



First Hop Security

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About First Hop Security

First-Hop Security (FHS) features enable a better IPv4 and IPv6 link security and management over the layer 2 links. In a service provider environment, these features closely control address assignment and derived operations, such as Duplicate Address Detection (DAD) and Address Resolution (AR).

The following supported FHS features secure the protocols and help build a secure endpoint database on the fabric leaf switches, that are used to mitigate security threats such as MIM attacks and IP thefts:

- **ARP Inspection**—allows a network administrator to intercept, log, and discard ARP packets with invalid MAC address to IP address bindings.
- **ND Inspection**—learns and secures bindings for stateless autoconfiguration addresses in Layer 2 neighbor tables.
- **DHCP Inspection**—validates DHCP messages received from untrusted sources and filters out invalid messages.
- **RA Guard**—allows the network administrator to block or reject unwanted or rogue router advertisement (RA) guard messages.
- **IPv4 and IPv6 Source Guard**—blocks any data traffic from an unknown source.
- **Trust Control**—a trusted source is a device that is under your administrative control. These devices include the switches, routers, and servers in the Fabric. Any device beyond the firewall or outside the network is an untrusted source. Generally, host ports are treated as untrusted sources.

FHS features provide the following security measures:

- **Role Enforcement**—Prevents untrusted hosts from sending messages that are out the scope of their role.
- **Binding Enforcement**—Prevents address theft.
- **DoS Attack Mitigations**—Prevents malicious end-points to grow the end-point database to the point where the database could stop providing operation services.
- **Proxy Services**—Provides some proxy-services to increase the efficiency of address resolution.

FHS features are enabled on a per tenant bridge domain (BD) basis. As the bridge domain, may be deployed on a single or across multiple leaf switches, the FHS threat control and mitigation mechanisms cater to a single switch and multiple switch scenarios.

Beginning with Cisco APIC release 6.0(2), FHS is supported on the VMware DVS VMM domain. If you need to implement FHS within an EPG, enable intra EPG isolation. If intra EPG isolation is not enabled, then, the endpoints within the same VMware ESX port-group can bypass FHS. If you do not enable intra EPG isolation, FHS features still take effect for endpoints that are in different port-groups, for instance, FHS can prevent a compromised VM from poisoning the ARP table of another VM in a different port-group.

ACI FHS Deployment

Most FHS features are configured in a two-step fashion: firstly you define a policy which describes the behavior of the feature, secondly you apply this policy to a "domain" (being the Tenant Bridge Domain or the Tenant Endpoint Group). Different policies that define different behaviors can be applied to different intersecting domains. The decision to use a specific policy is taken by the most specific domain to which the policy is applied.

The policy options can be defined from the Cisco APIC GUI found under the Tenant_*name*>Networking>Protocol Policies>First Hop Security tab.

Guidelines and Limitations

Follow these guidelines and limitations:

- Any secured endpoint entry in the FHS Binding Table Database in **DOWN** state will get cleared after **18 Hours** of timeout. The entry moves to **DOWN** state when the front panel port where the entry is learned is link down. During this window of **18 Hours**, if the endpoint is moved to a different location and is seen on a different port, the entry will be gracefully moved out of **DOWN** state to **REACHABLE/STALE** as long as the endpoint is reachable from the other port it is moved from.
- When IP Source Guard is enabled, the IPv6 traffic that is sourced using IPv6 Link Local address as IP source address is not subject to the IP Source Guard enforcement (i.e. Enforcement of Source Mac <=> Source IP Bindings secured by IP Inspect Feature). This traffic is permitted by default irrespective of binding check failures.
- FHS is not supported on L3Out interfaces.
- FHS is not supported N9K-M12PQ based TORs.
- FHS in ACI Multi-Site is a site local capability therefore it can only be enabled in a site from the APIC cluster. Also, FHS in ACI Multi-Site only works when the BD and EPG is site local and not stretched across sites. FHS security cannot be enabled for stretched BD or EPGs.

- FHS is not supported on a Layer 2 only bridge domain.
- Enabling FHS feature can disrupt traffic for 50 seconds because the EP in the BD are flushed and EP Learning in the BD is disabled for 50 seconds.
- FHS is not supported on uSeg EPGs that match an ESG by using EPG selectors. If FHS is required for endpoints that need to move to an ESG from a uSeg EPG, classify those endpoints to an ESG by using other selectors, such as an IP subnet or tag selector, and remove matching criteria from the uSeg EPG. Then, configure FHS on the base EPG.
- When EPGs are matched to an ESG by using EPG selectors, the FHS binding table and corresponding endpoints are flushed. Traffic will not work until the binding table is refreshed using ARP, DHCP, and so on.

Guidelines and Limitations for FHS support on VMM Domains

Follow these guidelines and limitations:

- EPG attached to a VMM domain must be deployed with resolution immediacy set to immediate/pre-provision.
- ARP flooding must be enabled on the bridge domain.

Configuring FHS Using the APIC GUI

Before you begin

- The tenant and Bridge Domain configured.

-
- Step 1** On the menu bar, click **Tenants > Tenant_name**. In the **Navigation** pane, click **Policies > Protocol > First Hop Security**. Right click on **First Hop Security** to open **Create Feature Policy** and perform the following actions:
- a) In the **Name** field, enter a name for the First Hop Security policy.
 - b) Verify that the **IP Inspection**, **Source Guard**, and **Router Advertisement** fields are enabled and click **Submit**.
- Step 2** In the **Navigation** pane, expand **First Hop Security** and right click on **Trust Control Policies** to open **Create Trust Control Policy** and perform the following actions:
- a) In the **Name** field, enter a name for the Trust Control policy.
 - b) Select the desired features to be allowed on the policy and click **Submit**.
- Step 3** (Optional) To apply the Trust Control policy to an EPG, in the **Navigation** pane, expand **Application Profiles > Application Profile_name > Application EPGs** and click on **Application EPG_name** and perform the following actions:
- a) In the **Work** pane, click on the **General** tab.
 - b) Click on the down-arrow for **FHS Trust Control Policy** and select the policy you previously created and click **Submit**.
- Step 4** In the **Navigation** pane, expand **Bridge Domains > Bridge Domain_name** and click on the **Advanced/Troubleshooting** tab and perform the following action:

- a) In the **First Hop Security Policy** field, select the policy you just created and click **Submit**. This completes FHS configuration.

Configuring FHS Using the NX-OS CLI

Before you begin

- The tenant and Bridge Domain configured.

Step 1 configure

Enters configuration mode.

Example:

```
apic1# configure
```

Step 2 Configure FHS policy.

Example:

```
apic1(config)# tenant coke
apic1(config-tenant)# first-hop-security
apic1(config-tenant-fhs)# security-policy poll
apic1(config-tenant-fhs-secpol)#
apic1(config-tenant-fhs-secpol)# ip-inspection-admin-status enabled-both
apic1(config-tenant-fhs-secpol)# source-guard-admin-status enabled-both
apic1(config-tenant-fhs-secpol)# router-advertisement-guard-admin-status enabled
apic1(config-tenant-fhs-secpol)# router-advertisement-guard
apic1(config-tenant-fhs-raguard)#
apic1(config-tenant-fhs-raguard)# managed-config-check
apic1(config-tenant-fhs-raguard)# managed-config-flag
apic1(config-tenant-fhs-raguard)# other-config-check
apic1(config-tenant-fhs-raguard)# other-config-flag
apic1(config-tenant-fhs-raguard)# maximum-router-preference low
apic1(config-tenant-fhs-raguard)# minimum-hop-limit 10
apic1(config-tenant-fhs-raguard)# maximum-hop-limit 100
apic1(config-tenant-fhs-raguard)# exit
apic1(config-tenant-fhs-secpol)# exit
apic1(config-tenant-fhs)# trust-control tcpoll
apic1(config-tenant-fhs-trustctrl)# arp
apic1(config-tenant-fhs-trustctrl)# dhcpv4-server
apic1(config-tenant-fhs-trustctrl)# dhcpv6-server
apic1(config-tenant-fhs-trustctrl)# ipv6-router
apic1(config-tenant-fhs-trustctrl)# router-advertisement
apic1(config-tenant-fhs-trustctrl)# neighbor-discovery
apic1(config-tenant-fhs-trustctrl)# exit
apic1(config-tenant-fhs)# exit
apic1(config-tenant)# bridge-domain bd1
apic1(config-tenant-bd)# first-hop-security security-policy poll
apic1(config-tenant-bd)# exit
apic1(config-tenant)# application ap1
apic1(config-tenant-app)# epg epg1
apic1(config-tenant-app-epg)# first-hop-security trust-control tcpoll
```

Step 3 Show FHS configuration example:

Example:

```
leaf4# show fhs bt all
```

Legend:

```

TR      : trusted-access          UNRES : unresolved          Age   : Age since
creation
UNTR    : untrusted-access       UNDTR : undetermined-trust  CRTNG : creating
UNKNW   : unknown                TENTV : tentative          INV   : invalid
NDP     : Neighbor Discovery Protocol STA   : static-authenticated REACH : reachable
INCOMP  : incomplete            VERIFY : verify            INTF  : Interface

TimeLeft : Remaining time since last refresh  LM   : lla-mac-match      DHCP  :
dhcp-assigned

```

EPG-Mode:

```
U : unknown   M : mac   V : vlan   I : ip
```

```

BD-VNID      BD-Vlan      BD-Name
15630220     3                t0:bd200

```

Origin	IP	MAC	INTF	EPG(sclass) (mode)	Trust-lvl	State
Age	TimeLeft					
ARP	192.0.200.12	D0:72:DC:A0:3D:4F	eth1/1	epg300 (49154) (V)	LM,TR	STALE
00:04:49	18:08:13					
ARP	172.29.205.232	D0:72:DC:A0:3D:4F	eth1/1	epg300 (49154) (V)	LM,TR	STALE
00:03:55	18:08:21					
ARP	192.0.200.21	D0:72:DC:A0:3D:4F	eth1/1	epg300 (49154) (V)	LM,TR	REACH
00:03:36	00:00:02					
LOCAL	192.0.200.1	00:22:BD:F8:19:FF	vlan3	LOCAL(16387) (I)	STA	REACH
04:49:41	N/A					
LOCAL	fe80::200	00:22:BD:F8:19:FF	vlan3	LOCAL(16387) (I)	STA	REACH
04:49:40	N/A					
LOCAL	2001:0:0:200::1	00:22:BD:F8:19:FF	vlan3	LOCAL(16387) (I)	STA	REACH
04:49:39	N/A					

The trust levels are:

- **TR**— Trusted. Displayed when the endpoint is learned from an EPG where the trust configuration is enabled.
- **UNTR**— Untrusted. Displayed when the endpoint is learned from an EPG where the trust configuration is not enabled.
- **UNDTR**— Undetermined. Displayed in the case of a DHCP relay topology where the DHCP server bridge domain (BD) is on a remote leaf and the DHCP clients are on a local leaf. In this situation, the local leaf will not know whether the DHCP server BD has trust DHCP enabled.

Step 4 Show violations with the different types and reasons example:

Example:

```
leaf4# show fhs violations all
```

Violation-Type:

```

POL : policy      THR : address-theft-remote
ROLE : role       TH  : address-theft
INT  : internal

```

```

Violation-Reason:
  IP-MAC-TH   : ip-mac-theft           OCFG_CHK   : ra-other-cfg-check-fail   ANC-COL
  : anchor-collision
  PRF-LVL-CHK : ra-rtr-pref-level-check-fail INT-ERR    : internal-error             TRUST-CHK
  : trust-check-fail
  SRV-ROL-CHK : srv-role-check-fail     ST-EP-COL  : static-ep-collision       LCL-EP-COL
  : local-ep-collision
  MAC-TH      : mac-theft               EP-LIM     : ep-limit-reached          MCFG-CHK
  : ra-managed-cfg-check-fail
  HOP-LMT-CHK : ra-hoplimit-check-fail  MOV-COL    : competing-move-collision   RTR-ROL-CHK
  : rtr-role-check-fail
  IP-TH       : ip-theft

```

```

EPG-Mode:
  U : unknown   M : mac   V : vlan   I : ip

```

```

BD-VNID      BD-Vlan      BD-Name
15630220     3             t0:bd200

```

```

-----
| Type | Last-Reason | Proto | IP           | MAC           | Port   | EPG(sclass) (mode) | Count |
-----
| THR  | IP-TH       | ARP   | 192.0.200.21 | D0:72:DC:A0:3D:4F | tunnel5 | epg300(49154) (V) | 21    |
-----

```

```
Table Count: 1
```

Step 5 Show FHS configuration:

Example:

```
swtb23-ifc1# show tenant t0 bridge-domain bd200 first-hop-security binding-table
```

Pod/Node State	Type	Family	IP Address	MAC Address	Interface	Level
1/102 reach	local	ipv4	192.0.200.1	00:22:BD:F8:19:FF	vlan3	static- authenticated
able 1/102 reach	local	ipv6	fe80::200	00:22:BD:F8:19:FF	vlan3	static- authenticated
able 1/102 reach	local	ipv6	2001:0:0:200::1	00:22:BD:F8:19:FF	vlan3	static- authenticated
able 1/101 stale	arp	ipv4	192.0.200.23	D0:72:DC:A0:02:61	eth1/2	lla-mac-match ,untrusted- access static-
1/101 reach	local	ipv4	192.0.200.1	00:22:BD:F8:19:FF	vlan3	authenticated
able 1/101 reach	nd	ipv6	fe80::d272:d272:dcff:fea0	D0:72:DC:A0:02:61	eth1/2	lla-mac-match ,untrusted-
able 1/101 stale	nd	ipv6	2001:0:0:200::20	D0:72:DC:A0:02:61	eth1/2	access lla-mac-match ,untrusted-

1/101 stale	nd	ipv6	2001::200:d272:dcff:fea0:261	D0:72:DC:A0:02:61	eth1/2	access lla-mac-match
1/101 reach	local	ipv6	fe80::200	00:22:BD:F8:19:FF	vlan3	,untrusted-access static- authenticated
able 1/101 reach	local	ipv6	2001:0:0:200::1	00:22:BD:F8:19:FF	vlan3	static- authenticated
able 1/103 reach	local	ipv4	192.0.200.1	00:22:BD:F8:19:FF	vlan4	static- authenticated
able 1/103 reach	local	ipv6	fe80::200	00:22:BD:F8:19:FF	vlan4	static- authenticated
able 1/103 reach	local	ipv6	2001:0:0:200::1	00:22:BD:F8:19:FF	vlan4	static- authenticated
able 1/104 stale	arp	ipv4	192.0.200.10	F8:72:EA:AD:C4:7C	eth1/1	lla-mac-match
1/104 stale	arp	ipv4	172.29.207.222	D0:72:DC:A0:3D:4C	eth1/1	,trusted-access lla-mac-match
1/104 reach	local	ipv4	192.0.200.1	00:22:BD:F8:19:FF	vlan4	,trusted-access static- authenticated
able 1/104 stale	nd	ipv6	fe80::fa72:eaff:fead:c47c	F8:72:EA:AD:C4:7C	eth1/1	lla-mac-match
1/104 stale	nd	ipv6	2001:0:0:200::10	F8:72:EA:AD:C4:7C	eth1/1	,trusted-access lla-mac-match
1/104 reach	local	ipv6	fe80::200	00:22:BD:F8:19:FF	vlan4	,trusted-access static- authenticated
able 1/104 reach	local	ipv6	2001:0:0:200::1	00:22:BD:F8:19:FF	vlan4	static- authenticated
able						
Pod/Node Lease	Type	IP Address	Creation TS	Last Refresh TS		
-----	-----	-----	-----	-----		
1/102	local	192.0.200.1	2017-07-20T04:22:38.000+00:00	2017-07-20T04:22:38.000+00:00		
1/102	local	fe80::200	2017-07-20T04:22:56.000+00:00	2017-07-20T04:22:56.000+00:00		
1/102	local	2001:0:0:200::1	2017-07-20T04:22:57.000+00:00	2017-07-20T04:22:57.000+00:00		
1/101	arp	192.0.200.23	2017-07-27T10:55:20.000+00:00	2017-07-27T16:07:24.000+00:00		
1/101	local	192.0.200.1	2017-07-27T10:48:09.000+00:00	2017-07-27T16:07:24.000+00:00		
1/101	nd	fe80::d272:dcff:fea0:261	2017-07-27T10:52:16.000+00:00	2017-07-27T16:04:29.000+00:00		
1/101	nd	2001:0:0:200::20	2017-07-27T10:57:32.000+00:00	2017-07-27T16:07:24.000+00:00		

```

1/101    nd      2001::200:d272:dcff:fea0:261  2017-07-27T11:21:45.000+00:00  2017-07-27T16:07:24.000+00:00
1/101    local  fe80::200                    2017-07-27T10:48:10.000+00:00  2017-07-27T10:48:10.000+00:00
1/101    local  2001:0:0:200::1              2017-07-27T10:48:11.000+00:00  2017-07-27T10:48:11.000+00:00
1/103    local  192.0.200.1                  2017-07-26T22:03:56.000+00:00  2017-07-26T22:03:56.000+00:00
1/103    local  fe80::200                    2017-07-26T22:03:57.000+00:00  2017-07-26T22:03:57.000+00:00
1/103    local  2001:0:0:200::1              2017-07-26T22:03:58.000+00:00  2017-07-26T22:03:58.000+00:00
1/104    arp    192.0.200.10                 2017-07-27T11:21:13.000+00:00  2017-07-27T16:05:48.000+00:00
1/104    arp    172.29.207.222               2017-07-27T11:54:48.000+00:00  2017-07-27T16:06:38.000+00:00
1/104    local  192.0.200.1                  2017-07-27T10:49:13.000+00:00  2017-07-27T10:49:13.000+00:00
1/104    nd      fe80::fa72:eaff:fead:c47c    2017-07-27T11:21:13.000+00:00  2017-07-27T16:06:19.000+00:00
1/104    local  fe80::200                    2017-07-27T10:49:14.000+00:00  2017-07-27T10:49:14.000+00:00
1/104    local  2001:0:0:200::1              2017-07-27T10:49:15.000+00:00  2017-07-27T10:49:15.000+00:00

```

```
swtb23-ifc1#
```

```
swtb23-ifc1# show tenant t0 bridge-domain bd200 first-hop-security statistics arp
```

```
Pod/Node      : 1/101
Request Received : 4
Request Switched : 2
Request Dropped : 2
Reply Received  : 257
Reply Switched  : 257
Reply Dropped   : 0
```

```
Pod/Node      : 1/104
Request Received : 6
Request Switched : 6
Request Dropped : 0
Reply Received  : 954
Reply Switched  : 954
Reply Dropped   : 0
```

```
swtb23-ifc1# show tenant t0 bridge-domain bd200 first-hop-security statistics dhcpv4
```

```
Pod/Node      : 1/102
Discovery Received : 5
Discovery Switched : 5
Discovery Dropped : 0
Offer Received    : 0
Offer Switched    : 0
Offer Dropped     : 0
Request Received  : 0
Request Switched  : 0
Request Dropped   : 0
Ack Received      : 0
Ack Switched      : 0
Ack Dropped       : 0
Nack Received     : 0
Nack Switched     : 0
Nack Dropped      : 0
Decline Received  : 0
Decline Switched  : 0
Decline Dropped   : 0
Release Received  : 0
Release Switched  : 0
Release Dropped   : 0
Information Received : 0
Information Switched : 0
```



```

Information Dropped      : 0
Lease Query Received    : 0
Lease Query Switched    : 0
Lease Query Dropped     : 0
Lease Active Received   : 0
Lease Active Switched   : 0
Lease Active Dropped    : 0
Lease Unassignment Received : 0
Lease Unassignment Switched : 0
Lease Unassignment Dropped : 0
Lease Unknown Received  : 0
Lease Unknown Switched  : 0
Lease Unknown Dropped   : 0

```

```
swtb23-ifcl# show tenant t0 bridge-domain bd200 first-hop-security statistics neighbor-discovery
```

```

Pod/Node                : 1/101
Neighbor Solicitation Received : 125
Neighbor Solicitation Switched : 121
Neighbor Solicitation Dropped : 4
Neighbor Advertisement Received : 519
Neighbor Advertisement Switched : 519
Neighbor Advertisement Drop : 0
Router Solicitation Received : 4
Router Solicitation Switched : 4
Router Solicitation Dropped : 0
Router Adv Received : 0
Router Adv Switched : 0
Router Adv Dropped : 0
Redirect Received : 0
Redirect Switched : 0
Redirect Dropped : 0

```

```

Pod/Node                : 1/104
Neighbor Solicitation Received : 123
Neighbor Solicitation Switched : 47
Neighbor Solicitation Dropped : 76
Neighbor Advertisement Received : 252
Neighbor Advertisement Switched : 228
Neighbor Advertisement Drop : 24
Router Solicitation Received : 0
Router Solicitation Switched : 0
Router Solicitation Dropped : 0
Router Adv Received : 53
Router Adv Switched : 6
Router Adv Dropped : 47
Redirect Received : 0
Redirect Switched : 0
Redirect Dropped : 0

```

FHS Switch iBASH Commands

Step 1 Show command to display the FHS feature configuration on the BD and the Trust control policy configuration on the EPG:

Example:

```
leaf4# show fhs features all
```

```

BD-VNID          BD-Vlan          BD-Name
15630220         4                 t0:bd200
  Feature Policy:
    Feature      Family      Protocol      Operational-State      Options
    ipinspect    IPV4      ARP           UP                     stalelifetime: 180s
    ipinspect    IPV4      DHCP          UP                     -
    ipinspect    IPV4      LOCAL         UP                     -
    ipinspect    IPV4      STATIC        UP                     -
    ipinspect    IPV6      ND            UP                     stalelifetime: 180s
    ipinspect    IPV6      DHCP          UP                     -
    ipinspect    IPV6      LOCAL         UP                     -
    ipinspect    IPV6      STATIC        UP                     -
    rguard       IPV6      -             UP                     ManagedCfgFlag: on
                                         OtherCfgFlag: on
                                         maxHopLimit: 15
                                         minHopLimit: 3
                                         routerPref: medium
-----
Trust Policy:
Epg-id          Epg-type          Epg-name
49154           Ckt-Vlan          epg300
  Trust-Attribute      Operational-State
  PROTO-ARP            UP
  PROTO-ND              UP
  DHCPV4-SERVER        UP
  DHCPV6-SERVER        UP
  ROUTER                UP

```

Step 2 Show commands to display the FHS secured endpoint database:**Example:**

```

leaf1# show fhs bt
all      data      dhcpv4    local    static
arp      detailed  dhcpv6    nd       summary

```

```
leaf1# show fhs bt all
```

Legend:

```

DHCP      : dhcp-assigned          TR      : trusted-access          UNRES : unresolved
Age       : Age since creation    CRTNG   : creating              TENTV  : tentative
VERIFY   : verify                 UNDR    : undetermined-trust    INV    : invalid
NDP      : Neighbor Discovery Protocol  STA    : static-authenticated    REACH  : reachable
LM       : lla-mac-match          UNKNW   : unknown                 INTF   : Interface
TimeLeft : Remaining time since last refresh  INCMP  : incomplete             UNTR   :
untrusted-access

```

EPG-Mode:

```
U : unknown  M : mac    V : vlan   I : ip
```

```

BD-VNID          BD-Vlan          BD-Name
15630220         3                 t0:bd200

```

```

-----
| Origin | IP          | MAC          | INTF  | EPG(sclass) (mode) | Trust-lvl |
| State | Age      | TimeLeft |
-----
| ARP   | 192.0.200.23 | D0:72:DC:A0:02:61 | eth1/2 | epg200 (32770) (V) | LM,UNTR |
| STALE | 00:07:47 | 00:01:33 |
| LOCAL | 192.0.200.1 | 00:22:BD:F8:19:FF | vlan3 | LOCAL (16387) (I) | STA |
-----

```

```

REACH | 00:14:58 | N/A |
| NDP | fe80::d272:dcff:fea0:261 | D0:72:DC:A0:02:61 | eth1/2 | ep200(32770) (V) | LM,UNTR |
STALE | 00:10:51 | 00:00:47 |
| NDP | 2001:0:0:200::20 | D0:72:DC:A0:02:61 | eth1/2 | ep200(32770) (V) | LM,UNTR |
STALE | 00:05:35 | 00:00:42 |
| LOCAL | fe80::200 | 00:22:BD:F8:19:FF | vlan3 | LOCAL(16387) (I) | STA |
REACH | 00:14:58 | N/A |
| LOCAL | 2001:0:0:200::1 | 00:22:BD:F8:19:FF | vlan3 | LOCAL(16387) (I) | STA |
REACH | 00:14:57 | N/A |

```

```
leaf1# show fhs bt summary all
```

```

-----
                          FHS Binding Table Summary
-----
BD-Vlan: 3          BD-Name: t0:bd200
  Total number of ARP entries      : 1
  Total number of DHCPv4 entries   : 0
  Total number of ND entries       : 2
  Total number of DHCPv6 entries   : 0
  Total number of Data entries     : 0
  Total number of Static entries   : 0
  Total number of Local entries    : 3
  Total number of entries         : 6
-----
Total entries across all BDs matching given filters
  Total number of ARP entries      : 1
  Total number of DHCPv4 entries   : 0
  Total number of ND entries       : 2
  Total number of DHCPv6 entries   : 0
  Total number of Data entries     : 0
  Total number of Static entries   : 0
  Total number of Local entries    : 3
  Total number of entries         : 6
-----

```

Step 3 Show command to display FHS endpoint violations:

Example:

```
leaf1# show fhs violations all
```

```

Violation-Type:
  POL : policy          THR : address-theft-remote
  ROLE : role          TH : address-theft
  INT : internal

Violation-Reason:
  IP-MAC-TH : ip-mac-theft          OCFG_CHK : ra-other-cfg-check-fail          ANC-COL
  : anchor-collision
  PRF-LVL-CHK : ra-rtr-pref-level-check-fail          INT-ERR : internal-error          TRUST-CHK
  : trust-check-fail
  SRV-ROL-CHK : srv-role-check-fail          ST-EP-COL : static-ep-collision          LCL-EP-COL
  : local-ep-collision
  MAC-TH : mac-theft          EP-LIM : ep-limit-reached          MCFG-CHK
  : ra-managed-cfg-check-fail
  HOP-LMT-CHK : ra-hoplimit-check-fail          MOV-COL : competing-move-collision          RTR-ROL-CHK
  : rtr-role-check-fail
  IP-TH : ip-theft

Trust-Level:
  TR : trusted-access          UNTR : untrusted-access          UNDTR : undetermined-trust
  INV : invalid          STA : static-authenticated          LM : lla-mac-match

```

```

DHCP : dhcp-assigned

EPG-Mode:
  U : unknown   M : mac   V : vlan   I : ip

BD-VNID          BD-Vlan          BD-Name
15630220         4                  t0:bd200
-----
| Type | Last-Reason | Proto | IP                               | MAC                               | Port |
EPG(sclass)(mode) | Trust-lvl | Count |
-----
| TH   | IP-TH      | ND   | 2001:0:0:200::20                | D0:72:DC:A0:3D:4F | eth1/1 | epg300(49154) (V)
| LM,UNTR | 2         |      |                                  |                   |        |
| POL  | HOP-LMT-CHK | RD   | fe80::fa72:eaff:fead:c47c       | F8:72:EA:AD:C4:7C | eth1/1 | epg300(49154) (V)
| LM,TR  | 2         |      |                                  |                   |        |
-----
Table Count: 2

```

Step 4 Show command to display FHS control packet forwarding counters:

Example:

```

leaf1# show fhs counters
all arp dhcpv4 dhcpv6 nd
leaf4# show fhs counters all

```

```

BD-VNID          BD-Vlan          BD-Name
15630220         4                  t0:bd200
-----
| Counter Type          | Received | Switched | Dropped |
-----
| Arp Request           | 6        | 6        | 0        |
| Arp Reply             | 94       | 94       | 0        |
-----
| Dhcpv4 Ack           | 0        | 0        | 0        |
| Dhcpv4 Decline       | 0        | 0        | 0        |
| Dhcpv4 Discover      | 0        | 0        | 0        |
| Dhcpv4 Inform        | 0        | 0        | 0        |
| Dhcpv4 Leaseactive   | 0        | 0        | 0        |
| Dhcpv4 Leasequery    | 0        | 0        | 0        |
| Dhcpv4 Leaseunassigned | 0        | 0        | 0        |
| Dhcpv4 Leaseunknown  | 0        | 0        | 0        |
| Dhcpv4 Nack          | 0        | 0        | 0        |
| Dhcpv4 Offer         | 0        | 0        | 0        |
| Dhcpv4 Release       | 0        | 0        | 0        |
| Dhcpv4 Request       | 0        | 0        | 0        |
-----
| Dhcpv6 Advertise     | 0        | 0        | 0        |
| Dhcpv6 Confirm       | 0        | 0        | 0        |
| Dhcpv6 Decline       | 0        | 0        | 0        |
| Dhcpv6 Informationreq | 0        | 0        | 0        |
| Dhcpv6 Rebind        | 0        | 0        | 0        |
| Dhcpv6 Reconfigure   | 0        | 0        | 0        |
| Dhcpv6 Relayforw     | 0        | 0        | 0        |
| Dhcpv6 Relayreply    | 0        | 0        | 0        |
| Dhcpv6 Release       | 0        | 0        | 0        |
| Dhcpv6 Renew         | 0        | 0        | 0        |
| Dhcpv6 Reply         | 0        | 0        | 0        |
| Dhcpv6 Request       | 0        | 0        | 0        |
| Dhcpv6 Solicit       | 0        | 0        | 0        |
-----
| Nd Na                | 18       | 18       | 0        |
| Nd Ns                | 26       | 22       | 4        |
| Nd Ra                | 11       | 6        | 5        |
| Nd Redirect          | 0        | 0        | 0        |

```

```
| Nd Rs | | 0 | | 0 | | 0 |
-----
```

Step 5 Display FHS secured endpoint database from the NxOS memory:

Example:

```
leaf1# vsh -c 'show system internal fhs bt'

Binding Table has 7 entries, 4 dynamic

Codes:
L - Local          S - Static          ND - Neighbor Discovery  ARP - Address Resolution Protocol
DH4 - IPv4 DHCP   DH6 - IPv6 DHCP   PKT - Other Packet     API - API created

Preflevel flags (prlvl):
0001: MAC and LLA match      0002: Orig trunk          0004: Orig access
0008: Orig trusted trunk    0010: Orig trusted access 0020: DHCP assigned
0040: Cga authenticated     0080: Cert authenticated  0100: Statically assigned

EPG types:
V - Vlan Based EPG      M - MAC Based EPG      I - IP Based EPG
```

Code	Network Layer Address	Link Layer Address	Interface	Vlan	Epg
	prlvl Age State Time left				
ARP	172.29.207.222	d0:72:dc:a0:3d:4c	Eth1/1	4	
0x40000c002 (V)	0011 29 s STALE 157 s				
L	192.0.200.1	00:22:bd:f8:19:ff	Vlan4	4	
0x400004003 (I)	0100 55 mn REACHABLE				
ARP	192.0.200.10	f8:72:ea:ad:c4:7c	Eth1/1	4	
0x40000c002 (V)	0011 156 s STALE 30 s				
L	2001:0:0:200::1	00:22:bd:f8:19:ff	Vlan4	4	
0x400004003 (I)	0100 55 mn REACHABLE				
ND	2001:0:0:200::10	f8:72:ea:ad:c4:7c	Eth1/1	4	
0x40000c002 (V)	0011 143 s STALE 47 s				
L	fe80::200	00:22:bd:f8:19:ff	Vlan4	4	
0x400004003 (I)	0100 55 mn REACHABLE				
ND	fe80::fa72:eaff:fead:c47c	f8:72:ea:ad:c4:7c	Eth1/1	4	
0x40000c002 (V)	0011 176 s STALE 11 s				

Step 6 Display FHS feature configuration from the NX-OS FHS process internal memory:

Example:

```
leaf4# vsh -c 'show system internal fhs pol'

Target      Type Policy          Feature      Target-Range Sub-Feature
epg 0x40000c002 EPG  epg 0x40000c002 Trustctrl  vlan 4      Device-Roles: DHCPv4-Server,
DHCPv6-Server, Router

                                           Protocols: ARP ND
vlan 4      VLAN  vlan 4      IP inspect  vlan all    Protocols: ARP, DHCPv4, ND, DHCPv6,
vlan 4      VLAN  vlan 4      RA guard    vlan all    Min-HL:3, Max-HL:15,
M-Config-flag:Enable,On

                                           O-Config-flag:Enable,On,
Router-Pref:medium
```

Step 7 Display FHS secured endpoint database from the NX-OS shared database:

Example:

```
leaf1# vsh -c 'show system internal fhs sdb bt'
```

Preflevel flags (preflvl):

```
0001: MAC and LLA match      0002: Orig trunk          0004: Orig access
0008: Orig trusted trunk    0010: Orig trusted access 0020: DHCP assigned
0040: Cga authenticated     0080: Cert authenticated  0100: Statically assigned
```

Origin	Zone ID If-name	L3 Address Preflvl	State	MAC Address	VLAN ID	EPG ID
ARP	0x4	172.29.207.222		d0:72:dc:a0:3d:4c	4	
0x40000c002	Eth1/1	0011	STALE			
L	0x4	192.0.200.1		00:22:bd:f8:19:ff	4	
0x400004003	Vlan4	0100	REACHABLE			
ARP	0x4	192.0.200.10		f8:72:ea:ad:c4:7c	4	
0x40000c002	Eth1/1	0011	REACHABLE			
L	0x4	2001:0:0:200::1		00:22:bd:f8:19:ff	4	
0x400004003	Vlan4	0100	REACHABLE			
ND	0x4	2001:0:0:200::10		f8:72:ea:ad:c4:7c	4	
0x40000c002	Eth1/1	0011	STALE			
L	0x80000004	fe80::200		00:22:bd:f8:19:ff	4	
0x400004003	Vlan4	0100	REACHABLE			
ND	0x80000004	fe80::fa72:eaff:fead:c47c		f8:72:ea:ad:c4:7c	4	
0x40000c002	Eth1/1	0011	STALE			

Step 8 Display FHS feature configurations from the NxOS shared database:

Example:

```
leaf1# vsh -c 'show system internal fhs sdb pol'
Policies:
```

```
IP inspect      Vlan 4          Protocols:ARP DHCPv4 ND DHCPv6
RA guard        Vlan 4          Min-HL:3 Max-HL:15 M-Config-Flag:enable,on
O-Config-Flag:enable,on Router-Pref:medium
Trustctrl       Epg 0x40000c002 Vlan:4
Device-Roles:DHCPv4-Server DHCPv6-Server Router
Protocols:ARP ND
```

Step 9 Show command to clear a secured database endpoint entry:

Example:

```
leaf1# vsh -c 'clear system internal fhs bt ipv4 172.29.207.222'
```

Configuring FHS in APIC Using REST API

Before you begin

- The tenant and bridge domain must be configured.

Configure the FHS and Trust Control policies.

Example:

```
<polUni>
  <fvTenant name="Coke">
    <fhsBDPol name="bdpol5" ipInspectAdminSt="enabled-ipv6" srcGuardAdminSt="enabled-both">
```

```
raGuardAdminSt="enabled" status="">
  <fhsRaGuardPol name="raguard5" managedConfigCheck="true" managedConfigFlag="true"
otherConfigCheck="true" otherConfigFlag="true" maxRouterPref="medium" minHopLimit="3" maxHopLimit="15"
status="" />
  </fhsBDPol>
  <fvBD name="bd3">
    <fvRsBDToFhs tnFhsBDPolName="bdpol5" status="" />
  </fvBD>
</fvTenant>
</polUni>

<polUni>
<fvTenant name="Coke">
  <fhsTrustCtrlPol name="trustctrl5" hasDhcpv4Server="true" hasDhcpv6Server="true"
hasIpv6Router="true" trustRa="true" trustArp="true" trustNd="true" />
  <fvAp name="wwwCokecom3">
    <fvAEPg name="test966">
      <fvRsTrustCtrl tnFhsTrustCtrlPolName="trustctrl5" status="" />
    </fvAEPg>
  </fvAp>
</fvTenant>
</polUni>
```
