. The number of entries in the log is 32. The number of system messages is limited to 5 per second. The logging-rate interval is 1 second.
Per-VLAN logging	All denied or dropped ARP packets are logged.

Additional References

For additional information related to implementing DAI, see the following sections:

- Related Documents, page 15-27
- Standards, page 15-27

Related Documents

Related Topic	Document Title
DHCP snooping	Information About DHCP Snooping, page 14-1
DAI commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco Nexus 7000 Series NX-OS Security Command Reference, Release 4.0*
DHCP snooping commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco Nexus 7000 Series NX-OS Security Command Reference, Release 4.0*

Standards

Standards	Title
RFC-826	*An Ethernet Address Resolution Protocol* (http://tools.ietf.org/html/rfc826)