Configuring Dynamic ARP Inspection

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

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Finding Feature Information

Your software release might not support all the features documented in this module. For the latest caveats and feature information, see the Bug Search Tool at https://tools.cisco.com/bugsearch/ and the release notes for your software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the "New and Changed Information"chapter or the Feature History table in this chapter.

Information About DAI

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.

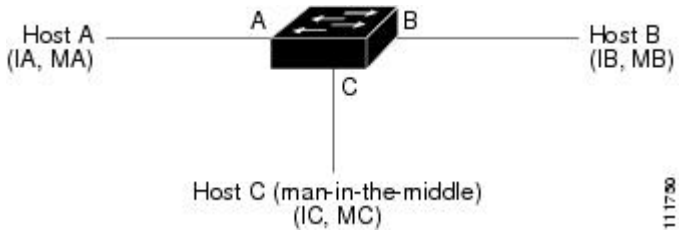
ARP Spoofing Attacks

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 1: ARP Cache Poisoning

This figure shows an example of ARP cache poisoning.



Hosts A, B, and C are connected to the device on interfaces A, B, and C, 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.

DAI and ARP Spoofing Attacks

DAI ensures that only valid ARP requests and responses are relayed. When DAI is enabled and properly configured, a Cisco Nexus 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. The device logs dropped packets.

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.

Related Topics

Applying ARP ACLs to VLANs for DAI Filtering, on page 9
Logging DAI Packets, on page 5
Enabling or Disabling Additional Validation, on page 10

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 are as follows:

Untrusted

Interfaces that are connected to hosts

Trusted

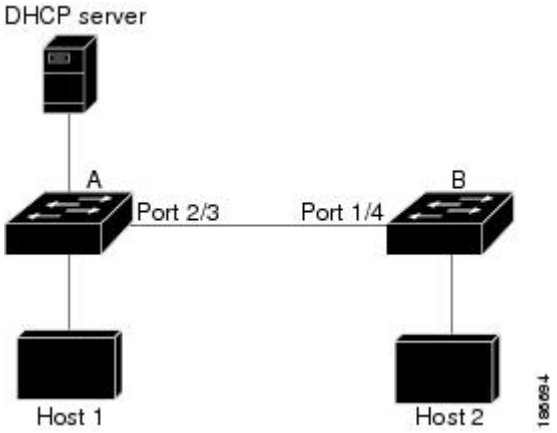
Interfaces that are connected to devices

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.

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

Figure 2: ARP Packet Validation on a VLAN Enabled for DAI

The following figure, 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.



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, the guidelines for configuring the trust state of interfaces on a device that runs 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 do not run DAI, configure ARP ACLs on the device that runs DAI. When you cannot determine the bindings, isolate at Layer 3 the devices that run DAI from devices that do not run DAI.

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

Related Topics

Configuring the DAI Trust State of a Layer 2 Interface, on page 8
Example 2 One Device Supports DAI, on page 18

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.

Related Topics

Configuring ARP ACLs, on page 20
Applying ARP ACLs to VLANs for DAI Filtering, on page 9

Logging DAI Packets

Cisco 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, aCisco Nexus device logs only packets that DAI drops.

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.

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

Related Topics

Configuring the DAI Logging Buffer Size, on page 11
Configuring DAI Log Filtering, on page 12

Virtualization Support for DAI

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.

Prerequisites for DAI

- You must enable the DHCP feature before you can configure DAI.

Guidelines and Limitations for DAI

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, you must configure DHCP snooping on the same VLANs on which you configure DAI.
- When you use the **feature dhcp** command to enable the DHCP feature, there is a delay of approximately 30 seconds before the I/O modules receive the DHCP or DAI configuration. This delay occurs regardless of the method that you use to change from a configuration with the DHCP feature disabled to a configuration with the DHCP feature enabled. For example, if you use the Rollback feature to revert to a configuration that enables the DHCP feature, the I/O modules receive the DHCP 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 and disable DAI.
- 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 does not retain 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 DHCP snooping is enabled and that you have configured the static IP-MAC address bindings.
- If you want DAI to use dynamic IP-MAC address bindings to determine if ARP packets are valid, ensure that DHCP snooping is enabled.

Default Settings for DAI

This table lists the default settings for DAI parameters.

Table 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.
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.

Configuring DAI

Enabling or Disabling DAI on VLANs

You can enable or disable DAI on VLANs. By default, DAI is disabled on all VLANs.

Before you begin

If you are enabling DAI, ensure the following:

- Ensure that the DHCP feature is enabled.
- The VLANs on which you want to enable DAI are configured.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **ip arp inspection vlan** *list*
3. (Optional) **show ip arp inspection vlan** *list*
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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	(Optional) **show ip arp inspection vlan** *list* **Example:** `switch(config)# show ip arp inspection vlan 13`	Shows the DAI status for the specified list of VLANs.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	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. By default, all interfaces are untrusted.

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 and 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.

Before you begin

If you are enabling DAI, ensure that the DHCP feature is enabled.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`switch# configure terminal` `switch(config)#`	

Step 2	**interface** *type number / slot*
	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	(Optional) **show ip arp inspection interface** *type number / slot* **Example:** `switch(config-if)# show ip arp inspection interface ethernet 2/1`	Displays the trust state and the ARP packet rate for the specified interface.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config-if)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Related Topics

Interface Trust States and Network Security, on page 3
Configuring DAI Log Filtering, on page 12

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. By default, no VLANs have an ARP ACL applied.

Before you begin

Ensure that the ARP ACL that you want to apply is correctly configured.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **ip arp inspection filter** *acl-name* **vlan** *list*
3. (Optional) **show ip arp inspection vlan** *list*
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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	(Optional) **show ip arp inspection vlan** *list* **Example:** `switch(config)# show ip arp inspection vlan 100`	Shows the DAI status for the specified list of VLANs, including whether an ARP ACL is applied.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Related Topics

Configuring ARP ACLs, on page 20

Enabling or Disabling Additional Validation

You can enable or disable additional validation of ARP packets. By default, no additional validation of ARP packets is enabled. When no additional validation is configured, the source MAC address and the source IP address check against the IP-to-MAC binding entry for ARP packets are done by using the Ethernet source MAC address (not the ARP sender MAC address) and the ARP sender IP address.

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.

You can use the following keywords with the **ip arp inspection validate** command to implement additional validations:

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 replaces 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, the src-mac and dst-mac validations are disabled when you enter the second command.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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	(Optional) **show running-config dhcp** **Example:** `switch(config)# show running-config dhcp`	Displays the DHCP snooping configuration, including the DAI configuration.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Configuring the DAI Logging Buffer Size

You can configure the DAI logging buffer size. The default buffer size is 32 messages.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **ip arp inspection log-buffer entries** *number*
3. (Optional) **show running-config dhcp**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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 1 and 1024 messages.
Step 3	(Optional) **show running-config dhcp** **Example:** `switch(config)# show running-config dhcp`	Displays the DHCP snooping configuration, including the DAI configuration.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	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. By default, the device logs DAI packets that are dropped.

SUMMARY STEPS

1. **configure terminal**
2. Enter one of the following commands:
   - **ip arp inspection vlan** *vlan-list* **logging dhcp-bindings all**
   - **ip arp inspection vlan** *vlan-list* **logging dhcp-bindings none**
   - **ip arp inspection vlan** *vlan-list* **logging dhcp-bindingspermit**
   - **no ip arp inspection vlan** *vlan-list* **logging dhcp-bindings** {**all** | **none** | **permit**}
3. (Optional) **show running-config dhcp**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	Enter one of the following commands: • **ip arp inspection vlan** *vlan-list* **logging dhcp-bindings all** • **ip arp inspection vlan** *vlan-list* **logging dhcp-bindings none** • **ip arp inspection vlan** *vlan-list* **logging dhcp-bindingspermit** • **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, as follows. The **no** option removes DAI log filtering. • Logs all packets that match DHCP bindings. • Does not log packets that match DHCP bindings. • Logs packets permitted by DHCP bindings. • Removes DAI log filtering.
Step 3	(Optional) **show running-config dhcp** **Example:** `switch(config)# show running-config dhcp`	Displays the DHCP snooping configuration, including the DAI configuration.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Verifying the DAI Configuration

To display the DAI configuration information, perform one of the following tasks. For detailed information about the fields in the output from these commands, see the *Cisco Nexus 7000 Series NX-OS Security Command Reference*.

Command	Purpose
show ip arp inspection	Displays the status of DAI.
show ip arp inspection interface ethernet	Displays the trust state.
show ip arp inspection vlan	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.

Monitoring and Clearing DAI Statistics

To monitor and clear DAI statistics, use the commands in this table. For more information about these commands, see the *Security Command Reference* for your Cisco Nexus device.

Command	Purpose
show ip arp inspection statistics	Displays DAI statistics.
clear ip arp inspection statistics vlan <id>	Clears DAI statistics.

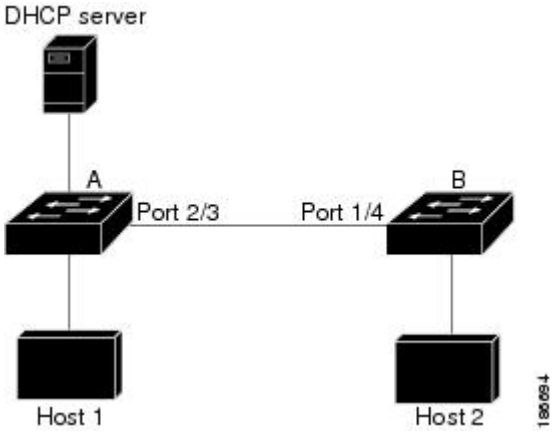
Configuration Examples for DAI

Example 1-Two Devices Support DAI

These procedures show how to configure DAI when two devices support DAI.

Figure 3: Two Devices Supporting DAI

The following figure shows the network configuration for this example. Host 1 is connected to device A, and Host 2 is connected to device B. 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.



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.

- 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, and are 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.

```
switchB# 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])
```

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

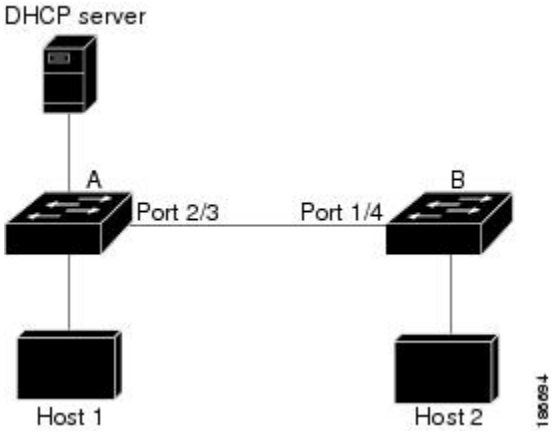
This procedure shows how to configure DAI when the second device involved in the network configuration does not support DAI or DHCP snooping.

Figure 4: One Device Supporting DAI

Device B, shown in this figure does not support DAI or DHCP snooping; therefore, 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.



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

Session Manager Support for ARP ACLs

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*.

Creating an ARP ACL

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

SUMMARY STEPS

1. **configure terminal**
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**]
4. [*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**]
5. [*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**]
6. (Optional) **show arp access-lists** *acl-name*
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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 192.168.2.0 255.2555.255.0 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.
Step 4	[*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.
Step 5	[*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 6	(Optional) **show arp access-lists** *acl-name* **Example:** `switch(config-arp-acl)# show arp access-lists arp-acl-01`	Shows the ARP ACL configuration.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config-arp-acl)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Changing an ARP ACL

You can change 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.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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.

Step 3	(Optional) [*sequence-number*] {**permit** | **deny**} [**request** | **response**] **ip** *IP-data* **mac** *MAC-data* **Example:** `switch(config-arp-acl)# 100 permit request ip 192.168.132.0 255.2555.255.0 mac any`	Creates a rule. 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	(Optional) **no** {*sequence-number* | {**permit** | **deny**} [**request** | **response**] **ip** *IP-data* **mac** *MAC-data* **Example:** `switch(config-arp-acl)# no 80`	Removes the rule that you specified from the ARP ACL.
Step 5	**show arp access-lists** **Example:** `switch(config-arp-acl)# show arp access-lists`	Displays the ARP ACL configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:**	Copies the running configuration to the startup configuration.

	Command or Action	Purpose
	`switch(config-arp-acl)# copy running-config startup-config`	

Related Topics

Creating an ARP ACL, on page 20
Changing Sequence Numbers in an ARP ACL, on page 24

Removing an ARP ACL

You can remove an ARP ACL from the device.

Before you begin

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. **configure terminal**
2. **no arp access-list** *name*
3. **show arp access-lists**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	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.

SUMMARY STEPS

1. **configure terminal**
2. **resequence arp access-list** *name starting-sequence-number increment*
3. **show arp access-lists** *name*
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`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	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Verifying the ARP ACL Configuration

To display ARP ACL configuration information, use the commands in this table. For detailed information about the fields in the output from these commands, see the *Cisco Nexus 7000 Series NX-OS Security Command Reference*.

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

Additional References for DAI

Related Documents

Related Topic	Document Title
DAI commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco Nexus 7000 Series NX-OS Security Command Reference*
DHCP snooping commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco Nexus 7000 Series NX-OS Security Command Reference*

Standards

Standards	Title
RFC-826	An Ethernet Address Resolution Protocol

Feature History for DAI

This table lists the release history for this feature.

Table 2: Feature History for DAI

Feature Name	Releases	Feature Information	
Dynamic ARP Inspection	6.0(1)	No change from Release 5.2.	
Dynamic ARP Inspection	5.2(1)	No change from Release 5.1.	
Dynamic ARP Inspection	5.1(1)	No change from Release 5.0.	
Dynamic ARP Inspection	5.0(2)	No change from Release 4.2.	
Dynamic ARP Inspection	4.2(1)	No change from Release 4.1.	