Example: Configuring Port Security, with DHCP Snooping, DAI, MAC Limiting, and MAC Move Limiting, on an EX-series Switch

You can configure DHCP snooping, dynamic ARP inspection (DAI), MAC limiting, and MAC move limiting on the access ports of EX-series switches to protect the switch and the Ethernet LAN against address spoofing and Layer 2 denial-of-service (DoS) attacks. You can also configure a trusted DHCP server and specific (allowed) MAC addresses for the switch interfaces.

This example describes how to configure basic port security features—DHCP snooping, DAI, MAC limiting, and MAC move limiting, as well as a trusted DHCP server and allowed MAC addresses—on a switch. The DHCP server and its clients are all members of a single VLAN on the switch.

Requirements

This example uses the following hardware and software components:

- One EX-series EX 3200-24P switch
- JUNOS Release 9.0 or later for EX-series switches
- A DHCP server to provide IP addresses to network devices on the switch

Before you configure DHCP snooping, DAI, and MAC limiting port security features, be sure you have:

- Connected the DHCP server to the switch.
- Configured the VLAN employee-vlan on the switch. See Example: Setting Up Bridging with Multiple VLANs for EX-series Switches.

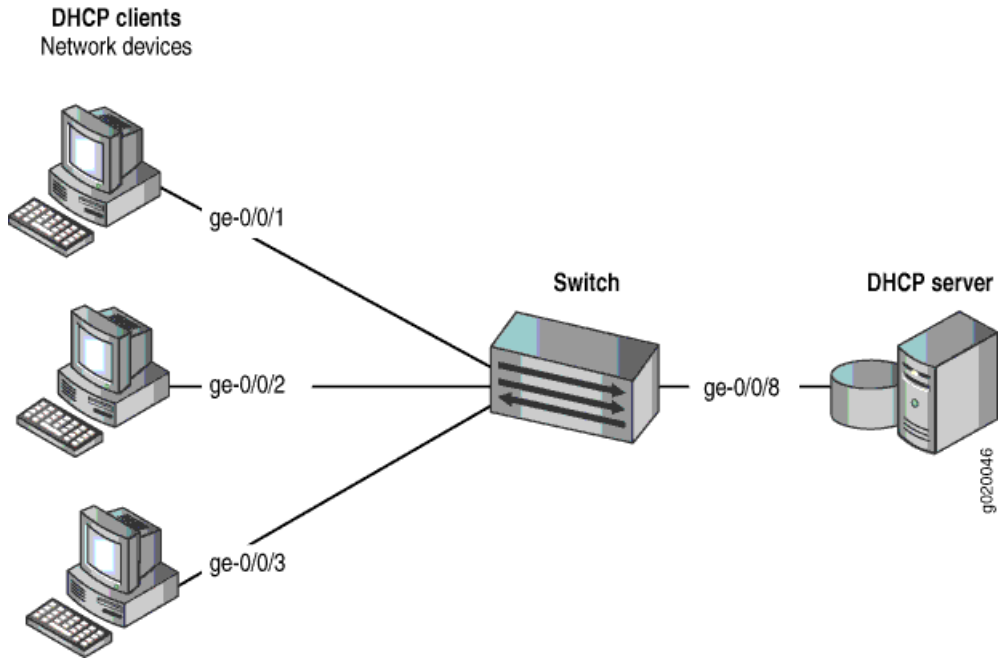
Overview and Topology

Ethernet LANs are vulnerable to address spoofing and DoS attacks on network devices. To protect the devices from such attacks, you can configure DHCP snooping to validate DHCP server messages, DAI to protect against MAC spoofing, and MAC cache limiting to constrain the number of MAC addresses the switch adds to its MAC address cache.

This example shows how to configure these security features on an EX 3200-24P switch. The switch is connected to a DHCP server.

The setup for this example includes the VLAN employee-vlan on the switch. The procedure for creating that VLAN is described in the topic Example: Setting Up Bridging with Multiple VLANs for EX-series Switches. That procedure is not repeated here. Figure 1 on page 2 illustrates the topology for this example.

Figure 1: Network Topology for Basic Port Security



The components of the topology for this example are shown in Table 1 on page 2.

Table 1: Components of the Port Security Topology

Properties	Settings
Switch hardware	One EX 3200-24P, 24 ports (8 PoE ports)
VLAN name and ID	employee-vlan, tag 20
VLAN subnets	192.0.2.16/28 192.0.2.17 through 192.0.2.30 192.0.2.31 is subnet's broadcast address
Interfaces in employee-vlan	ge-0/0/1, ge-0/0/2, ge-0/0/3, ge-0/0/8
Interface for DHCP server	ge-0/0/8

In this example, the switch is initially configured with the default port security setup. In the default configuration on the switch:

- Secure port access is activated on the switch.
- A dynamic limit on the maximum number of MAC addresses to be “learned” per port by the switch is already set in the default configuration. The default limit is 5.
- The switch does not drop any packets, which is the default setting.

- DHCP snooping and DAI are disabled on all VLANs.
- All access ports are untrusted and all trunk ports are trusted for DHCP snooping, which is the default setting.

In the configuration tasks for this example, you set the DHCP server first as untrusted and then as trusted; you enable DHCP snooping, DAI, and MAC move limiting on a VLAN; you modify the value for MAC limit; and you configure some specific (allowed) MAC addresses on an interface.

Configuration

To configure basic port security on a switch whose DHCP server and client ports are in a single VLAN:

CLI Quick Configuration To quickly configure basic port security on the switch, copy the following commands and paste them into the switch terminal window:

```
[edit ethernet-switching-options secure-access-port]
set interface ge-0/0/1 mac-limit 4 action drop
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:80
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:81
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:83
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:85
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:88
set interface ge-0/0/2 mac-limit 4 action drop
set interface ge-0/0/8 dhcp-trusted
set vlan employee-vlan arp-inspection
set vlan employee-vlan examine-dhcp
set vlan employee-vlan mac-move-limit 5 action drop
```

Step-by-Step Procedure Configure basic port security on the switch:

1. Enable DHCP snooping on the VLAN:

```
[edit ethernet-switching-options secure-access-port]
user@switch# set vlan employee-vlan examine-dhcp
```

2. Specify the interface (port) from which DHCP responses are allowed:

```
[edit ethernet-switching-options secure-access-port]
user@switch# set interface ge-0/0/8 dhcp-trusted
```

3. Enable dynamic ARP inspection (DAI) on the VLAN:

```
[edit ethernet-switching-options secure-access-port]
user@switch# set vlan employee-vlan arp-inspection
```

4. Configure the MAC limit of 4 and specify that packets with new addresses be dropped if the limit has been exceeded on the interfaces:

```
[edit ethernet-switching-options secure-access-port]
user@switch# set interface ge-0/0/1 mac-limit 4 action drop
```

```
user@switch# set interface ge-0/0/2 mac-limit 4 action drop
```

5. Configure a MAC move limit of 5 and specify that packets with new addresses be dropped if the limit has been exceeded on the VLAN:

```
[edit ethernet-switching-options secure-access-port]
user@switch# set vlan employee-vlan mac-move-limit 5 action drop
```

6. Configure the allowed MAC addresses:

```
[edit ethernet-switching-options secure-access-port]
user@switch# set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:80
user@switch# set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:81
user@switch# set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:83
user@switch# set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:85
user@switch# set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:88
```

Results Check the results of the configuration:

```
[edit ethernet-switching-options secure-access-port]
user@switch# show
interface ge-0/0/1.0 {
    mac-limit 4 action drop;
}
interface ge-0/0/2.0 {
    allowed-mac [ 00:05:85:3a:82:80 00:05:85:3a:82:81 00:05:85:3a:82:83
        00:05:85:3a:82:85 00:05:85:3a:82:88 ];
    mac-limit 4 action drop;
}
interface ge-0/0/8.0 {
    dhcp-trusted;
}
vlan employee-vlan {
    arp-inspection
    examine-dhcp;
    mac-move-limit 5 action drop;
}
```

Verification

To confirm that the configuration is working properly:

- Verifying That DHCP Snooping Is Working Correctly on the Switch on page 5
- Verifying That DAI Is Working Correctly on the Switch on page 5
- Verifying That MAC Limiting and MAC Move Limiting Are Working Correctly on the Switch on page 6
- Verifying That Allowed MAC Addresses Are Working Correctly on the Switch on page 7

Verifying That DHCP Snooping Is Working Correctly on the Switch

Purpose Verify that DHCP snooping is working on the switch.

Action Send some DHCP requests from network devices (here they are DHCP clients) connected to the switch.

Display the DHCP snooping information when the interface on which the DHCP server connects to the switch is trusted. The following output results when requests are sent from the MAC addresses and the server has provided the IP addresses and leases:

```
user@switch>  show dhcp snooping binding
DHCP Snooping Information:
MAC Address         IP Address    Lease    Type     VLAN          Interface
-----------------   ----------    -----    ----     ----          ---------
00:05:85:3A:82:77    192.0.2.17    600    dynamic  employee-vlan   ge-0/0/1.0
00:05:85:3A:82:79    192.0.2.18    653    dynamic  employee-vlan   ge-0/0/1.0
00:05:85:3A:82:80    192.0.2.19    720    dynamic  employee-vlan   ge-0/0/2.0
00:05:85:3A:82:81    192.0.2.20    932    dynamic  employee-vlan   ge-0/0/2.0
00:05:85:3A:82:83    192.0.2.21   1230    dynamic  employee-vlan   ge-0/0/2.0
00:05:85:27:32:88    192.0.2.22   3200    dynamic  employee-vlan   ge-0/0/2.0
```

Meaning When the interface on which the DHCP server connects to the switch has been set to trusted, the output (see preceding sample) shows, for each MAC address, the assigned IP address and lease time—that is, the time, in seconds, remaining before the lease expires.

If the DHCP server had been configured as untrusted, the output would look like this:

```
user@switch> show dhcp snooping binding
DHCP Snooping Information:
MAC Address          IP Address  Lease    Type     VLAN          Interface
-----------------    ----------  -----    ----     ----          ---------
00:05:85:3A:82:77      0.0.0.0      -    dynamic  employee-vlan   ge-0/0/1.0
00:05:85:3A:82:79      0.0.0.0      -    dynamic  employee-vlan   ge-0/0/1.0
00:05:85:3A:82:80      0.0.0.0      -    dynamic  employee-vlan   ge-0/0/2.0
00:05:85:3A:82:81      0.0.0.0      -    dynamic  employee-vlan   ge-0/0/2.0
00:05:85:3A:82:83      0.0.0.0      -    dynamic  employee-vlan   ge-0/0/2.0
00:05:85:27:32:88      0.0.0.0      -    dynamic  employee-vlan   ge-0/0/2.0
```

In the preceding output sample, IP addresses and lease times are not assigned because the DHCP clients do not have a trusted server to which they can send requests. In the database, the clients' MAC addresses are shown with no assigned IP addresses (hence the 0.0.0.0 content in the IP Address column) and no leases (the lease time is shown as a dash – in the Lease column).

Verifying That DAI Is Working Correctly on the Switch

Purpose Verify that DAI is working on the switch.

Action Send some ARP requests from network devices connected to the switch.

Display the DAI information:

```
user@switch>  show arp inspection statistics
ARP inspection statistics:
Interface        Packets received  ARP inspection pass   ARP inspection failed
---------------  ---------------   -------------------- ---------------------
ge-0/0/1.0                     7                     5                       2
ge-0/0/2.0                    10                    10                       0
ge-0/0/3.0                    12                    12                       0
```

Meaning The sample output shows the number of ARP packets received and inspected per interface, with a listing of how many packets passed and how many failed the inspection on each interface. The switch compares the ARP requests and replies against the entries in the DHCP snooping database. If a MAC address or IP address in the ARP packet does not match a valid entry in the database, the packet is dropped.

Verifying That MAC Limiting and MAC Move Limiting Are Working Correctly on the Switch

Purpose Verify that MAC limiting and MAC move limiting are working on the switch.

Action Suppose that two DHCP requests have been sent from hosts on ge-0/0/1 and five DHCP requests from hosts on ge-0/0/2, with both interfaces set to a MAC limit of 4 with the action drop.

Display the MAC addresses learned:

```
user@switch>  show ethernet-switching table
Ethernet-switching table:  7 entries, 6 learned
  VLAN                MAC address         Type         Age    Interfaces

  employee-vlan       *                   Flood          -    ge-0/0/2.0
  employee-vlan       00:05:85:3A:82:77   Learn          0    ge-0/0/1.0
  employee-vlan       00:05:85:3A:82:79   Learn          0    ge-0/0/1.0
  employee-vlan       00:05:85:3A:82:80   Learn          0    ge-0/0/2.0
  employee-vlan       00:05:85:3A:82:81   Learn          0    ge-0/0/2.0
  employee-vlan       00:05:85:3A:82:83   Learn          0    ge-0/0/2.0
  employee-vlan       00:05:85:3A:82:85   Learn          0    ge-0/0/2.0
```

Note that one of the MAC addresses on ge-0/0/2 was not learned because the limit of 4 MAC addresses for that interface had been exceeded.

Now suppose that DHCP requests have been sent from two of the hosts on ge-0/0/2 after they have been moved to other interfaces more than 5 times in 1 second, with employee-vlan set to a MAC move limit of 5 with the action drop.

Display the MAC addresses in the table:

```
user@switch>  show ethernet-switching table

Ethernet-switching table:  7 entries, 4 learned
  VLAN                MAC address         Type         Age    Interfaces

  employee-vlan       *                   Flood          -    ge-0/0/2.0
  employee-vlan       00:05:85:3A:82:77   Learn          0    ge-0/0/1.0
```

```
  employee-vlan        00:05:85:3A:82:79   Learn          0    ge-0/0/1.0
  employee-vlan        00:05:85:3A:82:80   Learn          0    ge-0/0/2.0
  employee-vlan        00:05:85:3A:82:81   Learn          0    ge-0/0/2.0
  employee-vlan        *                   Flood          -    ge-0/0/2.0
  employee-vlan        *                   Flood          -    ge-0/0/2.0
```

Meaning The first sample output shows that with a MAC limit of 4 for each interface, the DHCP request for a fifth MAC address on ge-0/0/2 was dropped because it exceeded the MAC limit. The second sample output shows that DHCP requests for two of the hosts on ge-/0/0/2 were dropped when the hosts had been moved back and forth from various interfaces more than 5 times in one second.

Verifying That Allowed MAC Addresses Are Working Correctly on the Switch

Purpose Verify that allowed MAC addresses are working on the switch.

Action Display the MAC cache information after 5 allowed MAC addresses have been configured on interface ge/0/0/2:

```
user@switch>  show ethernet-switching table
Ethernet-switching table:  5 entries, 4 learned
  VLAN                MAC address         Type         Age    Interfaces

  employee-vlan        00:05:85:3A:82:80   Learn          0    ge-0/0/2.0
  employee-vlan        00:05:85:3A:82:81   Learn          0    ge-0/0/2.0
  employee-vlan        00:05:85:3A:82:83   Learn          0    ge-0/0/2.0
  employee-vlan        00:05:85:3A:82:85   Learn          0    ge-0/0/2.0
  employee-vlan        *                   Flood          -    ge-0/0/2.0
```

Meaning Because the MAC limit value for this interface has been set to 4, only 4 of the 5 configured allowed addresses are learned.

Related Topics

- Example: Configuring DHCP Snooping, DAI , and MAC Limiting on an EX-series Switch with Access to a DHCP Server Through a Second Switch
- Example: Configuring a DHCP Server Interface as Untrusted to Protect the Switch from Rogue DHCP Server Attacks
- Example: Configuring Allowed MAC Addresses to Protect the Switch from DHCP Snooping Database Alteration Attacks
- Example: Configuring DHCP Snooping and DAI to Protect the Switch from ARP Spoofing Attacks
- Example: Configuring MAC Limiting, Including Dynamic and Allowed MAC Addresses, to Protect the Switch from Ethernet Switching Table Overflow Attacks
- Example: Configuring MAC Limiting to Protect the Switch from DHCP Starvation Attacks
- Configuring Port Security (CLI Procedure)
- Configuring Port Security (J-Web Procedure)