Security Best Practices in AOS

1. Introduction

This article describes AOS features which can be used to address selected dimensions in the X.805 "Security architecture for systems providing end-to-end communications" security model ("Data Integrity" and "Privacy" are not covered in this document). This article is focused on management and control plane (therefore port based access control, for example 802.1X, UNP, ClearPass are not covered in this document either, see section Access Guardian in Network Configuration Guide). It is explained how selected AOS features can be used to prevent network attacks including Denial-of-service (DoS), unauthorized access, intrusions, layer 2 and layer 3 attacks. This article covers only selected scenarios. Each network requires dedicated security policy.

This article is applicable to following hardware platforms and AOS releases:

6250	6400	6450	6850	6850E	6855	6860	6900	9000	9000E	10K
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

6.4.X	6.6.X	6.7.1	7.1.X	7.2.X	7.3.X	8.1.1	8.2.1
✓	✓	✓	✓	✓	✓	✓	✓

2. Access control, Authentication and Non-repudiation

Access Control is concerned with providing authorized access to network resources. Authentication is concerned with confirming the identity of communicating parties. Non-repudiation in concerned with maintaining an audit trail, so that the origin of data or the cause of an event or action cannot be denied.

2.1. Authentication and Authorization

- **RADIUS**

  T1.276-2003 and other standards recommend using a remote RADIUS server for account control. This allows network wide control of accounts reducing the risk of inadvertently leaving an account unsecured. The only local account should be the admin account to be used only for emergency reconfiguration.

  Applicable to AOS 6, AOS 7, AOS 8

  Extract from "OmniSwitch AOS Release 6 Network Configuration Guide":

  > RADIUS is a standard authentication and accounting protocol defined in RFC 2865 and RFC 2866. A built-in RADIUS client is available in the switch. A RADIUS server that supports Vendor Specific Attributes (VSAs) is required. The Alcatel-Lucent attributes can include VLAN information, time-of-day, or slot/port restrictions.
  >
  > Use the **aaa radius-server** command to configure RADIUS parameters on the switch. When creating a new server, at least one host name or IP address (specified by the **host** keyword) is required as well as the shared secret (specified by the **key** keyword). In this example, the server name is **rad**, the host address is 10.10.2.1, the backup address is 10.10.3.5, and the shared secret is **switch**. Note that the shared secret must be configured exactly the same as on the server.
  >
  > ```
  > -> aaa radius-server rad host 10.10.2.1 10.10.3.5 key switch
  > ```
  >
  > Use the **aaa authentication** command to specify the management interface through which switch access is permitted (such as **console**, **telnet**, **ftp**, **http**, or **ssh**). Specify the server and backup servers to be used for checking user login and privilege information. Multiple servers of different types may be specified. For example:
  >
  > ```
  > -> aaa authentication console rad
  > -> aaa authentication ssh rad
  > -> aaa authentication snmp rad
  > -> aaa authentication http rad
  > ```

  Suggested secure configuration:

  ```
  aaa radius-server radius_server host ip_address
  aaa authentication default radius_server local
  ```

  Privileges can be controlled using following attributes:

  - Alcatel-Acce-Priv-F-R1
  - Alcatel-Acce-Priv-F-R2
  - Alcatel-Acce-Priv-F-R3
  - Alcatel-Acce-Priv-F-W1
  - Alcatel-Acce-Priv-F-W2
  - Alcatel-Acce-Priv-F-W3

The list of available options can be displayed using the following command:

> **show aaa priv hexa**
>
> Displays hexadecimal values for command domains/families. Useful for determining how to express command families in hexadecimal; hexadecimal values are used in configuring user privileges in attributes on an external LDAP or RADIUS authentication server.

- **TACACS+**

  A TACACS+ server can be used to provide centralized authentication and authorization services for switch management users.

  Applicable to AOS 6, AOS 7, AOS 8

  Extract from "OmniSwitch AOS Release 6 Network Configuration Guide":

  > When creating a new server, at least one host name or IP address (specified by the **host** keyword) is required as well as the shared secret (specified by the **key** keyword). In this example, the server name is **tac**, the host address is 10.10.5.2, the backup address is 10.10.5.5, and the shared secret is **switch**. Note that the shared secret must be configured exactly the same as on the server.
  >
  > ```
  > -> aaa tacacs+-server tac host 10.10.5.2 10.10.5.5 key switch
  > ```
  >
  > Use the **aaa authentication** command to specify the management interface through which switch access is permitted (such as **console**, **telnet**, **ftp**, **http**, or **ssh**). Specify the server and backup servers to be used for checking user login and privilege information. Multiple servers of different types may be specified. For example:
  >
  > ```
  > -> aaa authentication console tac
  > -> aaa authentication ssh tac
  > -> aaa authentication snmp tac
  > -> aaa authentication http tac
  > ```
  >
  > **TACACS+ Client Limitations**
  >
  > The following limitations apply to this implementation of the TACACS+ client application:
  >
  > - TACACS+ supports Authenticated Switch Access and cannot be used for user authentication.
  > - Authentication and Authorization are combined together and cannot be performed independently.
  > - On the fly, command authorization is not supported. Authorization is similar to the AOS partition management families.
  > - Only inbound ASCII logins are supported.
  > - A maximum of 50 simultaneous TACACS+ sessions can be supported when no other authentication mechanism is activated.
  > - Accounting of commands performed by the user on the remote TACACS+ process is not supported in the boot.cfg file at boot up time.

- **User password policy**

  User password policies can be used to enforce strong passwords for locally stored user database.

  Applicable to AOS 6, AOS 7, AOS 8

  Extract from "OmniSwitch AOS Release 6 Switch Management Guide:

Description	Command	Default
Minimum password length	**user password-size min**	8 characters
Default password expiration for any user	**user password-expiration**	disabled
Password expiration for particular user	**expiration** keyword in the **user** command	none
Username is not allowed in password.	**user password-policy cannot-contain-username**	disabled
Minimum number of uppercase characters allowed in a password.	**user password-policy min-uppercase**	0 (disabled)
Minimum number of lowercase characters allowed in a password.	**user password-policy min-lowercase**	0 (disabled)
Minimum number of base-10 digits allowed in a password.	**user password-policy min-digit**	0 (disabled)
Minimum number of non-alphanumeric characters allowed in a password.	**user password-policy min-nonalpha**	0 (disabled)
Maximum number of old passwords to retain in the password history.	**user password-history**	4
Minimum number of days user is blocked from changing password.	**user password-min-age**	0 (disabled)

Suggested secure configuration:

```
user admin password user_defined_password
user password-expiration 90
user password-min-age 1
user lockout-window 3
user lockout-threshold 5
user lockout-duration 4
user password-size min 8
user password-policy cannot-contain-username enable
user password-policy min-uppercase 1
user password-policy min-lowercase 1
user password-policy min-digit 1
user password-policy min-nonalpha 1
user password-history 5
```

“user lockout-window”, “user lockout-threshold” and “user lockout-duration” are used to stop malicious actors and automated systems from trying to guess the password via a brute-force attack. The normal login process has built in delays on user-password authentication failure which discourages guessing. The literature suggests that a longer lock out period should be used after extend failures to allow an administrator to identify the breach. The period should be sufficiently long enough for an administrator to be notified and take appropriate action. The values recommended are a balance between blocking programmatic password crackers and potential denial of authorized access. Account lock up does not apply to the admin account.

“user password-size”, “user password-history”, and “user password-policy *” commands are used to require complex passwords be set by users. Values are taken from T1.276-2003. Passwords using these criteria are considered to be complex enough to provide minimum level of security. Organizations may require stronger passwords. Once commands for enforcing password strength are entered be sure to update existing passwords.

Once a password expires the next login will prompt the user to change the password. The password aging and lockout commands only apply to local accounts. See your RADIUS manufacturer's guide for applying these to remote accounts.

- **FIPS**

FIPS can be used to ensure that only strong cryptographic algorithms are used when accessing a switch.

Applicable to AOS 6.4.5.R02, AOS 7, AOS 8

Extract from "OmniSwitch AOS Release 6 Switch Management Guide":

> Federal Information Processing Standards (FIPS) is a mode of operation that satisfies security requirements for cryptographic modules. It is a requirement as per the National Institute of Standards and Technology (NIST), FIPS 140-2 standard that strong cryptographic algorithms has to be supported to achieve FIPS compliance. When FIPS mode is enabled on OmniSwitch, FIPS 140-2 compliant encryption is used by the OmniSwitch devices in the various management interfaces such as SFTP, HTTP, SSh and SSL.
>
> These strong cryptographic algorithms ensure secure communication with the device to provide interoperable, high quality, cryptographically-based security for IP networks through the use of appropriate security protocols, cryptographic algorithms, and keys and prevent any form of hijacking/ hacking or attack on the device through the secure mode of communication.
>
> FIPS mode functionalities:
>
> - FIPS operates in OpenSSL mode allowing only highly secure and strong cryptographic algorithms.
> - OpenSSH and Web Server which use the OpenSSL as the underlying layer for secure communications also works in the FIPS mode.
> - SNMPv3 supports secure AES and 3-DES. MD5 is not allowed.
> - The FIPS mode is enabled/disabled only with a reboot of the switch.
>
> The SNMPv3 module as well as all switch management protocols such as SFTP, HTTP, SSH, and SSL use the FIPS 140-2 compliant encryption algorithms.
>
> **FIPS Specifications**
>
> | | |
> |---|---|
> | Algorithms Supported for ESP: | DES-CBC - 64 bits
3DES-CBC - 192 bits
AES-CBC - 128, 192, or 256 bits
AES-CTR - 160, 224, or 288 bits
Note: MD5 is not allowed |
> | Access types: | SSH, SFTP, HTTPS, SNMPV3 |
>
> Prior to enabling the FIPS mode of communication, complete the following pre-requisites:
>
> - The SSH/SFTP/SSL/SNMPv3 clients should support the secure FIPS standard cryptographic algorithms to communicate with an OmniSwitch device on FIPS mode.
> - SNMPv3 communications in the FIPS mode should only support SHA+AES or SHA+3DES algorithms. Session establishment with MD5 or DES should be rejected.
> - User-specific certificates/ keys have to be generated using FIPS compliant cryptographic algorithms. There are no checks in the OpenSSL module to verify the FIPS compliance of the certificate/keys in the flash.

- When takeover happens, management sessions with the old Primary will be disconnected. User will have to reconnect to the new Primary.

Enable the FIPS mode on an OmniSwitch using the following command:

```
-> system fips enable
WARNING: FIPS mode has been enabled. System reboot required for
the changes to take effect.
```

Reboot the system.

Use the **show system fips-status** to view the configured and running status of the FIPS mode on the Switch. **show system fips-status** is the only show command which displays the FIPS status on the switch. The FIPS status is not displayed by a **show configuration snapshot** command.

Disable insecure management interfaces such as Telnet/ FTP manually after FIPS mode is enabled to achieve a complete secure device.

Configure a user-id and password.

```
-> user snmpadmin password trustno1 sha+3des
```

This user-id and password can be used to access an OmniSwitch in secure mode when FIPS is enabled on the switch.

Access the OmniSwitch from the SSH/SFTP/SSL/SNMPv3 clients with encryption AES using the user credentials defined.

Use the show user command to view the SNMP level configured for the user.

```
User name = snmpadmin,
Password expiration = 12/22/2012 11:01 (30 days from now),
Password allow to be modified date = 12/25/2007 10:59 (3 days from now),
Account lockout = Yes (Automatically unlocked after 19 minute(s)from now),
Password bad attempts = 3,
Read Only for domains = None,
Read/Write for domains = Admin System Physical Layer2 Services policy Security ,
Read/Write for families = ip rip ospf bgp vrrp ip-routing ipx ipmr ipms ,
Snmp allowed = YES,
Snmp authentication = SHA,
Snmp encryption = DES
Console-Only = Disabled
```

A secure session of the user “snmpadmin” is established between the client and the OmniSwitch in FIPS enabled mode.

2.2. Access control

- **ACLs with destination network group Switch**

  The build in network group Switch can be used in ACLs to facilitate creation of Access Control Lists allowing management connections only from predefined list of IP addresses.

  Applicable to AOS 6.4.6.R01

  Example configuration:

```
policy network group management <ip_address> mask <mask> <ip_address> mask
➥ <mask> <ip_address> mask <mask> ...
policy condition trusted source network group management destination network
➥ group Switch
```

```
policy condition untrusted destination network group Switch
policy action accept
policy action drop disposition drop
policy rule trusted precedence 65010 condition trusted action accept
policy rule untrusted precedence 65000 condition untrusted action drop
qos apply
```

> It may be necessary for protocols like BGP and BFD to include in the management network group IP addresses of all neighbor routers.

> This kind of QoS configuration may consume a lot of TCAM entries in case there are many predefined management network ranges and many active local IP addresses (the number of predefined management network ranges multiplied by the number of active local IP addresses gives the number of consumed TCAM entries). It is recommended to use network ranges in place of IP addresses with 32 bit mask to reduce the number of reserved TCAM entries.

In AOS 7.3.2.613.R01 and AOS 7.3.4.R01 there is an option to reduce the number of consumed TCAM resources using "qos switch-group compact". See below an example of configuration on OS6900, which consumes 16 (4×4) TCAM entries in the expanded mode and 4 (4×1) in the compact mode. A reboot is necessary to apply changes.

```
-> show configuration snapshot qos ip
! IP:
ip interface "vlan100" address 192.168.100.1 vlan 100
ip interface "vlan101" address 192.168.101.1 vlan 101
ip interface "vlan102" address 192.168.102.1 vlan 102
ip interface "vlan103" address 192.168.103.1 vlan 103

! QOS:
qos switch-group compact
policy network group management 192.168.200.1 192.168.201.1
policy network group management 192.168.202.1 192.168.203.1
policy condition trusted source network group management destination network
➥ group Switch
policy action accept
qos apply
```

Before reboot 16 TCAM entries are consumed in slice 7:

```
-> show qos slice | grep " 7 "
                                    7   256/240          256/240 …
```

After reboot the number of consumed entries in slice 7 is reduced to 4:

```
-> show qos slice | grep " 7 "
                                    7   256/252          256/252 …
```

- **Console port access restriction**

  Console access can be used for example to reset the admin password. Access to console port can be disabled for security reasons.

  Applicable to AOS 6.4.6.R01

  Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

  > Enable or disable the CLI shell through the console port of the switch.

session console {enable | disable}

Syntax Definitions

enable Enables the switch access through the console port via the CLI shell.

disable Disables the switch access through the console port via the CLI shell.

Defaults

default: enable

Usage Guidelines

- It is recommended to create a back-up of the configuration file before using this command. If the telnet or SSH or webview access to the switch is lost, contact customer support to recover the switch.
- Before disabling the CLI console shell, configuration for telnet or SSH access with proper user privilege should be made.
- The command should be issued only via telnet or SSH session, and not through console sessions.
- When the CLI console shell is disabled, the switch log output to the console is also disabled.
- When the CLI console shell is disabled, switch can be accessed through SSH or telnet or webview session.
- The command can be stored to the configuration file using write memory.
- The command can be used on standalone unit and in a stack on the primary switch.

2.3. Event logging

- **Command logging**

  Command logging can be used to keep audit trail of all commands entered through CLI.

  Applicable to AOS 7, AOS 8

  In AOS 7 and AOS 8 CLI commands are logged by default in SWLOG. Enter the following command to list commands entered via CLI:

  ```
  -> show log swlog | grep "CLI log"
  ```

  Applicable to AOS 6, AOS 7, AOS 8

  Extract from "OmniSwitch AOS Release 6 Switch Management Guide":

  By default, command logging is *disabled*. To enable command logging on the switch, enter the following command:

  ```
  -> command-log enable
  ```

  When **command** logging is enabled via the **command-log enable** syntax, a file called **command.log** is automatically created in the switch's **flash** directory. Once enabled, configuration commands entered on the command line will be recorded to this file until command logging is disabled.

The **command.log** file has a 66402 byte capacity. This capacity allows up to 100 of the most recent commands to be recorded. Because all CLI command logging information is archived to the **command.log** file, command history information will be lost if the file is deleted.

To view a list of logged commands, along with the corresponding information (including entry results), enter the **show ssh config** command. For example:

```
-> show command-log
Command : ip interface vlan-68 address 168.14.12.120 vlan 68
UserName : admin
Date : MON APR 28 01:42:24
Ip Addr : 128.251.19.240
Result : SUCCESS
```

Remote command logging can be enabled using the following command:

```
swlog remote command-log enable
```

- **RADIUS and TACACS+**

  Accounting through RADIUS or TACACS+ can be used to keep audit trail of all user sessions.

  Applicable to AOS 6, AOS 7, AOS 8

  Extract from "OmniSwitch AOS Release 6 Network Configuration Guide":

  To enable accounting (logging a user session) for Authenticated Switch Access, use the **aaa accounting session** command with the relevant server name(s). In this example, the RADIUS and LDAP servers have already been configured through the **aaa radius-server** and **aaa ldap-server** commands.

  After this command is entered, accounting will be performed through the **rad1** RADIUS server. If that server is unavailable, the LDAP server, **ldap2**, will be used for accounting. If that server is unavailable, logging will be done locally on the switch through the Switch Logging feature

  ```
  -> aaa accounting session rad1 ldap2 local
  ```

  Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

  ### aaa accounting session

  Configures an accounting server or servers for authenticated switch sessions. Accounting servers keep track of network resources (time, packets, bytes, etc.) and user activity.

  aaa accounting session [*server_name1***] [***server_name2***...] [local]**

  no aaa accounting session

  ### Syntax Definitions

server_name1	The name of the RADIUS, TACACS+, or LDAP server used for accounting of authenticated switch sessions. At least one server is required. RADIUS, TACACS+, and LDAP server names are set up through the **aaa radius-server**, **aaa tacacs+-server**, and **aaa ldap-server** commands.
server_name2...	The names of backup servers. Up to 3 backups may be specified (including **local**); each server name should be separated by a space. These backups are only used if *server1* becomes unavailable. They are polled in the order they

	are listed in this command. The first available server becomes the accounting server.
Local	Local accounting is done through the Switching Logging feature on the switch. See Chapter 57, "Switch Logging Commands," for information about Switch Logging commands.

Defaults

Accounting is disabled by default.

Platforms Supported

OmniSwitch 6400, 6850E, 6855, 9000E

Usage Guidelines

- Use the **no** form of the command to disable accounting for Authenticated Switch Access.
- Up to 4 accounting servers (total) may be specified. At least one server is required. Each server name should be separated by a space.
- The servers may be RADIUS, TACACS+, LDAP servers, and/or the local Switch Logging facility.
- If **local** is specified as *server1*, the switch will ***only*** use the local Switching Logging facility for accounting.
- If **local** is specified as a backup, it should be entered last in the list of servers. The Switch Logging facility is always available if the switch is up.
- The switch uses ***only the first available server*** in the list for accounting. For example, if *server1* is not available, the switch will use *server2*.
- RADIUS, TACACS+, and LDAP servers may each have an additional backup specified through the **aaa radius-server**, **aaa tacacs+-server**, and **aaa ldap-server** commands.

- **Centralized audit trail using SNMP traps, SWLOG and Syslog**

  OmniSwitch is set up to assist in monitoring activity on the switch with SNMP traps, local switch log and remote syslog (via switch log).

  Suggested secure configuration:

```
snmp station <ip_address> <username> v3 enable
no swlog output
swlog output flash
swlog output socket <ip_address>
swlog appid all level info
swlog
```

  "snmp station <ip_address> <username> v3 enable" is used to set up a trap interface to an SNMP station. Alcatel-Lucent recommends using an OmniVista 2500 Network Management Station to monitor and log traps coming from a switch. Traps which may indicate tampering with a network should be forwarded to the network administrator for immediate attention. Traps which may require immediate security action are:

  - coldStart, warmStart – detect physical tampering with a switch. Physical access to switches and wiring closets allows an intruder to power cycle a switch, remove or replace critical components, and to alter cable wiring. Physical

access to network jacks allows an intruder to enter the network inside the firewall. It is recommended that critical switches be housed in locked rooms with limited access. The OmniSwitch's coldStart and warmStart traps should be monitored to detect cycling of critical switches.

- alaStackMgrRoleChangeTrap – The primary or secondary stack was changed. This also could indicate physical tampering.
- httpServerDoSAttackTrap – HTTP server is under possible DoS attack.
- alaDoSTrap – A possible DoS attack on the switch has been identified.
- stpRootPortChange – Spanning Tree root port changed. A change of root may indicate a possible hijacking of the spanning tree configuration. Networks which change configuration often may be difficult to monitor this trap.
- Depending on the configuration of your network these traps may also provide important security information.
- chassisTrapsPossibleDuplicateMac – Possible spoofing of a device.
- lpsViolationTrap – Learned Port Security violation has occurred.

"swlog output flash" causes the switch log output to be stored in the switch's flash. This keeps a copy in case the syslog server is unreachable.

"swlog output socket <ip_address>" causes the switch log output to be sent to a remote syslog server. Having a remote server is important for backup, protection from swlog clear, and from wrap around of the flash file. Free or reasonably priced syslog servers can be found by searching the web. Alcatel-Lucent's OmniVista Network Management Suite can act as a syslog server.

"swlog appid all level info" resets the log level to info. Level "warn" and higher should always be logged for security reasons. "Info" level gives additional information which can aid in security audits. Debug levels should not be used except when tracking specific issues as they can cause premature wrap around of the swlog file overwriting important security information.

"swlog" enables logging to the swlog output destinations. Logging is enabled by default. This should never be turned off.

It is recommended that the swlog be cleared (swlog clear) when first configuring a switch to remove events which are not applicable.

"swlog output flash file-size bytes" should not be reduced from the shipped default. The shipped size is determined specifically for each product family to allow for maximum logging.

3. Data confidentiality and Communication

Data Confidentiality is concerned with protecting data from unauthorized disclosure. Communication Security is concerned with ensuring that information only flows between authorized end-points without being diverted or intercepted.

3.1. Secure Socket Layer

- **Allowing only secure protocols**

  Insecure protocols are provided by AOS to support legacy systems. They are not recommended. Secure protocols are available which provide the same type of functionality. All services which are not used should be disabled to further reduce exposure. For example, if SNMP is not used then remove the enable commands for SNMP.

Disabled Protocol	Replacement	Reason
telnet	ssh	telnet does not use encryption nor certificates.
ftp	sftp scp	FTP does not use encryption or certificates.
tftp	sftp scp	TFTP does not require user authentication and does not use encryption.
snmp v1	snmp v3	SNMP v1 does not provide for user authentication. V3 provides encryption.
snmp v2	snmp v3	SNMP v1 does not provide for user authentication. V3 provides encryption.
avlan-http	avlan-secure-http	Disable unless avlan is used. HTTP is an insecure protocol.
avlan-secure-http		Disable unless AVLAN is used.
avlan-telnet		Disable unless AVLAN is used. Telnet is an insecure protocol.
udp-relay		Disable unless relay service is used.
ntp		Disable unless NTP is used.

Applicable to AOS 6

Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

> **ip service**
>
> Enables (opens) or disables (closes) well-known TCP/UDP service ports (SSH, telnet, FTP, and so on). Selectively enabling or disabling these types of ports provides an additional method for protecting against denial of service (DoS) attacks.
>
> **ip service {all** | *service_name* | **port** *service_port***}**
> **no ip service {all** | *service_name* | **port** *service_port***}**

Suggested secure configuration:

```
no ip service all
ip service ssh
ssh enable
ssh pubkey-auth enable
ip service snmp
ip service https
snmp security privacy all    (default)
```

"ssh enable", "ssh pubkey-auth enable" require SSH to work with public key certificates. The user key must be loaded on the switch in /flash/network/pub.

"snmp security privacy all" requires SNMP accesses to use v3.

Enabled services can be verified using "show ip service":

```
-> show ip service

  Name                    Port   Status
----------------------+-------+---------
  ftp                      21   disabled
  ssh                      22   enabled
  telnet                   23   disabled
  udp-relay                67   disabled
  http                     80   disabled
  network-time            123   enabled
  snmp                    161   enabled
  avlan-telnet            259   disabled
  avlan-http              260   disabled
  avlan-secure-http       261   disabled
  secure-http             443   enabled
  avlan-http-proxy        262   disabled
```

Applicable to AOS 7, AOS 8

Extract from "OmniSwitch AOS Release 7 CLI Reference Guide":

> **ip service**
>
> Enables (opens) or disables (closes) well-known or user-defined TCP/UDP service ports. Selectively enabling or disabling these types of ports provides an additional method for protecting against unauthorized switch access or Denial of Service (DoS) attacks.
>
> **[vrf** *vrf_name***] ip service {all** | *service_name* | **port** *service_port***} admin-state {enable** | **disable}**

Note: "ip service http admin-state enable/disable" enables/disables both http and https. Even if the http port is open, a user is always redirected to https port and it is not a security threat. It is the expected behavior. More details can be found in PR 201677 notes.

Suggested secure configuration:

```
ip service all admin-state disable
ip service ssh admin-state enable
ssh enforce-pubkey-auth enable
ip service snmp admin-state enable
ip ip service http admin-state enable
webview force-ssl enable
snmp security privacy all
```

"ssh enforce-pubkey-auth enable" is required by SSH to work with public key certificates. The user key must be loaded on the switch in /flash/network/pub.

"snmp security privacy all" requires SNMP accesses to use v3.

Enabled services can be verified using "show ip service":

```
-> show ip service

  Name                      Port   Status
----------------------+-------+---------
  ftp                       21   disabled
  ssh                       22   enabled
  telnet                    23   disabled
  http                      80   enabled
  ntp                      123   enabled
  snmp                     161   enabled
  https                    443   enabled
```

- **SNMPv3**

SNMPv3 requires additional configuration.

Applicable to AOS 6, AOS 7, AOS 8

Extract from "OmniSwitch AOS Release 6 Switch Management Guide"

> By default, the switch is set to "privacy all", which means the switch accepts only authenticated and encrypted v3 Sets, Gets, and Get-Nexts. You can configure different levels of SNMP security by entering **snmp security** followed by the command parameter for the desired security level. For example, the following syntax sets the SNMP security level as "authentication all" as defined in the table below:
>
> ```
> -> snmp security authentication all
> ```

A new user needs to be created and AAA configured:

```
-> user snmp3 password 4G76qpjQqBtsY69g sha+des read-write all
-> aaa authentication snmp local
```

Trap support required additional configuration:

```
-> snmp station 1.1.1.1 snmp3 v3 enable
```

It is recommended to enable authentication traps:

```
-> snmp authentication-trap enable
```

- **Replacing the default SSL certificate**

We assume that you have a working copy of OpenSSL installed on your computer. In case you don't have OpenSSL yet, you can download it from http://www.openssl.org. If you already have a certificate and RSA key you can skip generating it and go on with “Install the certificate on the OmniSwitch”.

Generating certificate and RSA key

Open a Windows command-box or UNIX shell and go to the OpenSSL-bin directory. From the command prompt enter the following command to generate a SSL certificate and RSA key. You will have to answer some questions for the certificate.

```
C:\OpenSSL\bin>openssl req -x509 -nodes -days 1460 -newkey rsa:1024
-keyout wv-key.pem -out wv-cert.pem
Loading 'screen' into random state - done
Generating a 1024 bit RSA private key
.....................................++++++
......++++++
writing new private key to 'wv-key.pem'
-----
You are about to be asked to enter information that will be
incorporated into your certificate request.
What you are about to enter is what is called a Distinguished Name or a
DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:DE
State or Province Name (full name) [Some-State]:Hamburg
Locality Name (eg, city) []:Hamburg
Organization Name (eg, company) [Internet Widgits Pty Ltd]:Example Corp
Organizational Unit Name (eg, section) []:Example Dept
Common Name (eg, YOUR name) []:John Doe
Email Address []:John.Doe@example-corp.com
```

You will find two new files in the OpenSSL-bin directory.

Install the certificate on the OmniSwitch

Connect to the switch via console/SSH/Telnet and rename the files "wvcert.pem" and "wv-key.pem" in the /switch directory to e.g. “wv-cert.bak” and “wv-key.bak”. Now connect to the switch via FTP to upload your certificates. You need to upload the files to the /switch directory of the switch:

```
C:\OpenSSL\bin>ftp 192.168.30.1
Connected to 192.168.30.1.
220 FTP server ready
User (192.168.30.1:(none)): admin
331 Password required
Password:
230-
Welcome to the Alcatel-Lucent OmniSwitch 6000
Software Version 6.3.1.1052.R01 Service Release, December 11, 2008.
Copyright(c), 1994-2007 Alcatel-Lucent. All Rights reserved.
OmniSwitch(TM) is a trademark of Alcatel-Lucent registered
```

```
in the United States Patent and Trademark Office.
230
ftp> pwd
257 Current directory is "/flash/working"
ftp> cd ..
250 Changed directory to "/flash"
ftp> cd switch
250 Changed directory to "/flash/switch"
ftp> put wv-key.pem
200 Port set okay
150 Opening ASCII mode data connection
226 Transfer complete
ftp: 891 bytes sent in 0,00Seconds 891000,00Kbytes/sec.
ftp> put wv-cert.pem
200 Port set okay
150 Opening ASCII mode data connection
226 Transfer complete
ftp: 1359 bytes sent in 0,00Seconds 1359000,00Kbytes/sec.
```

After the upload is finished you need to reboot the switch to load the new certificates. When you connect to the switch via HTTPS afterwards you will see the new certificate.

4. Availability

Availability is concerned with ensuring that there is no denial of authorized access to network elements, stored information, information flows, services, and applications.

4.1. DoS attacks on reserved network ranges

- **Multicast Dynamic Control**

  MDC was introduced to protect AOS switches against high CPU utilization due to unwanted traffic being copied to CPU. There are no limitations for enabling MDC, although there are limitations for MDC in drop-all mode (see below for details).

  Applicable to AOS 6.4.4.707.R01, AOS 6.4.6.218.R01

  In AOS, IPv4 and IPv6 multicast protocol messages are by default always copied to CPU. High CPU may impact the normal operations of the OmniSwitch protocols such as LACP, ERP, IGMP. In order to resolve this high CPU issue, this feature is introduced to control the processing of the IPv4 multicast protocols.

  In other words in pre-AOS 6.4.4.707.R01 and pre-AOS 6.4.6.218.R01 versions all packets from IPv4 range 224.0.0.0/24 and IPv6 range ff02:0::/32 were copied to CPU. There were multiple workarounds introduced to minimize the impact:

  In AOS 6.4.4.581.R01 (PR 176341, saved in boot.cfg):

  ```
  debug ip set ipv4ControlProtocolDisable 0
  ```

  In AOS 6.4.4.581.R01 (PR 176341, saved in AlcatelDebug.cfg):

  ```
  debug set ipv6ControlProtocolDisable 0
  ```

  In AOS 6.4.4.626.R01 (PR 179967, saved in boot.cfg):

  ```
  debug ip set ipedrL3SlowPathToCpu 0
  ```

  In AOS 6.4.4.707.R01 and newer the processing of all IPv6 multicast protocols is globally controlled by the presence of an IPv6 Interface:

  - No IPv6 interface configured - all protocols in the ff02::/32 range are transparently forwarded and not copied to CPU.
  - At least one IPv6 interface configured - all protocol packets in the ff02::/32 range are copied to CPU on all VLANs irrespective on which VLAN IPV6 interface is enabled.

  IGMP packets are copied to CPU based on the global IPv4 IPMS status. When IPv4 IPMS is globally enabled, IGMP packets are copied to CPU. When IPMS is globally disabled, IGMP packets are not copied to CPU.

  MLD packets are copied to CPU based on the global IPv6 IPMS status. When IPv6 IPMS is globally enabled, MLD packets are copied to CPU. When IPMS is globally disabled, MLD packets are not copied to CPU.

  Therefore following workarounds are not applicable anymore (protection is enabled by default):

  ```
  debug set ipv6ControlProtocolDisable 0
  debug ip set ipedrL3SlowPathToCpu 0
  ```

The last workaround:

```
debug ip set ipv4ControlProtocolDisable 0
```

Was replaced by the new "ip multicast dynamic-control" command.

Based on AOS 6.4.4.707.R01 Intermediate Release Notes:

ip multicast dynamic-control

Enables or disables Multicast Dynamic Control feature

ip multicast dynamic-control [drop-all] status [{enable|disable}]

Syntax Definitions

drop-all	Enables or disables copy to CPU action for all packets in 224.0.0.0/24 range (the same behavior as "ipv4ControlProtocolDisable").

Defaults

enable | disable:	disable
drop-all enable | disable:	disable

Platform Supported

OmniSwitch 6400, 6850, 6850E, 6855, 6855-U24X, 9700E, 9702E

Usage Guidelines

- If MDC it is enabled, IPv4 multicast well-known protocol packets alone will be trapped to CPU and the other multicast packets will be transparently forwarded. Below are the well-known IPv4 multicast protocol packets:
  OSPF: 224.0.0.5/32 + IP protocol 89
  OSPF: 224.0.0.6/32 + IP protocol 89
  VRRP: 224.0.0.18/32 + IP protocol 112
  RIPv2: 224.0.0.9 + UDP port 520
  PIM: 224.0.0.13/32
  DVMRP: 224.0.0.4/32
- The proposed solution does not address all DoS attack concerns
- Dynamic-Control "drop-all" feature should not be enabled if any routing protocol or VRRP is configured on the OmniSwitch as protocol packets will be dropped.
- Drop-all status can be enabled only after enabling global dynamic control status.

Examples

```
-> ip multicast dynamic-control status enable
-> ip multicast dynamic-control status disable
-> ip multicast dynamic-control drop-all status enable
-> ip multicast dynamic-control drop-all status disable
-> ip multicast status enable
-> ip multicast status disable
-> ipv6 multicast status enable
-> ipv6 multicast status disable
```

```
-> show ip multicast

Status                                              = disabled,
Querying                                            = disabled,
Proxying                                            = disabled,
Spoofing                                            = disabled,
Zapping                                             = disabled,
Querier Forwarding                                  = disabled,
Flood Unknown                                       = disabled,
Dynamic control status                              = enabled,
Dynamic control drop-all status                     = enabled,
Buffer Packet                                       = disabled,
Version                                             = 2,
Robustness                                          = 2,
Query Interval (seconds)                            = 125,
Query Response Interval (tenths of seconds)         = 100,
Last Member Query Interval (tenths of seconds)      = 10,
Unsolicited Report Interval (seconds)               = 1,
Router Timeout (seconds)                            = 90,
Source Timeout (seconds)                            = 30,
Max-group                                           = 0,
Max-group action                                    = none
Helper-address                                      = 0.0.0.0
-> show configuration snapshot ipms
! IPMS :
ip multicast dynamic-control status enable
ip multicast dynamic-control drop-all status enable
```

Release History

Release 6.4.4.707.R01 and 6.4.6.218.R01; command was introduced.

In AOS 6.6.X.R01 only the “drop-all” option is available.

Extract from “OmniSwitch AOS Release 6.6.5.R01 Switch Management Guide”

ip multicast dynamic-control drop-all status

Enables or disables the processing of IPV4 protocol packets through the CPU.

ip multicast dynamic-control drop-all status [{enable | disable}]

Platforms Supported

OmniSwitch 6250, 6450

Usage Guidelines

- On enabling this feature the IPV4 protocol packets are not trapped to the CPU. The packets are transparently forwarded.
- This feature should not be enabled if routing protocol or VRRP is configured on the switch.
- This feature has no influence on MDNS traffic since the MDNS Relay rule has higher precedence over IPV4 specific protocols.

Examples

```
-> ip multicast dynamic-control drop-all status enable
```

```
-> ip multicast dynamic-control drop-all status disable
```

Release History

Release 6.6.5; command was introduced.

- **CPU priority 17**

MDC is not available on AOS 7 & 8 platforms. In AOS 7 and 8 (just like in pre-AOS 6.4.4.707.R01 and pre-AOS 6.4.6.218.R01) all packets with IPv6 destination address ff02::/32 and IPv4 with destination address 224.0.0.0/24 are copied to CPU regardless of the configuration. MDC can be easily replaced by a QoS rules using CPU priority 17. Packets which are classified in CPU queue 17 are dropped by CPU, but are still forwarded. This way CPU is protected and the network is transparent to this kind of traffic.

Applicable to AOS 7, AOS 8

The example below can be applied if there are no IPv6 interfaces configured. In rules corresponding to unused routing protocol the "q17" action should be applied:

```
-> show configuration snapshot qos
! QOS:
policy condition mdc-dvmrp destination ip 224.0.0.4
policy condition mdc-ipv4mc-reserved destination ip 224.0.0.0
➥ mask 255.255.255.0
policy condition mdc-ipv6mc-reserved destination ipv6 ff02::
➥ mask ff:ff:ff:ff::
policy condition mdc-ospf-5 destination ip 224.0.0.5 ip-protocol 89
policy condition mdc-ospf-6 destination ip 224.0.0.6 ip-protocol 89
policy condition mdc-pim destination ip 224.0.0.13
policy condition mdc-ripv2 destination ip 224.0.0.9 destination udp-port 520
policy condition mdc-vrrp destination ip 224.0.0.18 ip-protocol 112
policy action accept
policy action q17 cpu priority 17
policy rule mdc-vrrp precedence 65070 condition mdc-vrrp action accept
policy rule mdc-ripv2 precedence 65060 condition mdc-ripv2 action accept
policy rule mdc-pim precedence 65050 condition mdc-pim action accept
policy rule mdc-ospf-6 precedence 65040 condition mdc-ospf-6 action accept
policy rule mdc-ospf-5 precedence 65030 condition mdc-ospf-5 action accept
policy rule mdc-dvmrp precedence 65020 condition mdc-dvmrp action accept
policy rule mdc-ipv6mc-reserved precedence 65010
➥ condition mdc-ipv6mc-reserved action q17
policy rule mdc-ipv4mc-reserved precedence 65000
➥ condition mdc-ipv4mc-reserved action q17
qos apply
```

4.2. TTL 0 flooding

Packets with TTL equal zero (not only ICMP packets) are copied to CPU regardless of the configuration. This attack can be used by an attacker to exhaust CPU resources.

- **ipedrL3UcTtlErrToCpu0 variable**

Applicable to AOS 6.4.X

In AOS 6.4.4.658.R01 (see PR 188063) there was a CLI command introduced, which controls ipedrL3UcTtlErrToCpu0 register, this command is saved in boot.cfg):

```
-> debug ip set ipedrL3UcTtlErrToCpu0
```

4.3. IGMP flooding

IGMP packets are copied to CPU based on the global IPMS status only in AOS version supporting MDC (regardless of MDS status). In this case when IPMS is globally enabled, IGMP packets are copied to CPU. When IPMS is globally disabled, IGMP packets are not copied to CPU. In all previous AOS version IGMP packets are copied to CPU regardless of the IPMS status. IGMP flooding might be dangerous to system stability especially on AOS 6 platforms.

- **QoS with mode split**

Rate limiting with "mode split" allows rate limiting IGMP messages per port.

On AOS 6.4.X platforms IGMP packets copied to CPU can be rate limited using user QoS rules (they are not rate limited by default).

On AOS 6.6.X platforms IGMP packets copied to CPU cannot be rate limited using user QoS rules (they are not rate limited by default).

On AOS 7 and AOS 8 IGMP packets copied to CPU are rate limited by default.

Extract from "OmniSwitch AOS Release 6 Network Configuration Guide":

> **policy port group**
>
> Configures a port group and its associated slot and port numbers. A port group can be attached to a policy condition. The action associated with that policy will be applied to all members of the port group. This command can be used to specify a rate limiter for the group of ports or individual port by specifying the mode for the port group.
>
> **policy port group** *group_name* **[mode {split | non-split}]** *slot/port***[-***port***]** **[***slot/port***[-***port***]...]**
>
> **no policy port group** *group_name*
>
> **policy port group** *group_name* **no** *slot/port***[-***port***]** **[***slot/port***[-***port***]...]**
>
> **Syntax Definitions**
>
> | | |
> |---|---|
> | *group_name* | The name of the port group (up to 31 alphanumeric characters). |
> | **split** | Select the mode as split when the policy action is required to be applied on individual port basis. |
> | **non-split** | Select the mode as non-split when the policy action is required to be applied on the port group. |

Applicable to AOS 6.4.X

```
-> show configuration snapshot qos
! QOS :
policy port group untrusted mode split 1/1-23
policy condition igmp source port group untrusted
➥ destination ip 224.0.0.0 mask 224.0.0.0 ip protocol 2
policy action limit-64 maximum bandwidth 64K
policy rule limit-igmp condition igmp action limit-64
qos apply
```

4.4. DHCP flooding

All DHCP packets with destination UDP port 68 are copied to CPU regardless of the DHCP Snooping configuration. Rate limiting with "mode split" allows rate limiting DHCP messages per port.

- **QoS with mode split**

Rate limiting with "mode split" allows rate limiting DHCP messages per port.

Extract from "OmniSwitch AOS Release 6 Network Configuration Guide":

> **policy port group**
>
> Configures a port group and its associated slot and port numbers. A port group can be attached to a policy condition. The action associated with that policy will be applied to all members of the port group. This command can be used to specify a rate limiter for the group of ports or individual port by specifying the mode for the port group.
>
> **policy port group** *group_name* **[mode {split | non-split}]** *slot/port***[-***port***]** **[***slot/port***[-***port***]...]**
>
> **no policy port group** *group_name*
>
> **policy port group** *group_name* **no** *slot/port***[-***port***]** **[***slot/port***[-***port***]...]**
>
> **Syntax Definitions**
>
> | | |
> |---|---|
> | *group_name* | The name of the port group (up to 31 alphanumeric characters). |
> | **split** | Select the mode as split when the policy action is required to be applied on individual port basis. |
> | **non-split** | Select the mode as non-split when the policy action is required to be applied on the port group. |

Applicable to AOS 6.4.X and AOS 6.6.4.R01 or newer

For AOS 6.6.X branch 6.6.4.292.R01 or newer is recommended.

```
-> show configuration snapshot qos
! QOS :
policy port group untrusted mode split 1/1-23
policy condition dhcp-server source port group untrusted
➥ source udp port 67 destination udp port 68
policy action limit-64 maximum bandwidth 64K
```

```
policy rule limit-dhcp-server condition dhcp-server action limit-64
qos apply
```

All DHCP packets with destination UDP port 67 are copied to CPU with rate limit of 64 kb/s. Switch configuration:

```
-> show configuration snapshot ip-helper
! UDP Relay :
ip helper forward delay 0
ip helper dhcp-snooping enable
ip helper dhcp-snooping binding enable
ip helper dhcp-snooping port 1/24 trust
```

In this example DHCP messages from user connected to port 1/2 are not transferred to DHCP server (which is connected to port 1/24) during the attack.

This attack may be prevented using the following QoS configuration (this is a workaround):

```
-> show configuration snapshot qos
! QOS :
qos stats interval 10
policy condition dhcp-client-1001 source port 1/1 source udp port 68
➥ destination udp port 67
policy condition dhcp-client-1002 source port 1/2 source udp port 68
➥ destination udp port 67
...
policy action limit64 maximum bandwidth 64K
policy rule limit-dhcp-client-1001 condition dhcp-client-1001
➥ action limit64
policy rule limit-dhcp-client-1002 condition dhcp-client-1001
➥ action limit64
...
qos apply
-> debug qos internal "slice 1/0 dhcppps 1048575"
-> more/flash/working/AlcatelDebug.cfg
debug qos internal "slice 1/0 dhcppps 1048575"
```

Another option is rate limiting with “mode split” - this way DHCP messages are rate limited per port:

```
-> show configuration snapshot qos
! QOS :
policy port group untrusted mode split 1/1-23
policy condition dhcp-client source port group untrusted
➥ source udp port 68 destination udp port 67
policy action limit64 maximum bandwidth 64K
policy rule limit-dhcp-client condition dhcp-client action limit64
qos apply
-> debug qos internal "slice 1/0 dhcppps 1048575"
-> more/flash/working/AlcatelDebug.cfg
debug qos internal "slice 1/0 dhcppps 1048575"
```

Explanation to « debug qos internal "slice 1/0 dhcppps 1048575" »: There is an additional system rule configured in system slices, which limits all DHCP messages originated by DHCP clients to 64 kb/s – this rule is processed in parallel to the previously applied user rules.

The "qosDhcpRateLimit" setting through dshell is lost after a reload. Please use AlcatelDebug.cfg and the following command (this command is not saved in boot.cfg, an example for a single ASIC standalone switch):

```
-> debug qos internal "slice 1/0 dhcppps 1048575"
```

- **CPU priority 17**

  DHCP packets are copied to CPU by default irrespective of the set of enabled features. To protect the CPU against DHCP flooding CPU priority 17 can be used. Packets which are handled by CPU queue 17 are dropped by CPU, but are still forwarded. This way CPU is protected and the network is transparent to this kind of traffic.

  Applicable to AOS 7, AOS 8

  This configuration is applicable only in case DHCP Snooping and IP helper features are disabled.

```
-> show configuration snapshot qos
! QOS:
policy condition dhcp-67 destination udp-port 67
policy condition dhcp-68 destination udp-port 68
policy action q17 cpu priority 17
policy rule dhcp-67 precedence 65100 condition dhcp-67 action q17
policy rule dhcp-68 precedence 65110 condition dhcp-68 action q17
qos apply
```

4.5. Cisco proprietary MAC flooding

In AOS 6 versions, which supports mac-tunnelling for ethernet-services all frames with the destination MAC 01:00:0c:cd:cd:d0 are copied to CPU regardless of the configuration and not only on UNI and NNI ports. It can be used by an attacker to exhaust CPU resources.

- **ethernet-service mac-tunneling**

  Applicable to AOS 6

  The MAC 01:00:0c:cd:cd:d0 is the default tunnel MAC. All frames with this destination MAC address are handled in software by default. Therefore this MAC address can be used by an attacker to flood traffic to CPU. In case they need to be handled only in hardware, noMacTunnelFeature has to be set to 1 in AlcatelDebug.cfg or ethernet-service mac-tunneling in CLI:

```
-> ethernet-service mac-tunneling disable
```

  Both options require a reload. The debug variable was introduced in PR 179716.

4.6. MLD flooding

MLD packets are copied to CPU based on the global IPv6 IPMS status only in AOS version supporting MDC (regardless of MDS status). In this case when IPv6 IPMS is globally enabled, MLD packets are copied to CPU. When IPv6 IPMS is globally disabled, MLD packets are not copied to CPU. In all previous AOS version MLD packets are copied to CPU regardless of the IPv6 IPMS status. MLD flooding might be dangerous to system stability especially on AOS 6 platforms.

Faulty driver for Intel NICs can cause a storm of ICMPv6 Multicast Listener Report Packets. The issue is seen in the S1 sleep/standby state. The network can be flooded with more than 10000 pps from every machine.

- **ACL**

Create an ACL to drop all ICMPv6. This solution is applicable only to fully IPv4 networks.

> On AOS 6.4.X platforms MLD packets copied to CPU can be rate limited or dropped using user QoS rules (they are not rate limited by default).

> On AOS 6.6.X platforms MLD packets copied to CPU cannot be rate limited or dropped using user QoS rules (they are not rate limited by default), but they are copied to CPU only in case "ipv6 multicast status enable"

> On AOS 7 and AOS 8 IGMP packets copied to CPU are rate limited by default.

Applicable to AOS 6.4.X, AOS 7, AOS 8

```
-> show configuration snapshot qos
policy condition mld ipv6 icmptype 131
policy action drop disposition drop
policy rule drop-mld condition mld action drop
```

4.7. ARP flooding

ARP flooding can lead to routing issues, even if CPU utilization on the router stays below 100%.

- **Traffic Anomaly Detection (TAD)**

ARP flooding is one of many types of attacks, which can be detected and prevented by TAD.

Applicable to AOS 6 running on OS6855, OS6850E, OS9000E

Extract from "OmniSwitch AOS Release 6 Network Configuration Guide":

> Network Security (also known as Alcatel-Lucent Traffic Anomaly Detection feature) is a network monitoring feature that aims to detect the anomalies in the network by analyzing the patterns of ingress and egress packets on a port. These anomalies occur when the traffic patterns of a port do not meet the expectations. The detection of anomalies results in logging, SNMP trap generation, and shutting down of the anomalous port. This feature is mainly used in the Layer2 domain. (…)
>
> Network Security detects the following anomalies:

Anomaly	Description
ARP Address Scan	Occurs when a host sends a burst of ARP requests for multiple IP addresses.
ARP Flood	Occurs when a host receives a burst of ARP request packets.
ARP Failure	Occurs when ARP queries do not elicit ARP responses.
ICMP Address Scan	Occurs when multiple hosts receive ICMP echo request packets at the same time.
ICMP Flood	Occurs when a host receives a burst of ICMP echo request packets.
ICMP Unreachable	Occurs when a host receives a flood of ICMP Unreachable packets.
TCP Port Scan	Occurs when a host receives a burst of TCP SYN packets for multiple TCP ports.
TCP Address Scan	Occurs when multiple hosts receive TCP SYN packets at the same time.
SYN Flood	Occurs when a host receives a burst of TCP SYN packets on the same TCP port.
SYN Failure	Occurs when a host receives fewer SYNACKs than SYNs it sent out.
SYN-ACK Scan	Occurs when a host receives more SYNACKs than SYNs it sent out.
Fin Scan	Occurs when a host receives a burst of FIN packets.
Fin-Ack Diff	Occurs when a host sees more or fewer FINACK packets than it sent.
Rst Count	Occurs when a host receives a flood of RST packets.

Below an example of an attack and a solution.

Tools used by the attacker: “mz” from “mz” package for Ubuntu

The attacker starts an ARP Flood attack on an IP address in the network (please use a correct interface name):

```
attacker@ubuntu:~$ sudo mz eth1 -c 256 -t arp
➥ "reply, targetip=192.168.0.254, targetmac=00:00:00:00:00:01"
```

Traffic Anomaly Detection detects an ARP Flood attack for all IP addresses in the network:

```
-> netsec group untrusted port 1/1-24
-> netsec group untrusted anomaly arp-flood state enable
➥ log enable trap enable quarantine enable count 1000 period 5
```

```
->
+++ ++++++++++++++++++++++++++++++++++++++++++++++++++
+++ ARPFLOOD target detected on 1/2...
+++   Trigger Operation...
+++     Interval    Count     Sensitivity
+++   ------------------------------------------------
+++            5      200              50
+++   Traffic Statistics...
+++     Packet-Type    Direction   Count
+++   ------------------------------------------------
+++     ARP_REP         IN            351
+++     ARP_REP         OUT             0
+++     ARP_REQ         IN              0
+++ ++++++++++++++++++++++++++++++++++++++++++++++++++
```

Traffic Anomaly Detection status may be monitored using following command:

```
-> show netsec anomaly arp-flood summary
```

Example configuration:

```
-> show configuration snapshot netsec
! Netsec :
netsec group untrusted port 1/1-23
netsec group untrusted anomaly all state enable log enable
➥ trap enable quarantine enable count 200 period 5
```

- **QoS rules with mode split**

  Rate limiting with "mode split" allows rate limiting ARP messages per port. AOS devices are protected by default against copying too many ARP packets to CPU. This solution should be used on edge devices to protect network from routing issues and link saturation.

  Applicable to AOS 6.4.X and AOS 6.6.4.R01 or newer

  For AOS 6.6.X branch 6.6.4.292.R01 or newer is recommended.

  > On AOS 6.6.X platforms ARP packets are copied to CPU only in VLANs with IP interfaces configured. ARP packets copied to CPU cannot be rate limited using user QoS rules (they are rate limited by default).

  > On AOS 6.4.X platforms packets are copied to CPU in all VLANs irrespective of IP interface configuration. APR packets copied to CPU can be rate limited.

  The port group should not include ports facing routers:

```
-> show configuration snapshot qos
policy port group Users  mode split 1/1-23
policy condition arp source port group Users ethertype 0x0806
policy action limit-64 maximum bandwidth 64K
policy rule limit-arp condition arp action limit-64
qos apply
```

  Applicable only to AOS 6.4.X

  If this device is routing, then additional configuration is required to make sure that all ARP packet not dropped by the rule above are copied to CPU (this example is applicable to a standalone unit):

```
-> debug qos internal "slice 1/0 arppps 1048575"
-> more/flash/working/AlcatelDebug.cfg
debug qos internal "slice 1/0 arppps 1048575"
```

4.8. ARP attacks on end stations and MAC spoofing

ARP spoofing is used by an attacker to "poison" ARP tables of a user and a server. This way packets exchanged between the user and the server are transferred through attacker's PC. The attacker continuously sends ARP Replys towards the user and the server.

- **DHCP Snooping with IP Source Filter**

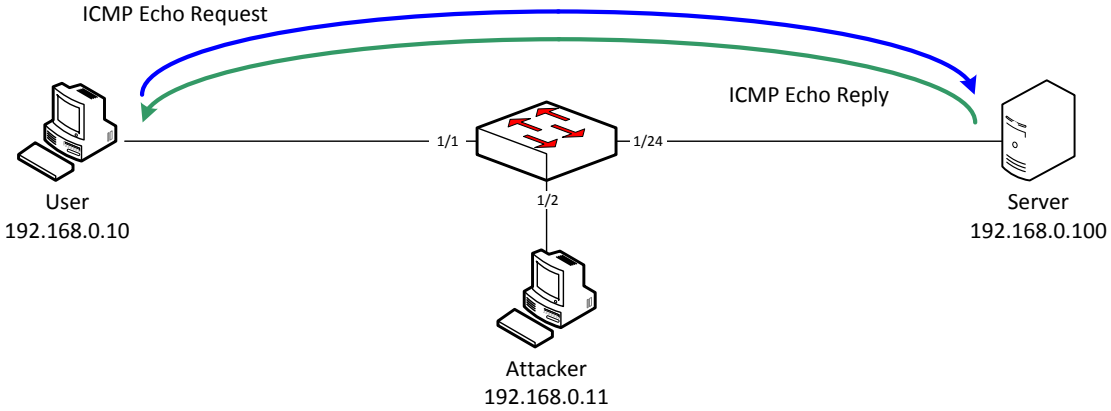
  Applicable to AOS 6, AOS 8

  Below an example of an attack and a solution.

  Tools used by the attacker:

  - "arpspoof" from the "dsniff" package for Ubuntu

  During normal network operation the attacker is not able to sniff packets exchanged between the user and the server. In this example there is "ping 192.168.0.100 -t" command executed on the user PC:



The ARP table of the user:

```
C:\>arp -a
Interface: 192.168.0.10 --- 0x4
  Internet Address      Physical Address      Type
  192.168.0.100         00-00-1c-b6-1f-13     dynamic
```

The ARP table of the server:

```
C:\>arp -a
Interface: 192.168.0.100 --- 0x10008
  Internet Address      Physical Address      Type
  192.168.0.10          00-50-da-19-78-91     dynamic
```

The attacker enables IP forwarding feature and starts injecting ARPs:

```
attacker@ubuntu:~$ sudo echo 1 > /proc/sys/net/ipv4/ip_forward
attacker@ubuntu:~$ sudo arpspoof -t 192.168.0.10 192.168.0.100
➥ & >/dev/null
attacker@ubuntu:~$ sudo arpspoof -t 192.168.0.100 192.168.0.10
➥ & >/dev/null
```

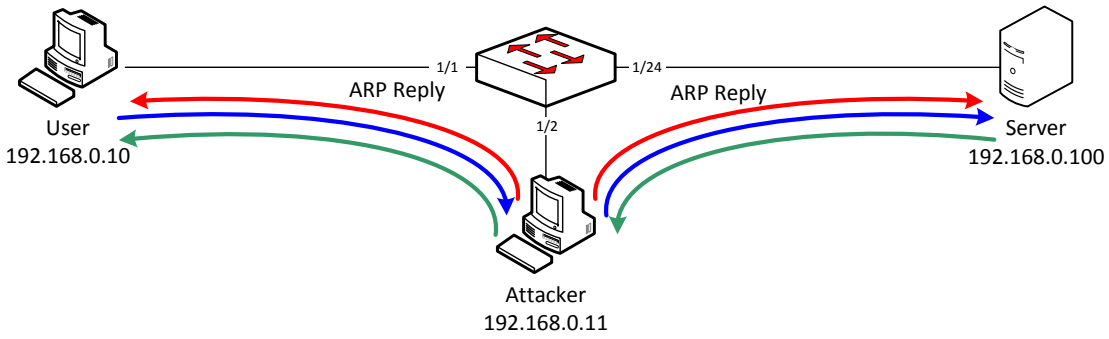
Spoofed ARP table of the user:

```
C:\>arp -a
Interface: 192.168.0.10 --- 0x4
  Internet Address      Physical Address      Type
  192.168.0.11          00-0c-29-29-b3-76     dynamic
  192.168.0.100         00-0c-29-29-b3-76     dynamic
```

Spoofed ARP table of the server:

```
C:\>arp -a
Interface: 192.168.0.100 --- 0x10008
  Internet Address      Physical Address      Type
  192.168.0.10          00-0c-29-29-b3-76     dynamic
  192.168.0.11          00-0c-29-29-b3-76     dynamic
```

The packet flow after the attack is illustrated below:



The attacker is now able to sniff all frames exchanged between the user and the server:

```
attacker@ubuntu:~$ sudo tcpdump -i eth0 -c 6 'src 192.168.0.10
➥ or dst 192.168.0.10'
tcpdump: verbose output suppressed, use -v or -vv for full protocol
➥ decode
listening on eth0, link-type EN10MB (Ethernet), capture size
➥ 96 bytes
02:07:25.784007 IP 192.168.0.10 > 192.168.0.100: ICMP echo request,
➥ id 1024, seq 3379, length 40
02:07:25.784021 IP 192.168.0.10 > 192.168.0.100: ICMP echo request,
➥ id 1024, seq 3379, length 40
02:07:25.784202 IP 192.168.0.100 > 192.168.0.10: ICMP echo reply,
➥ id 1024, seq 3379, length 40
02:07:25.784205 IP 192.168.0.100 > 192.168.0.10: ICMP echo
➥ reply, id 1024, seq 3379, length 40
02:07:26.239264 ARP, Reply 192.168.0.100 is-at 00:0c:29:29:b3:76
➥ (oui Unknown), length 28
02:07:26.239385 ARP, Reply 192.168.0.10 is-at 00:0c:29:29:b3:76
➥ (oui Unknown), length 28
…
```

Solution in non-DHCP environment

ARP spoofing attacks may be mitigated using ACLs. Example:

```
-> show configuration snapshot qos
! QOS :
policy network group ARP 192.168.0.10 192.168.0.11 192.168.0.100
policy condition ARP_192_168_0_10 source mac 00:50:DA:19:78:91
➥ ethertype 0x0806 source ip 192.168.0.10
policy condition ARP_192_168_0_100 source mac 00:00:1C:B6:1F:13
➥ ethertype 0x0806 source ip 192.168.0.100
policy condition ARP_192_168_0_11 source mac 00:0C:29:29:B3:76
➥ ethertype 0x0806 source ip 192.168.0.11
policy condition IncorrectARP ethertype 0x0806 source network
➥ group ARP
policy action Accept
policy action Drop disposition drop
policy rule ARP_192_168_0_10 precedence 200 condition
➥ ARP_192_168_0_10 action Accept
policy rule ARP_192_168_0_11 precedence 200 condition
➥ ARP_192_168_0_11 action Accept
policy rule ARP_192_168_0_100 precedence 200 condition
➥ ARP_192_168_0_100 action Accept
policy rule DropIncorrectARP precedence 100 condition IncorrectARP
➥ action Drop
qos apply
```

These ACLs allow correct ARPs and drop incorrect ARPs for protected IP addresses. For more details see TKC article 000006888.

Solution in DHCP environment

ARP spoofing attacks may be avoided using DHCP Snooping with ip-source-filter. Example:

```
-> show configuration snapshot ip-helper
! UDP Relay :
ip helper forward delay 0
ip helper dhcp-snooping enable
ip helper dhcp-snooping binding enable
ip helper dhcp-snooping ip-source-filter port 1/1 enable
ip helper dhcp-snooping ip-source-filter port 1/2 enable
ip helper dhcp-snooping port 1/24 trust
```

AOS 8:

```
-> show configuration snapshot dhcp-snooping
! DHCP Snooping:
dhcp-snooping admin-state enable
dhcp-snooping binding admin-state enable
dhcp-snooping ip-source-filter port 1/1/1 admin-state enable
dhcp-snooping ip-source-filter port 1/1/2 admin-state enable
dhcp-snooping port 1/1/24 trust
```

After enabling DHCP Snooping with ip-source-filter a binding table is created on the switch.

AOS 6:

```
-> show ip helper dhcp-snooping binding

Total Number of Binding Entries: 2

       MAC            Slot         IP              Lease         VLAN      Binding
     Address          Port       Address            Time          ID        Type
-------------------+------+----------------+---------------+-------+---------
00:0c:29:29:b3:76     1/2    192.168.0.11       360             1       Dynamic
00:50:da:19:78:91     1/1    192.168.0.10       305             1       Dynamic
```

AOS 8 (similar output is expected):

```
-> show dhcp-snooping binding
```

Only packets with registered source IP and MAC addresses are allowed to be received on a particular port. For more details see TKC article 000006888.

DHCP Snooping with ip-source-filter is an equivalent of two Cisco features enabled at the same time: Dynamic ARP Inspection (DAI) with IP Source Filter. For differences see TKC article 000006888.

DHCP Snooping with ip-source-filter can be also used to avoid CAM overflow attacks.

4.9. Broadcast and unknown unicast flooding

- **Flood rate control**

Flood rate control can be used to limit Broadcast, Unknown unicast and Multicast (BUM) traffic. Rate limiting is based on 512 byte packet size, therefore it might be not accurate for very small or very big packets. Flood rate control is applied only on ingress traffic

Applicable to AOS 6

Flood rate limit, action and status has to be specified separately for broadcast, unknown unicast and multicast.

Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

> **interfaces flood**
>
> Enables broadcast, multicast or unknown unicast traffic storm control on the specified interface.
>
> **interfaces {***slot* | *slot/port***[-***port2***]} flood [broadcast | multicast | unknown-unicast | all] [enable | disable]**
>
> **Syntax Definitions**
>
> | | |
> |---|---|
> | *slot* | The slot number for a specific module. |

slot/port[**-***port2*]	The slot and port number (3/1). Use a hyphen to specify a range of ports (3/1-3/10).
broadcast	Packets with a destination MAC address of FF:FF:FF:FF:FF:FF.
multicast	Packets with a multicast MAC address.
unknown-unicast	Unicast packets with an unknown destination MAC address.
all	Applies to broadcast, multicast, and unknown unicast packets.
enable	Enables broadcast, multicast, or unknown unicast rate limiting.
disable	Disables broadcast, multicast, or unknown unicast rate limiting.

Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

interfaces flood rate

Configures flood rate limiting for broadcast, multicast, or unknown unicast traffic on the specified interface.

interfaces {*slot* | *slot/port*[**-***port2*]**} flood {broadcast | multicast | unknown-unicast | all} rate {mbps** *mbps* **| pps** *pps* **| percentage** *percent* | **default} [low-threshold** *num*]

Syntax Definitions

slot	The slot number for a specific module.
slot/port[**-***port2*]	The slot and port number (3/1). Use a hyphen to specify a range of ports (3/1-3/10).
mbps	The number of megabits per second.
pps	The number of packets per second.
percent	The percentage of the port speed.
default	Default speed of the port.
num	The low threshold value. The low threshold value must be lesser than the high threshold (rate limiting) value.

Defaults

- The default flood limit settings:
- The default value for low threshold is '0'. This means, by default, auto recovery is not enabled.

Usage Guidelines

- By default, unknown unicast and multicast traffic is flooded to all Layer 2 ports in a VLAN.
- Enter a slot number to configure flood rate limiting for all interfaces on a specific slot.
- Enter a slot and port number or a range of port numbers to configure flood rate limiting on a specific interface or range of interfaces.
- The keyword **all** applies to all traffic types, broadcast, multicast and unknown-unicast.

- The CLI command '**interfaces** *slot***[/***port***[-***port2***]] flood rate** *num***'** is supported only during boot up process for backward compatibility.
- The high (rate limit value) and low threshold (if) configured will have same threshold type [Mbps or PPS or percentage].
- Low threshold cannot be configured for unknown unicast traffic.
- The violated port is displayed as "Storm" violation in the "show interface port" command.
- The violated port can be recovered by any of the following ways when low threshold is not configured on the port: - Use 'interface slot/port admin down', then 'interface slot/port admin up' command on the port. - Unplug and replug the cable. - Use 'interface slot/port clear-violation-all' command to clear all the violation on the port.
- The global interface violation recovery timer is not applicable for storm threshold violation.

Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

interfaces flood action

Configures the storm control action when the port reaches the storm violated state.

interfaces {*slot* | *slot/port***[-***port2***]} flood [broadcast | multicast] action [shutdown | trap | default]**

Syntax Definitions

slot	The slot number for a specific module.
*slot/port***[-***port2***]**	The slot and port number (3/1). Use a hyphen to specify a range of ports (3/1-3/10).
broadcast	Packets with a destination MAC address of FF:FF:FF:FF:FF:FF.
multicast	Packets with a multicast MAC address.
shutdown	When the ingress storm traffic exceeds high threshold value, the port moves to violated state (Storm Violation) and a violation trap is generated. The port state moves to operationally down and admin enable**.** When the ingress traffic reaches the low threshold or goes below the low threshold, the port state moves to normal state, and a trap is generated.
trap	When the ingress storm traffic exceeds high threshold value, the port controls the storm by rate limiting the traffic, and a violation trap is generated. The port remains in the normal state. When the ingress traffic reaches the low threshold, a trap is generated.
default	When the ingress storm traffic exceeds high threshold value, the port controls the storm by rate limiting the traffic. No trap is generated, and the port remains in the normal state.

Example configuration:

```
-> show configuration snapshot interface
! Interface :
interfaces 1/1 flood broadcast rate pps 244
interfaces 1/1 flood unknown-unicast rate pps 244
interfaces 1/1 flood multicast rate pps 244
interfaces 1/1 flood broadcast action shutdown
interfaces 1/1 flood unknown-unicast action shutdown
interfaces 1/1 flood multicast action shutdown
```

Applicable to AOS 7, AOS 8

Extract from "OmniSwitch AOS Release 8 CLI Reference Guide":

interfaces flood-limit

Configures the flood rate settings on a single port, a range of ports, or an entire Network Interface (NI).

interfaces {slot [*chassis_id/***]***slot*| **port [***chassis_id/***]***slot/port***[-***port2***]} flood-limit {bcast|mcast|uucast|all} rate { pps** *pps_num*| **mbps** *mbps_num* | **cap%** *cap_num* | **enable** | **disable}**

Syntax Definitions

chassis_id	The chassis identifier when running in virtual chassis mode.
slot	Slot number you want to configure.
port	Port number of the interface you want to configure.
port2	Last port number in a range of ports you want to configure.
bcast	Specifies broadcast flood limit.
mcast	Specifies multicast flood limit.
uucast	Specifies unicast flood limit.
all	Specifies flood limit for all types of traffic.
pps_num	Packets per second.
mbps_num	Megabits per second.
cap_num	Percentage of port's capacity.
enable	Enables flood rate limits.
disable	Disables flood rate limits.

Defaults

parameter	default
admin-status	enable

Example configuration:

```
-> show configuration snapshot interface
! Interface:
interfaces port 1/1/1 flood-limit bcast rate pps 244
interfaces port 1/1/1 flood-limit uucast rate pps 244
interfaces port 1/1/1 flood-limit uucast rate pps 244
```

4.10. ICMP attack on router interfaces

ICMP Request packets are copied to CPU. This attack can be used by an attacker to exhaust CPU resources.

- **QoS rules**

This attack can be prevented by using a QoS rule to rate limit ICMP packet with IP destination address matching local IP addresses. This attack is not applicable to AOS 7 and 8 due to different CPU queue handling.

Applicable to AOS 6.4.X

```
-> show configuration snapshot qos
! QOS :
policy condition icmp destination network group Switch ip protocol 1
policy action limit128 maximum bandwidth 128K
policy rule limit-icmp condition icmp action limit128
qos apply
```

4.11. ARP attacks on router interfaces

ARP spoofing against router interfaces is used by an attacker to “poison” ARP tables of a user and a router. Then routed packets can be transferred through attacker’s PC.

- **IP Anti-Spoofing**

Applicable to AOS 6

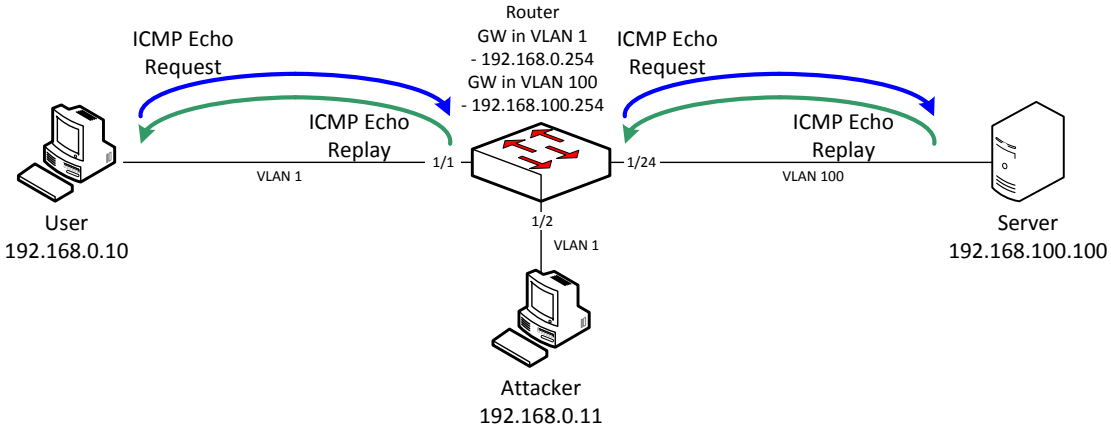
Below an example of an attack and a solution.

> By default ARP Spoofing protection is enabled on AOS switches. In this example it will be disabled only for demonstration purposes. It is not recommended to disable ARP Spoofing protection in a production environment.

Tools used by the attacker:

- “arpspoof” from the “dsniff” package for Ubuntu

During normal network operation the attacker is not able to sniff packets exchanged between the user and the server. In this example there is the “ping 192.168.100.100 -t” command executed on the user PC:



To disable ARP Spoofing protection on an AOS switch use the “ip dos anti-spoofing disabled” command and update “ipni_arp_poison_lrn” variable in dshell:

```
-> ip dos anti-spoofing disable
-> dshell
Working: [Kernel]->ipni_arp_poison_lrn=1
ipni_arp_poison_lrn = 0xc8aabbc: value = 1 = 0x1
Working: [Kernel]->exit
```

Also an additional VLAN and two IP interfaces are configured on the router:

```
-> show configuration snapshot ip vlan
! VLAN :
vlan 1 enable name "VLAN 1"
vlan 100 enable name "VLAN 100"
vlan 100 port default 1/24
! VLAN SL:
! IP :
ip service all
ip dos anti-spoofing disable
ip interface "vlan100" address 192.168.100.254 mask 255.255.255.0
➥ vlan 100 ifindex 1
ip interface "vlan1" address 192.168.0.254 mask 255.255.255.0 vlan 1
➥ ifindex 2
! VLAN AGG:
! VLAN STACKING:
```

The attacker enables IP forwarding feature and starts injecting ARPs:

```
attacker@ubuntu:~$ sudo echo 1 > /proc/sys/net/ipv4/ip_forward
attacker@ubuntu:~$ sudo arpspoof -t 192.168.0.10 192.168.0.254
➥ & >/dev/null
attacker@ubuntu:~$ sudo arpspoof -t 192.168.0.254 192.168.0.10
➥ & >/dev/null
```

The ARP table of the user is updated with a new entry:

```
C:\>arp -a
Interface: 192.168.0.10 --- 0x4
  Internet Address      Physical Address      Type
  192.168.0.11          00-0c-29-29-b3-76     dynamic
  192.168.0.254         00-0c-29-29-b3-76     dynamic
```

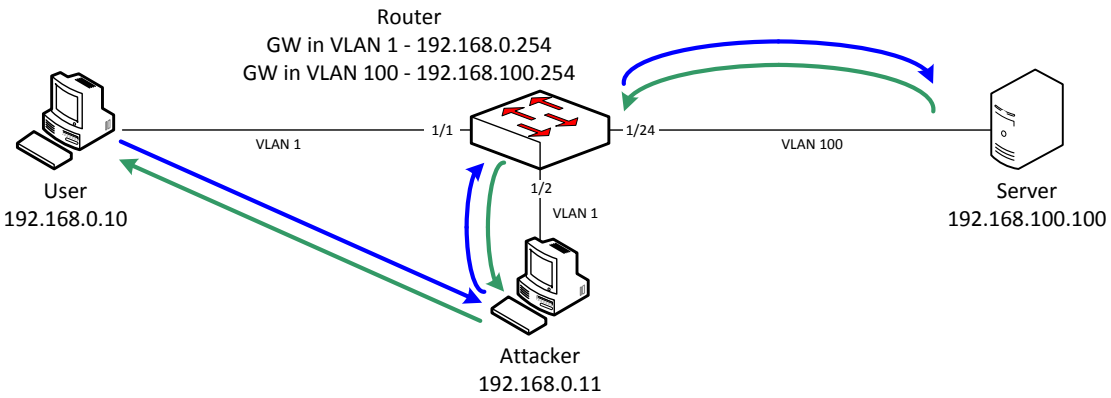
The ARP table of the router is updated with a new entry:

```
-> show arp

Total 3 arp entries
 Flags (P=Proxy, A=Authentication, V=VRRP)

 IP Addr           Hardware Addr       Type       Flags   Port     Interface   Name
-------------------+-------------------+----------+-------+--------+-----------+-------
 192.168.0.10      00:0c:29:29:b3:76   DYNAMIC                1/2  vlan 1
 192.168.0.11      00:0c:29:29:b3:76   DYNAMIC                1/2  vlan 1
 192.168.100.100   00:00:1c:b6:1f:13   DYNAMIC               1/24  vlan 100
```

The attacker is now able to sniff all frames exchanged between the user and the server:

```
attacker@ubuntu:~$ sudo tcpdump -i eth0 -c 4 'src 192.168.0.10 or dst
➥ 192.168.0.10'
tcpdump: verbose output suppressed, use -v or -vv for full protocol
➥ decode
listening on eth0, link-type EN10MB (Ethernet), capture size 96 bytes
01:09:22.290831 IP 192.168.0.10 > 192.168.100.100: ICMP echo request,
➥ id 1024, seq 45664, length 40
01:09:22.290851 IP 192.168.0.10 > 192.168.100.100: ICMP echo request,
➥ id 1024, seq 45664, length 40
01:09:22.291031 IP 192.168.100.100 > 192.168.0.10: ICMP echo reply,
➥ id 1024, seq 45664, length 40
01:09:22.291037 IP 192.168.100.100 > 192.168.0.10: ICMP echo reply,
➥ id 1024, seq 45664, length 40
…
```

The packet flow after the attack is illustrated below:



To enable the ARP Spoofing protection on the router use the “ip dos anti-spoofing disabled” command and update “ipni_arp_poison_lrn” variable in dshell:

```
-> ip dos anti-spoofing enable
-> dshell
Working: [Kernel]->ipni_arp_poison_lrn=0
ipni_arp_poison_lrn = 0xc8aabbc: value = 0 = 0x0
Working: [Kernel]->exit
```

From now on the router drops all incorrect ARP messages with its own IP addresses and it doesn’t learn IP addresses in its ARP table from unexpected ARP Replies.

Detailed statistics are available only if the “ip dos anti-spoofing” feature is explicitly enabled:

```
-> show ip dos anti-spoofing

Global Status:
IP Spoof Status - ENABLED
ARP Spoof Status - DISABLED

* - VRRP IP Address

                                                  Last Attempted Source
 IP Address       Anti-Spoofing     Attacks    VLAN      MAC               PORT
---------------+----------------+-----------+-----+--------------------+---------
127.0.0.1            IN              0          0    00:00:00:00:00:00     0/0
192.168.0.254        IP              79         1    00:0c:29:29:b3:76     1/2
192.168.100.254      IP              0          0    00:00:00:00:00:00     0/0

IP - Anti-spoofing for IP Pkts
ARP - Anti-spoofing for ONLY ARP Pkts
IN - Inactive
```

The attacker is not able to sniff packets exchanged between the user and the server if “ip dos anti-spoofing” feature is enabled.

4.12. CAM overflow attack

Conditional Access Memory (CAM) stores the MAC address table. CAM overflow is used by an attacker to turn a switch into a hub. The attacker sends frames with random source MAC addresses. These addresses are learned in MAC address table, which has limited capacity. When the MAC address table is full, then the switch starts flooding instead of switching – it becomes a hub.

- **Learned Port Security**

  Learned Port Security (LPS) provides a mechanism for authorizing source learning of MAC addresses on Ethernet ports.

  LPS does not support link aggregate and tagged (trunked) link aggregate ports. Using LPS to control source MAC address learning provides the following benefits:

  - A configurable source learning time limit that applies to all LPS ports.
  - A configurable limit on the number of MAC addresses allowed on an LPS port.
  - Dynamic configuration of a list of authorized source MAC addresses.
  - Static configuration of a list of authorized source MAC addresses.
  - Two methods for handling unauthorized traffic: stopping all traffic on the port or only blocking traffic that violates LPS criteria.

By default, LPS is disabled on all switch ports. To enable LPS on a port, use the port-security command. For example, the following command enables LPS on port 1 of slot 4:

```
port-security 1/1 admin-status enable
```

To enable LPS on multiple ports, specify a range of ports or multiple slots. For example:

```
port-security 1/1-5 admin-status enable
port-security 1/1-5 1/10-15 admin-status enable
```

When LPS is enabled on an active port, all MAC addresses learned on that port prior to the time LPS was enabled are cleared from the source learning MAC address table.

To disable LPS on a port, use the port-security command with the disable parameter. For example, the following command disables LPS on a range of ports:

```
port-security 1/1-5 1/10-15 admin-status disable
```

To convert all learned bridge MAC address on LPS port into static MAC address, use the port-security chassis command with the convert-to-static parameter. For example:

```
port-security chassis convert-to-static
```

To disable all the LPS ports on a chassis, use the port-security chassis disable command, as shown:

```
port-security chassis disable
```

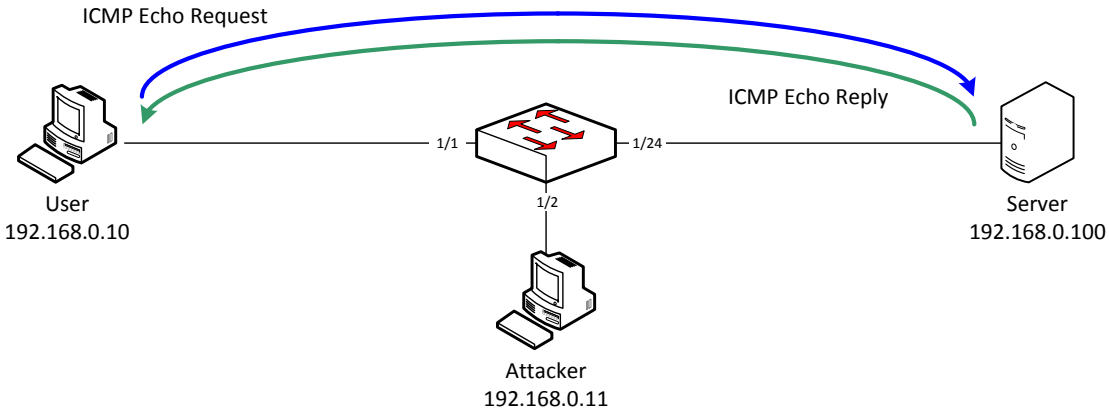
When LPS is disabled on a port, MAC address entries for that port are retained in the LPS table. The next time LPS is enabled on the port, the same LPS table entries are again active. If there is a switch reboot before the switch configuration is saved, however, dynamic MAC address entries are discarded from the table.

Applicable to AOS 6, AOS 7, AOS 8

Below an example of an attack and a solution.

Tools used by the attacker: “macof” from the “dsniff” package for Ubuntu

During normal network operation the attacker is not able to sniff packets exchanged between the user and the server, because the switch forwards frames only to ports, which were associated with MAC addresses during learning process. In this example there is “ping 192.168.0.100 -t” command executed on the user PC:



The MAC address table content before the attack

AOS 6:

```
-> show mac-address-table count
Mac Address Table Count:
  Permanent Address Count             = 0,
  DeleteOnReset Address Count         = 0,
  DeleteOnTimeout Address Count       = 0,
  Dynamic Learned Address Count       = 2,
  Static Multicast Address Count      = 0,
  Total MAC Address In Use            = 2
```

AOS 7&8:

```
-> show mac-learning summary
Mac Address Table Summary:

   Domain       Static     Static-Multicast       Bmac         Dynamic
-----------+------------+-------------------+------------+-------------
    VLAN               0                   0          0               2
    VPLS               0                   0          0               0
     SPB               0                   0          0               0
     EVB               0                   0          0               0

 Total MAC Address In Use  = 2
```

To demonstrate the attack, the continuous ping from the user PC to the server should be stopped and the MAC address table needs to be flushed.

AOS 6:

```
-> no mac-address-table learned
```

AOS 7&8:

```
-> mac-learning flush dynamic
```

The attacker starts injecting frames with random source MAC addresses:

```
attacker@ubuntu:~$ sudo macof -i eth0
b6:79:f1:7a:df:3f 1a:3d:bc:11:b1:c9 0.0.0.0.19183 >
➥ 0.0.0.0.25870: S 445219310:445219310(0) win 512
2f:f3:d3:50:71:e2 43:1b:fe:2d:ba:5d 0.0.0.0.19317 >
➥ 0.0.0.0.19903: S 1050665926:1050665926(0) win 512
d2:fe:5e:14:b2:da 2:cd:de:53:cf:27 0.0.0.0.6583 >
➥ 0.0.0.0.50881: S 475908301:475908301(0) win 512
…
```

The MAC address table becomes full after a few seconds.

AOS 6:

```
-> show mac-address-table count
Mac Address Table Count:
  Permanent Address Count             = 0,
  DeleteOnReset Address Count         = 0,
  DeleteOnTimeout Address Count       = 0,
  Dynamic Learned Address Count       = 16382,
  Static Multicast Address Count      = 0,
  Total MAC Address In Use            = 16382
```

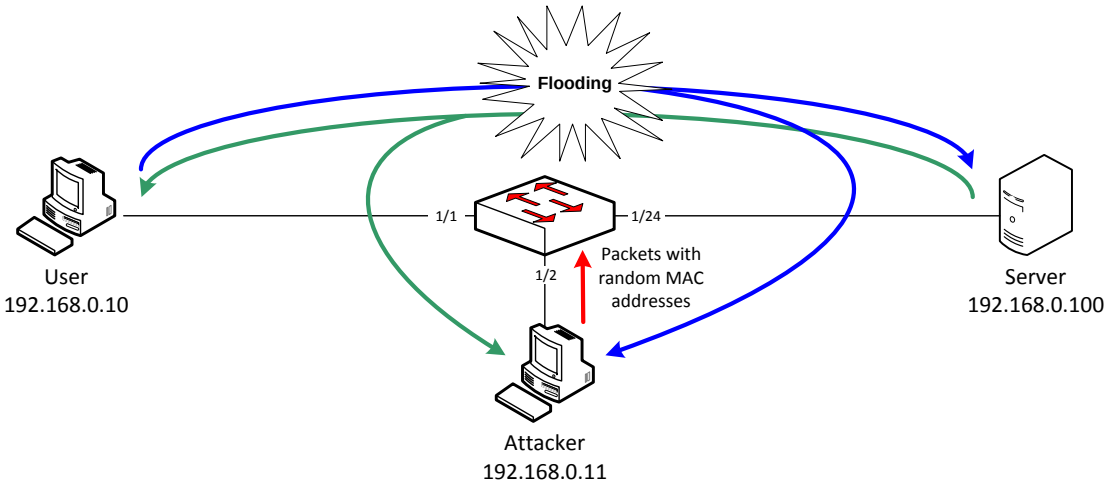
AOS 7&8:

```
-> show mac-learning summary
Mac Address Table Summary:

   Domain       Static     Static-Multicast       Bmac        Dynamic
------------+------------+------------------+------------+------------
    VLAN              0                   0            0          16382
    VPLS              0                   0            0              0
     SPB              0                   0            0              0
     EVB              0                   0            0              0

 Total MAC Address In Use  = 16382
```

The switch starts flooding and the attacker may capture packets exchanged between the user and the server:

```
attacker@ubuntu:~$ sudo tcpdump -i eth0 -c 2 'src 192.168.0.10
➥ or dst 192.168.0.10'
tcpdump: verbose output suppressed, use -v or -vv for full protocol
➥ decode
listening on eth0, link-type EN10MB (Ethernet), capture size 96 bytes
05:45:01.716963 IP 192.168.0.10 > 192.168.0.100: ICMP echo request,
➥ id 1024, seq 38945, length 40
05:45:01.717143 IP 192.168.0.100 > 192.168.0.10: ICMP echo reply,
➥ id 1024, seq 38945, length 40
2 packets captured
…
```

The packet flow after the attack is illustrated below:



CAM overflows attacks can be mitigated using the Learned Port Security feature (LPS). This feature limits the maximum number of MAC addresses which can be learned on a port, or shuts a port down if this limit is reached.

To enable LPS on a port, use the port-security command. For example, the following command enables LPS on port 24 of slot.

AOS 6:

```
port-security 1/1-2 maximum 1
port-security 1/1-2 admin-state enable
```

AOS 7&8:

```
port-security port 1/1-2 maximum 1
port-security port 1/1-2 admin-state enable
```

Shutdown or restrict actions may be used if the maximum number of MAC addresses is reached:

```
-> port-security 1/1-2 violation ?
                                    ^
                                    SHUTDOWN RESTRICT
 (Source Learning Command Set
```

A network administrator can be notified by a trap if a specified number of MAC addresses are learned on one port.

AOS 6:

```
port-security 1/1-2 learn-trap-threshold 5
```

AOS 7&8:

```
port-security port 1/1-2 learn-trap-threshold 5
```

After enabling LPS the attacker is not able to overflow the MAC address table with random addresses.

AOS 6:

```
-> show mac-address-table count
Mac Address Table Count:
  Permanent Address Count             = 0,
  DeleteOnReset Address Count         = 0,
  DeleteOnTimeout Address Count       = 0,
  Dynamic Learned Address Count       = 7,
  Static Multicast Address Count      = 0,
  Total MAC Address In Use            = 7
```

AOS 7&8:

```
-> show mac-learning summary
Mac Address Table Summary:

   Domain       Static     Static-Multicast       Bmac         Dynamic
------------+------------+------------------+------------+------------
    VLAN              0                   0            0             7
    VPLS              0                   0            0             0
     SPB              0                   0            0             0
     EVB              0                   0            0             0

 Total MAC Address In Use  = 7
```

LPS status can be verified per port using the “show port-security” command.

AOS 6:

```
-> show port-security 1/2

Port:  1/2
 Operation Mode    :             RESTRICTED,
 Max MAC bridged   :                      2,
 Trap Threshold    :                      5,
 Max MAC filtered  :                      5,
 Low MAC Range     :      00:00:00:00:00:00,
 High MAC Range    :      ff:ff:ff:ff:ff:ff,
 Violation         :               RESTRICT

 MAC Address        VLAN   TYPE
-------------------+------+--------
 42:ee:7a:39:ec:ac     1   FILTER
 66:43:28:2c:38:aa     1   FILTER
 78:81:97:2c:e3:42     1   BRIDGE
 cc:03:d2:1f:22:c9     1   FILTER
 d0:f6:09:52:66:b1     1   FILTER
 e0:68:d3:1e:f4:ae     1   FILTER
```

4.13. DHCP rogue server attack

The DHCP rogue server attack is used by an attacker to configure a false DNS server and a false gateway. The attacker may use his own IP address as the gateway in DHCP Offers to be able to sniff traffic.

- **DHCP Snooping**

  Applicable to AOS 6, AOS 8

  Below an example of an attack and a solution.

  Tools used by the attacker:

  - "macchanger" from the "macchanger" package for Ubuntu
  - "dhcp3-server" from the "dhcp3-server" package for Ubuntu

  A DHCP rogue server attack may be preceded by a DHCP starvation attack, which exhausts DHCP pool, an example for the "eth0" port:

```
attacker@attacker-desktop:~$ sudo -i
root@ubuntu:~# while true; do ifconfig eth0 down;
➥ macchanger -a eth0 2>&1 | grep Faked; ifconfig eth0 up;
➥ dhclient eth0 2>&1 | grep ACK; done
Faked MAC:   00:0f:f2:3b:79:1d (Loud Technologies Inc.)
DHCPACK of 192.168.0.150 from 192.168.0.100
…
```

  This script may be stopped when all addresses from DHCP pool are reserved. An example configuration of the rogue DHCP server:

```
root@ubuntu:~# ifconfig eth0 192.168.0.11
root@ubuntu:~# cp /etc/default/dhcp3-server
➥ /etc/default/dhcp3-server.bak
root@ubuntu:~# cp /etc/dhcp3/dhcpd.conf /etc/dhcp3/dhcpd.conf.bak
root@ubuntu:~# echo '' > /etc/default/dhcp3-server
root@ubuntu:~# echo 'INTERFACES="eth0";' > /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'subnet 192.168.0.0 netmask 255.255.255.0 {' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'range 192.168.0.200 192.168.0.210;' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'option domain-name-servers 192.168.0.11;' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'option domain-name "attacker";' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'option routers 192.168.0.11;' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'option broadcast-address 192.168.0.255;' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'default-lease-time 600;' >>
➥ /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo 'max-lease-time 7200;' >> /etc/dhcp3/dhcpd.conf
root@ubuntu:~# echo '}' >> /etc/dhcp3/dhcpd.conf
```

  Commands above create an empty "/etc/default/dhcp3-server" file and a "/etc/dhcp3/dhcpd.conf" file:

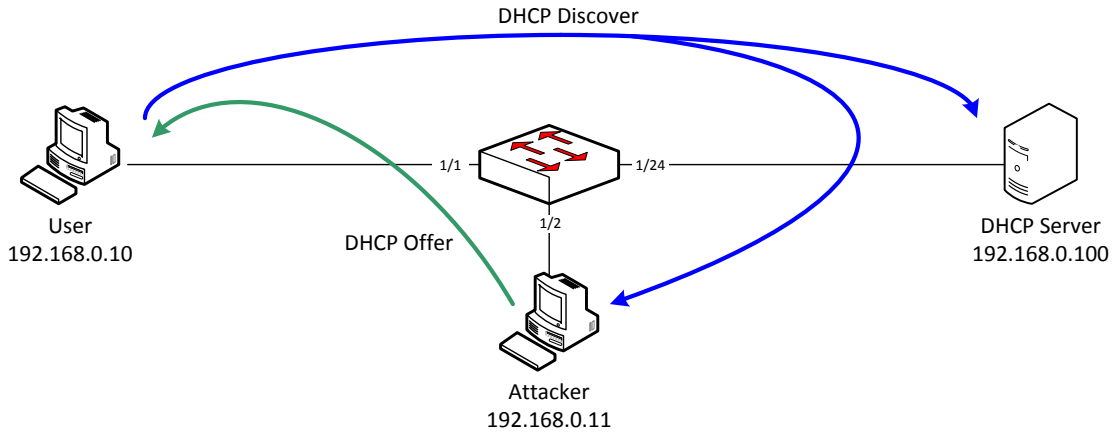
```
root@ubuntu:~# cat /etc/default/dhcp3-server

root@ubuntu:~# cat /etc/dhcp3/dhcpd.conf
INTERFACES="eth0";
subnet 192.168.0.0 netmask 255.255.255.0 {
range 192.168.0.200 192.168.0.210;
option domain-name-servers 192.168.0.11;
option domain-name "attacker";
option routers 192.168.0.11;
option broadcast-address 192.168.0.255;
```

```
default-lease-time 600;
max-lease-time 7200;
}
```

The attacker starts the rogue DHCP server:

```
root@ubuntu:~# /etc/init.d/dhcp3-server restart
 * Stopping DHCP server dhcpd3 [ OK ]
 * Starting DHCP server dhcpd3 [ OK ]
```

A user in the network from now on will receive now a response only from the rogue DHCP server with a fake default gateway and a fake DNS server addresses:



The attacker is now able to sniff all user connections to the Internet and redirect user to his servers using fake DNS:

```
C:\>ipconfig /renew User
Windows IP Configuration
…
Ethernet adapter User:

        Connection-specific DNS Suffix  . : attacker
        IP Address. . . . . . . . . . . . : 192.168.0.200
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        Default Gateway . . . . . . . . . : 192.168.0.11
…
```

DHCP rogue server attacks may be avoided using DHCP Snooping.

AOS 6:

```
-> show configuration snapshot ip-helper
! UDP Relay :
ip helper forward delay 0
ip helper dhcp-snooping enable
ip helper dhcp-snooping binding enable
ip helper dhcp-snooping port 1/24 trust
```

AOS 8:

```
-> show configuration snapshot dhcp-snooping
! DHCP Snooping:
dhcp-snooping admin-state enable
dhcp-snooping binding admin-state enable
dhcp-snooping port 1/1/24 trust
```

After applying this configuration the attacker is not able to inject non-user DHCP messages into the network (only DHCP Discover and DHCP Offer are allowed). DHCP Reply and ACK messages are accepted only on trusted ports where DCHP servers are connected.

4.14. STP claiming root role attack

QoS User Port can be used to protect network infrastructure against L2 and L3 attacks (not only against STP attacks as in the example below). The principle is to block traffic or shutdown a port where the feature is enabled on reception of predefined type of traffic.

- **QoS User Port**

  Applicable to AOS 6, AOS 7, AOS 8

  Extract from "OmniSwitch AOS Release 6 CLI Reference Guide" (selected options are not available on AOS 7&8 platforms):

> **qos user-port**
>
> Configures the option to filter packets or administratively disable a port when the specified type of traffic is received on a port that is a member of the pre-defined UserPorts group.
>
> **qos user-port {filter | shutdown} {spoof | bgp | bpdu | rip | ospf | vrrp | dvmrp | pim | isis | dhcp-server | dns-reply}**
>
> **qos no user-port {filter | shutdown}**
>
> **Syntax Definitions**
>
> | | |
> |---|---|
> | **filter** | Filters the specified type of traffic when it is received on UserPort ports. |
> | **shutdown** | Administratively disables UserPort ports that receive the specified type of traffic. |
> | **spoof** | Detects IP spoofing. The source IP address of a packet ingressing on a user port is compared to the subnet of the VLAN for the user port; the packet is dropped if these two items do not match. Also applies to ARP packets. |
> | **bgp** | Filters only BGP protocol packets from a TCP session that was not originated by the same switch that has this filter configured. |
> | **bpdu** | Filters conventional Spanning Tree BPDU (destination MAC address 0x0180c2:000000) packets and GVRP (destination MAC address 0x0180c2:000021) packets. |
> | **rip** | Filters RIP protocol packets. |
> | **ospf** | Filters OSPF protocol packets. |
> | **vrrp** | Filters VRRP protocol packets. |
> | **dvmrp** | Filters IGMP packets with a type of 0x13. This applies only to IP packets with no options. |

pim	Filters PIMv1, PIM-DM, and PIM-SM packets. The PIMv1 filter applies only to IP packets with no options.
isis	Filters IS-IS protocol packets.
dhcp-server	Filters response packets originating from a DHCP or BOOTP server that is configured on the known UDP port 67.
dns-reply	Filters all packets (both TCP and UDP) that originate from the known DNS port 53.

Defaults

Platforms Supported

OmniSwitch 6400, 6850E, 6855, 9000E

Usage Guidelines

- Use the **no** form of this command to disable the filter or shutdown function. This form of the command effects the overall operation of the feature.
- To specify more than one traffic type in the same command line, enter each type separated by a space (e.g., **spoof bgp ospf**).
- Note that existing traffic types to filter or shutdown are removed each time the **filter** or **shutdown** option is configured. Specify all desired traffic types each time the **qos user-port** command is performed to retain previously configured traffic types.
- No changes to the **filtering** and **shutdown** options are applied to the switch until the **qos apply** command is performed.
- This command only applies to ports that are members of the UserPorts group. Use the **policy port group** command to create and assign members to the UserPorts group.
- An SNMP trap is sent when a port is administratively disabled through a UserPorts shutdown function or a port disable action.
- To enable a port disabled by a user port shutdown operation, use the **interfaces admin** command to administratively enable the port or disconnect and reconnect the port cable.
- Up to 126 IP interfaces are supported with spoof detection on user ports. If the number of interfaces exceeds this amount, user port packets ingressing on those interfaces that exceed the 126 limit are dropped.

Examples

```
-> qos user-port filter spoof bpdu
-> qos user-port shutdown spoof bgp ospf
-> qos no user-port shutdown
```

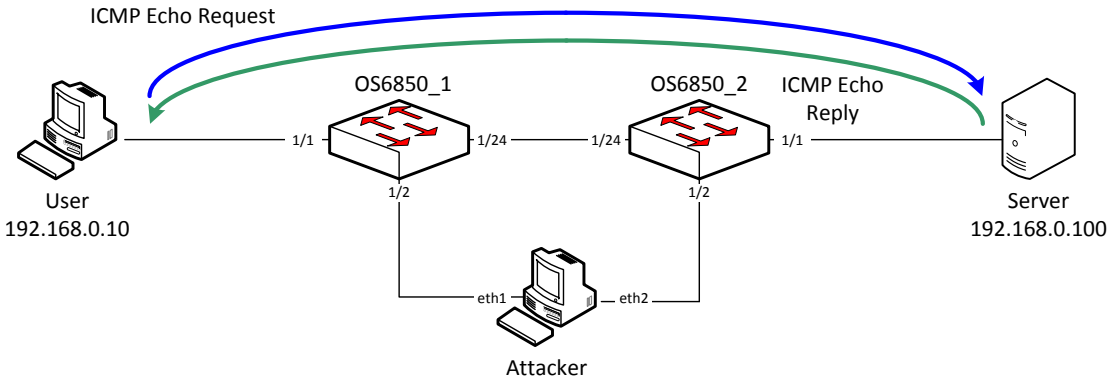
Below an example of an attack, which can be prevented using QoS User Port.

STP attacks are used by an attacker to destabilize STP operation in the network. In this example the attacker is connected to two switches simultaneously. The attacker PC takes a role of the root bridge.

Tools used by the attacker:

- “mz” from the “mz” package for Ubuntu
- “brctl” from “uml-utilities” and “bridge-utils” packages for Ubuntu

During normal network operation the attacker is not able to sniff packets exchanged between the user and the server. In this example there is the “ping 192.168.0.100 -t” command executed on the user PC:



STP configuration on the OS6850_1 switch before the attack:

```
OS6850_1-> show spantree 1
Spanning Tree Parameters
  Spanning Tree Status :                    ON,
  Protocol             :        IEEE Rapid STP,
  mode                 :     FLAT (Single STP),
  Auto-Vlan-Containment:             Enabled   ,
  Priority             :         32768 (0x8000),
  Bridge ID            :    8000-00:e0:b1:a4:23:4a,
  Designated Root      :    8000-00:d0:95:f2:47:dc,
  Cost to Root Bridge  :                      4,
  Root Port            :    Slot 1 Interface 24,
  Next Best Root Cost  :                      0,
  Next Best Root Port  :                   None,
…
OS6850_1-> show vlan port
 vlan   port     type       status
------+-------+---------+-------------
    1    1/1    default    forwarding
    1    1/2    default    forwarding
…
    1    1/24   default    forwarding
```

STP configuration on the OS6850_2 switch before the attack:

```
OS6850_2-> show spantree 1
Spanning Tree Parameters
  Spanning Tree Status :                    ON,
  Protocol             :        IEEE Rapid STP,
  mode                 :     FLAT (Single STP),
  Auto-Vlan-Containment:             Enabled   ,
  Priority             :         32768 (0x8000),
  Bridge ID            :    8000-00:d0:95:f2:47:dc,
  Designated Root      :    8000-00:d0:95:f2:47:dc,
  Cost to Root Bridge  :                      0,
  Root Port            :                   None,
  Next Best Root Cost  :                      0,
  Next Best Root Port  :                   None,
```

```
…
OS6850_2-> show vlan port
 vlan    port     type       status
------+-------+---------+-------------
    1    1/1    default    forwarding
    1    1/2    default    forwarding
…
    1    1/24   default    forwarding
```

The attacker creates a bridge between interfaces eth1 and eth2:

```
attacker@ubuntu:~$ sudo brctl addbr bridge0
attacker@ubuntu:~$ sudo brctl addif bridge0 eth1
attacker@ubuntu:~$ sudo brctl addif bridge0 eth2
attacker@ubuntu:~$ sudo ifconfig bridge0 up
```

The attacker starts injecting STP BPDUs in the network:

```
attacker@ubuntu:~$ sudo mz eth1 -c 0 -d 2s -t bpdu
➥ "rid=00:00:11:11:11:11:11:11" &
attacker@ubuntu:~$ sudo mz eth2 -c 0 -d 2s -t bpdu
➥ "rid=00:00:11:11:11:11:11:11" &
```

STP configuration on the OS6850_1 switch after the attack is updated with a new root bridge MAC address:

```
OS6850_1-> show spantree 1
Spanning Tree Parameters
  Spanning Tree Status :                    ON,
  Protocol             :       IEEE Rapid STP,
  mode                 :    FLAT (Single STP),
  Auto-Vlan-Containment:            Enabled   ,
  Priority             :       32768 (0x8000),
  Bridge ID            :   8000-00:e0:b1:a4:23:4a,
  Designated Root      :   0000-11:11:11:11:11:11,
  Cost to Root Bridge  :                    19,
  Root Port            :   Slot 1 Interface 2,
  Next Best Root Cost  :                    23,
  Next Best Root Port  :   Slot 1 Interface 24,
…
OS6850_1-> show vlan port
 vlan    port     type       status
------+-------+---------+-------------
    1    1/1    default    forwarding
    1    1/2    default    forwarding
…
    1    1/24   default     blocking
```

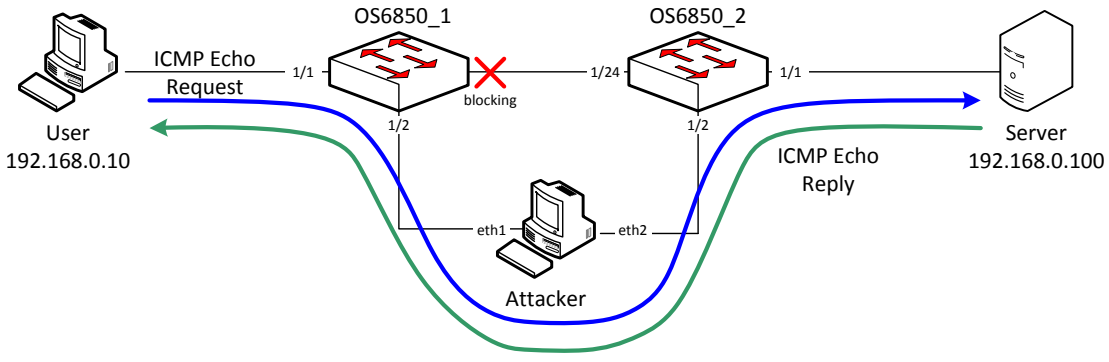
STP configuration on the OS6850_2 switch after the attack is updated with a new root bridge MAC address:

```
OS6850_2-> show spantree 1
Spanning Tree Parameters
  Spanning Tree Status :                    ON,
  Protocol             :        IEEE Rapid STP,
  mode                 :     FLAT (Single STP),
  Auto-Vlan-Containment:           Enabled   ,
  Priority             :        32768 (0x8000),
  Bridge ID            :    8000-00:d0:95:f2:47:dc,
  Designated Root      :    0000-11:11:11:11:11:11,
  Cost to Root Bridge  :                    19,
  Root Port            :    Slot 1 Interface 2,
  Next Best Root Cost  :                     0,
  Next Best Root Port  :                  None,
…
OS6850_2-> show vlan port
 vlan    port      type       status
------+-------+---------+-------------
    1     1/1     default    forwarding
    1     1/2     default    forwarding
…
    1     1/24    default    forwarding
```

The link status between core switches is changed to blocking. Now the attacker is able to sniff all the traffic (not only traffic exchanged between the user and the server):

```
attacker@attacker-desktop:~$ sudo tcpdump -i eth1 -c 2
➥ 'src 192.168.0.10 or dst 192.168.0.10'
tcpdump: verbose output suppressed, use -v or -vv for full protocol
➥ decode
listening on eth1, link-type EN10MB (Ethernet), capture size 96 bytes
16:07:53.086290 IP 192.168.0.10 > 192.168.100.100: ICMP echo request,
➥ id 1280, seq 8221, length 40
16:07:53.086574 IP 192.168.100.100 > 192.168.0.10: ICMP echo reply,
➥ id 1280, seq 8221, length 40
```

The packet flow after the attack is illustrated below:



This type of an attack can be prevented using the “qos user-port” feature with BPDU shutdown action:

```
OS6850_1-> policy port group UserPorts 1/1-23
OS6850_1-> qos user-port shutdown bpdu
OS6850_1-> qos apply
OS6850_2-> policy port group UserPorts 1/1-23
OS6850_2-> qos user-port shutdown bpdu
OS6850_2-> qos apply
```

- **STP Root Guard**

  All ports are automatically eligible for root port selection. A port in a CIST/MSTI instance or per-VLAN instance can be prevented from becoming the root port by restricting the role of the port (also referred to as enabling root guard). This is done using the "spantree cist restricted-role" command or the "spantree lan restricted-role" command regardless of which mode (per-VLAN or flat) is active for the switch. For example:

  ```
  -> spantree cist port 1/1/2 restricted-role enable
  -> spantree cist linkagg 10 restricted-role enable
  -> spantree vlan 100 port 8/1/1 restricted-role enable
  -> spantree vlan 20 linkagg 1 restricted-role enable
  ```

  Note that the above commands also provide optional syntax; restricted-role or root-guard. For example, the following two commands perform the same function:

  ```
  -> spantree vlan port 2/1/1 restricted-role enable
  -> spantree vlan port 2/1/1 root-guard enable
  ```

  When root guard is enabled for a port, it cannot become the root port, even if it is the most likely candidate for becoming the root port. However, this same port is designated as the alternate port when the root port is selected.

  Enabling the restricted role status is used by network administrators to prevent bridges external to the core region of the network from influencing the Spanning Tree topology. Note that enabling the restricted role status for a port may impact connectivity within the network.

  Applicable to AOS 6

  Extract from "OmniSwitch AOS Release 6 CLI Reference Guide":

  > **bridge cist restricted-role**
  >
  > Configures whether or not to prevent a port (or an aggregate of ports) from becoming the root port. When this parameter is enabled, the port does not become the root even if the port is the most likely candidate for the root. Once another port is selected as the root port, the restricted port becomes the Alternate Port.
  >
  > **bridge cist {***slot/port* **|** *logical_port***} {restricted-role | root-guard} {on | off | enable | disable}**
  >
  > **Syntax Definitions**
  >
  > | | |
  > |---|---|
  > | *slot/port* | Enter the slot number for the module and the physical port number on that module (for example, 3/1 specifies port 1 on slot 3). |
  > | *logical_port* | Link aggregate ID number (0–31). |

root-guard	Optional command syntax. Enter **root-guard** instead of **restricted-role**; both parameters specify the same functionality for this command.
on	Turns on (enables) the restricted role status for the specified port.
off	Turns off (disables) the restricted role status for the specified port.
enable	Enables the restricted role status for the specified port.
disable	Disables the restricted role status for the specified port.

By default, all ports are eligible for root port selection. A port in a CIST/MSTI instance or 1x1 instance can be prevented from becoming the root port by restricting the role of the port (also referred to as enabling root guard). This is done using the **bridge cist restricted-role** command or the **bridge 1x1 restricted-role** command. For example:

```
-> bridge cist 1/24 restricted-role enable
-> bridge 1x1 100 8/1 restricted-role enable
```

Note that the above commands also provide optional syntax; **restricted-role** or **root-guard**. For example, the following two commands perform the same function:

```
-> bridge 1x1 2/1 restricted-role enable
-> bridge 1x1 2/1 root-guard enable
```

When root guard is enabled for a port, it cannot become the root port, even if it is the most likely candidate for becoming the root port. It can be selected as the alternate port when the root port is selected.

Applicable to AOS 7, AOS 8

Extract from “OmniSwitch AOS Release 7 CLI Reference Guide”:

spantree cist restricted-role

Configures the restricted role status for a port or a link aggregate of ports. Enabling this parameter blocks the port from becoming the Root Port, even if it is the most likely candidate for root. Once a root port is selected, the restricted port is selected as an Alternate Port.

spantree cist {port [*chassis_id/***]***/slot/port***[-***port2***] | linkagg** *linkagg_id***[-***linkagg_id2***]} restricted-role {enable | disable}**

Syntax Definitions

chassis_id	The chassis identifier when running in virtual chassis mode.
*slot/port***[-***port2***]**	The slot number and port number of the physical port. Use a hyphen to specify a range of ports (4/1-8)**.**
*linkagg_id***[-***linkagg_id2***]**	The link aggregate ID number. Use a hyphen to specify a range of IDs
enable	Enables the restricted role status for the specified port.
disable	Disables the restricted role status for the specified port.

Defaults

By default, the restricted role status for the port is disabled.

Usage Guidelines

• When running in flat mode, this is a per-port setting and is applicable to any CIST or MSTI instances
configured on that port.
• Enabling the restricted role status is used by network administrators to prevent bridges external to the
core region of the network from influencing the Spanning Tree topology.
• Note that enabling the restricted role status for a port may impact connectivity within the network.

Examples

```
-> spantree cist linkagg 15-20 restricted-role enable
-> spantree cist port 8/23 restricted-role disable
-> spantree cist port 8/24-27 restricted-role disable
-> spantree cist linkagg 10 restricted-role disable
```

4.15. Attacks on routing protocols

Routing protocols need to be protected against unauthorized injection of routes.

- **Routing protocol authentication**

  RIP, OSPF, ISIS, BGP allow for the use of authentication on configured interfaces. When authentication is enabled, only neighbors using the same type of authentication and the matching passwords or keys can communicate.

  In OSPF there are two types of authentication: simple and MD5. Simple authentication requires only a text string as a password, while MD5 is a form of encrypted authentication that requires a key and a password. Both types of authentication require the use of more than one command.

  Simple Authentication

  To enable simple authentication on an interface, enter the “ip ospf interface auth-type” command with the interface name, as shown:

  ```
  -> ip ospf interface vlan100 auth-type simple
  ```

  Once simple authentication is enabled, the password must be set with the “ip ospf interface auth-key” command, as shown:

  ```
  -> ip ospf interface vlan100 auth-key switch
  ```

  In the above instance, only other interfaces with simple authentication and a password of “switch” will be able to use the configured interface.

  MD5 Encryption

  To configure the same interface for MD5 encryption, enter the ip ospf interface auth-type as shown:

  ```
  -> ip ospf interface vlan100 auth-type md5
  ```

  Once MD5 authentication is set, a key identification and key string must be set with the “ip ospf interface md5 key” command. For example to set interface vlan100 to

use MD5 authentication with a key identification of 1 and key string of “switch”, enter:

```
-> ip ospf interface vlan100 md5 1
```

And

```
-> ip ospf interface vlan100 md5 1 key "switch"
```

Note that setting the key ID and key string must be done in two separate commands. Once the key ID and key string have been set, MD5 authentication is enabled. To disable it, use the “ip ospf interface md5” command, as shown:

```
-> ip ospf interface vlan100 md5 1 disable
```

To remove all authentication, enter the “ip ospf interface auth-type” as follows:

```
-> ip ospf interface vlan100 auth-type none
```

Applicable to AOS 6

```
-> show configuration snapshot ospf
! OSPF:
ip load ospf
ip ospf area 0.0.0.0
ip ospf interface "vlan100"
ip ospf interface "vlan100" area 0.0.0.0
ip ospf interface "vlan100" auth-type md5
ip ospf interface "vlan100" status enable
ip ospf interface "vlan100" md5 1
ip ospf interface "vlan100" md5 1 key switch
ip ospf status enable
```

Applicable to AOS 7, AOS 8

```
-> show configuration snapshot ospf
! OSPF:
ip load ospf
ip ospf area 0.0.0.0
ip ospf interface "vlan100"
ip ospf interface "vlan100" area 0.0.0.0
ip ospf interface "vlan100" auth-type md5
ip ospf interface "vlan100" admin-state enable
ip ospf interface "vlan100" md5 1
ip ospf interface "vlan100" md5 1 key switch
ip ospf admin-state enable
```

- **OSPF Passive Interface**

Setting hello interval to 0 enabled OSPF Passive Interface on a particular interface. Passive interfaces should be enabled in all VLANs without OSPF neighbors.

Applicable to AOS 6

```
-> show configuration snapshot ospf
! OSPF:
ip load ospf
ip ospf area 0.0.0.0
ip ospf interface "vlan1"
ip ospf interface "vlan1" area 0.0.0.0
ip ospf interface "vlan1" hello-interval 0
ip ospf interface "vlan1" status enable
ip ospf interface "vlan100"
ip ospf interface "vlan100" area 0.0.0.0
```

```
ip ospf interface "vlan100" status enable
ip ospf status enable
```

Applicable to AOS 7, AOS 8

```
-> show configuration snapshot ospf
! OSPF:
ip load ospf
ip ospf area 0.0.0.0
ip ospf interface "vlan1"
ip ospf interface "vlan1" area 0.0.0.0
ip ospf interface "vlan1" hello-interval 0
ip ospf interface "vlan1" admin-state enable
ip ospf interface "vlan100"
ip ospf interface "vlan100" area 0.0.0.0
ip ospf interface "vlan100" admin-state enable
ip ospf admin-state enable
```

- **Disabling Auto-Fabric**

  Auto-Fabric might be very useful in well controlled environments. It enables autodiscovery using LLDP and MVRP. For security reasons it should be disabled in case network can be accessed by unauthorized users.

  Applicable to AOS 7.3.X

  Extract from "OmniSwitch AOS Release 7 Network Configuration Guide":

  > **Auto-Fabric Overview**
  >
  > Auto-Fabric can be used to dynamically discover and configure a switch for the LACP, SPB, and MVRP protocols. It is supported in both standalone or virtual chassis mode. If LACP auto discovery is enabled, the system will attempt LACP discovery and auto configuration for a set discovery window. After LACP discovery window expires, SPB auto discovery will occur if enabled. Then, MVRP auto discovery will occur if enabled.
  >
  > Some of the key benefits provided by Auto-Fabric are:
  > • Automatic discovery reduces administrative overhead.
  > • Auto discovery supports the discovery of the LACP, SPB, and MVRP protocols.
  > • The automatically discovered configuration for LACP and SPB (not MVRP) can be permanently saved to the switch's configuration file so it is kept after a reboot.
  >
  > **Basic Auto-Fabric Operation**
  >
  > By default, the auto-fabric discovery window will be started to determine if there are any eligible ports to participate in discovery. In order for a port to be eligible for auto-fabric discovery it must be in it's default state. If the port is in its default state, the system will attempt to determine a port can be a member of an existing or new link aggregate by analyzing any received LACP PDUs or Auto-discovery LLDP PDUs. If any ports are determined to be possible link aggregate members with an existing port that is already up both ports plus any subsequent ports will be placed into a single link-aggregate. After link aggregates are formed or new non-aggregate ports are brought up, SPB will run its discovery on those ports followed by MVRP which will be enabled on all the newly formed aggregates and ports which are participating and did not join any aggregates.
  >
  > The switch will continue to stay in auto discovery mode on all ports in their default state unless:
  > • A port had previously participated in the auto-fabric discovery window. Once a port participates in the discovery window the port will not participate in the next discovery window.

- If the learned configuration is written to the configuration file, the port will not participate in discovery on next reload.
- If only an MVRP configuration is discovered on a port and there are no VLAN registrations for that port, during the next discovery window the MVRP configuration will be removed and the auto-discovery process will again run on that port.

From AOS 7.3.2.375.R01 Auto Fabric can be disabled using a single command:

```
auto-fabric admin-state disable remove-global-config
```

In previous AOS version following commands need to be applied:

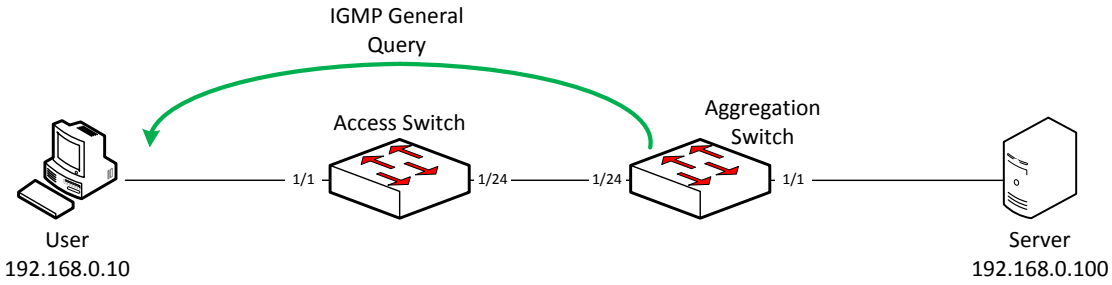
```
auto-fabric admin-state disable
no spb isis interface linkagg 1
spb isis admin-state disable
no spb bvlan 4000-4015
mvrp disable
mvrp linkagg 1 disable
spantree mode per-vlan
```

4.16. Rogue IGMP Querier attack

In case IPMS Querying is enabled in L2 multicast network there will be only one elected (the one with lower IP address) as the active querier and only this querier is allowed to send IGMP General Queries. All IPMS enabled devices in L2 multicast network maintain a table with active queriers and forward IGMP Membership Reports to the active querier. An attacker may use a lower IP address to inject an IGMP General Query on an untrusted port.

- **QoS rules**

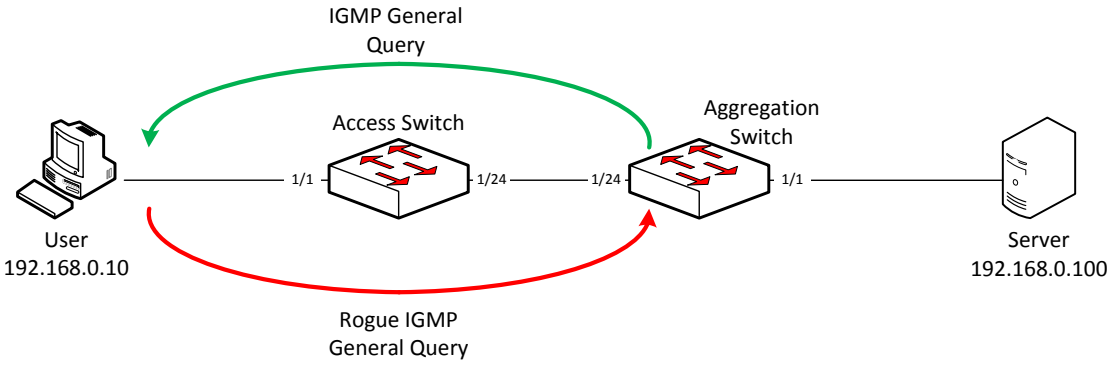
Before the attack the aggregation switch is the active querier:



Output from the access switch:

```
-> show ip multicast querier

Total 1 Queriers

Host Address     VLAN  Port  Static  Count  Life
---------------+-----+-----+-------+------+-----
192.168.0.254       1  1/24  no      1      252
```

After the attack the attacker becomes the active querier:



Output from the access switch:

```
-> show ip multicast querier

Total 1 Queriers

Host Address     VLAN  Port  Static  Count  Life
---------------+-----+-----+-------+------+-----
192.168.0.10         1   1/1  no       1      167
```

This attack can be prevented using QoS policies. Note that this policy doesn't drop the rogue IGMP General Query. It prevents the rogue IGMP General Query to be learned locally on the switch where the QoS rule is configured.

AOS 6

```
-> show configuration snapshot qos
! QOS :
policy port group untrusted   1/1-23
policy condition general-query-sw destination port group untrusted multicast
ip 224.0.0.1
policy action drop disposition deny
policy rule deny-general-query-sw condition general-query-sw action drop
qos apply
```

4.17. LLDP rogue agent attack

This feature is applicable to AOS 6 platforms only.

The OmniSwitch LLDP Agent Security mechanism provides a solution for secure access to the network by detecting rogue devices and preventing them from accessing the internal network. LLDP agent security can be achieved by allowing only one trusted LLDP remote agent on a network port.

User is provided an option to configure the Chassis ID subtype that can be used in validating the Chassis ID type in the incoming LLDP PDU. If the Chassis ID is not configured, by default, the first LLDP remote agent is learned with the received Chassis ID. When more than one LLDP agent is learned on a port, the port is moved to a violation state.

The OmniSwitch LLDP Agent Security mechanism provides a solution for secure access to the network by detecting rogue devices and preventing them from accessing the internal network. LLDP agent security can be achieved by allowing only one trusted LLDP remote agent on a network port.

For example, when someone tries to take control over the network by connecting non-registered devices to an NNI port, the LLDP Security mechanism is activated. Following actions are performed according to the security configuration:

- When the rogue device is detected, a violation is reported on the port
- The NNI port that is connected to the rogue device is blocked, thus the rogue device is prevented from accessing the internal network
- Only a learned and validated LLDP remote agent is declared as a valid user
- Statically configuring a trusted agent is not allowed
- Converting the trusted database to a permanent database is not allowed
- If the port on which LLDP trusted remote agent is enabled does not receive any LLDP PDU within 2-3 times the LLDP transmit interval (20-30 seconds) after the link is UP, the port is moved to a violated state
- By default, the violation status is set to "Trusted" and the admin status is set to "Disabled" when LLDP trust agent is not enabled on the port
- The violation status is set to "Trusted" and the admin status is changed to "Enabled" after enabling a LLDP trust agent configuration on the port
- The violation status is moved to "Violated" from "Trusted" if the port does not receive LLDP PDU or if received LLDP PDU does not match the Chassis ID subtype (if Chassis ID subtype is configured by user on the port explicitly)
- If the Chassis ID subtype is not configured for validating the remote agent, then LLDP will learn the first remote agent with whatever chassis ID TLV received in the PDU
- The learned remote agent entry is also stored in the switch (/flash directory) as a database file, "lldpTrustedRemoteAgent.db", which is updated every 2 to 5 minutes
- There are three configurable options to specify the action taken when the port moves into the violation state: send trap, shut down the port, or send trap and shut down the port
- When a LLDP trusted agent port shutdown occurs, a CLI command is used to clear the violation. However, clearing the violation does not clear the trusted remote agent on a port. To clear a trusted remote agent, disable the LLDP security mechanism for the port

LLDP Trusted Agent Configuration example:

```
-> lldp chassis notification enable
-> lldp chassis tlv management port-description enable
-> lldp chassis tlv system-name enable system-description enable
-> lldp chassis tlv management management-address enable
-> lldp chassis tlv dot1 vlan-name enable port-vlan enable
-> lldp chassis tlv dot3 mac-phy enable
-> lldp 1/1 trust-agent enable
```

LLDP Violation Action Configuration

```
-> lldp 1/1 trust-agent violation-action trap
```

or

```
-> lldp 1/1 trust-agent violation-action trap-and-shutdown
```

or

```
-> lldp 1/1 trust-agent violation-action shutdown
```

Chassis-ID Subtype Configuration

```
-> lldp 1/1 trust-agent chassis-id-subtype <chassis-id-subtype-name>
```

4.18. Filtering DoS attacks on router interfaces

By default OmniSwitches filters denial of service (DoS) attacks on IP router interfaces, which are security attacks aimed at devices that are available on a private network or the Internet. Few attacks aim at system bugs or vulnerabilities (for example teardrop attacks), while other types of attacks involve generating large volumes of traffic so that network service is denied to legitimate network users (such as pepsi attacks). These attacks include the following:

- ICMP Ping of Death—Ping packets that exceed the largest IP datagram size (65535 bytes) are sent to a host and crash the system.
- SYN Attack — Floods a system with a series of TCP SYN packets, resulting in the host issuing SYN-ACK responses. The half open TCP connections can exhaust TCP resources, such that no other TCP connections are accepted.
- Land Attack — Spoofed packets are sent with the SYN flag set to a host on any open port that is listening. The machine can crash or reboot in an attempt to respond.
- Pepsi Attack — The most common form of UDP flooding directed at harming networks. A pepsi attack is an attack consisting of a large number of spoofed UDP packets aimed at diagnostic ports on network devices. A pepsi attack can cause network devices to use up a large amount of CPU time responding to these packets.
- ARP Flood Attack — Floods a switch with a large number of ARP requests, resulting in the switch using a large amount of the CPU time to respond to these requests. If the number of ARP requests exceeds the preset value of 500 per second, an attack is detected.
- Invalid IP Attack — Packets with invalid source or destination IP addresses are received by the switch. When such an Invalid-IP attack is detected, the packets are dropped, and SNMP traps are generated. Following are few examples of invalid source and destination IP addresses:
    - Invalid Source IP address
        - 0.X.X.X
        - 255.255.255.255
        - Subnet broadcast
        - In the range 224.X.X.X - 255.255.255.254
        - Source IP address equals one of Switch IP Interface addresses
    - Invalid Destination IP address
        - 127.X.X.X
        - In the range 240.X.X.X - 255.255.255.254
        - 0.0.0.0 (valid exceptions - certain DHCP packets)
        - 172.28.0.0 for a router network 172.28.4.11/16
        - 0.x.x.x.
- Multicast IP and MAC Address Mismatch — When such an IP address mismatch attack is detected, the packets are dropped, and SNMP traps are generated

(exception: the destination IP is a unicast IP and the destination MAC address is either a broadcast or multicast address. In such a condition, an event is recorded in the DoS statistics. No SNMP traps are generated as valid packets can also fall under this category). This attack is detected when:

  - The source MAC address of a packet received by a switch is a Multicast MAC address.
  - The destination IP and MAC addresses of a packet received by a switch is same as the Multicast IP and MAC addresses, but the Multicast IP and the Multicast MAC addresses do not match.

- Ping overload—Floods a switch with a large number of ICMP packets, resulting in the switch using a large amount of CPU time to respond to these packets. If the number of ICMP packets exceeds 100 per second, a DoS attack is detected. By default, the detection of attack is disabled.
- Packets with loopback source IP address — Packets with an invalid source address of 127.0.0.0/8 (loopback network) are received by the switch. When such packets are detected, they are dropped, and SNMP traps are generated.

The switch can be set to detect various types of port scans by monitoring for TCP or UDP packets sent to open or closed ports. If the total penalty value exceeds the set port scan penalty value threshold, a trap is generated to alert the administrator that a port scan can be in progress. Monitoring is done in the following manner:

- Packet penalty values set. TCP and UDP packets destined for open or closed ports are assigned a penalty value. Each time a packet of this type is received, its assigned penalty value is added to a running total. This total is cumulative and includes all TCP and UDP packets destined for open or closed ports.
- Port scan penalty value threshold. The switch is given a port scan penalty value threshold. This number is the maximum value the running penalty total can achieve before triggering an SNMP trap.
- Decay value. A decay value is set. The running penalty total is divided by the decay value every minute.

5. Important security fixes

Updated March 2nd, 2016

Vulnerability	Security Advisory	TKC Article	AOS 6.4.X	AOS 6.6.X	AOS 7.3.X	AOS 8.1.1
JPAKE	CVE-2010-5107 CVE-2011-5000 CVE-2010-4755	000017740	*PR 198586:* • 6.4.4.713.R01 • 6.4.5.595.R02 • 6.4.6.224.R01	*PR 198586:* • 6.6.3.R01 vulnerable • 6.6.4.R01 vulnerable • 6.6.5.R02 vulnerable	*PR 197844:* • 7.3.2.R01 vulnerable • 7.3.3.R01 vulnerable	*PR 197844:* • 8.1.1.567.R01
DTLS	CVE-2014-3571 CVE-2015-0206	000020226	*PR 202371:* • 6.4.4.R01 vulnerable • 6.4.5.R02 vulnerable • 6.4.6.241.R01	*PR 202371:* • 6.6.3.R01 vulnerable • 6.6.4.289.R01 • 6.6.5.67.R02	*PR 202371:* • 7.3.2.629.R01 • 7.3.3.555.R01	*PR 202371:* • 8.1.1.600.R01
ntpd	CVE-2013-5211 CVE-2014-9295	-	*PR 201881:* • 6.4.4.R01 vulnerable • 6.4.5.R02 vulnerable • 6.4.6.238.R01	*PR 201881:* • 6.6.3.R01 vulnerable • 6.6.4.287.R01 • 6.6.5.67.R02	*PR 201881:* • 7.3.2.625.R01 • 7.3.3.547.R01	*PR 201881:* • 8.1.1.593.R01
POODLE	CVE-2014-3566	000017736	*PR 199440:* • 6.4.4.721.R01 • 6.4.5.595.R02 • 6.4.6.216.R01	*PR 199440:* • 6.6.3.R01 vulnerable • 6.6.4.275.R01 • 6.6.5.67.R02	*PR 199440:* • 7.3.2.590.R01 • 7.3.3.514.R01	*PR 199440:* • 8.1.1.568.R01
Heartbleed	CVE-2014-0160	000013243	Not applicable	Not applicable	*PR 195083:* • 7.3.2.524.R01 • 7.3.3.468.R01	Not applicable
ShellShock	CVE-2014-6271 CVE-2014-7169	000017297	Not applicable	Not applicable	*No impact as non-admin users don't have access to Maintenance Shell* *PR 198700:* • 7.3.2.590.R01 • 7.3.3.516.R01	*No impact as non-admin users don't have access to Maintenance Shell* *PR 198700:* • 8.1.1.609.R01
Weak Session ID	CVE-2015-2804	-	Vulnerable	Vulnerable	Not applicable	Not applicable
Cross-Site Request Forgery	CVE-2015-2805	-	• 6.4.5.635.R02 • 6.4.6.302.R01	• 6.6.5.101.R02	• 7.3.4.204.R02	• 8.1.1.663.R01 • 8.2.1.R01
Glibc DNS Stack-based Buffer Overflow	CVE-2014-9761 CVE-2015-5229 CVE-2015-7547 CVE-2015-8776 CVE-2015-8778 CVE-2015-8779	000031391	Vulnerable	Vulnerable	Vulnerable	Vulnerable

6. AOS 6 example configuration

Requirements:

- OmniSwitch 6850E running 6.4.6.218.R01
- An edge device
- Ports 1/1-22 are user ports with PCs and/or an IP phones connected
- Ports 1/23-24 are uplinks
- PCs and IP phones use DHCP for IP assignment
- IPv6 is not used by end stations
- Routing protocol support is disabled
- A single management interface activated and a single static route
- Security features are configured in aggressive mode – in case of a violation a port is blocked
- LLDP is enabled only on uplinks
- AMAP is completely disabled
- NMS and Syslog IP address is 192.168.100.253
- Gateway IP address is 192.168.100.254

```
! Chassis :
system name OS6850E
system timezone CET
system daylight savings time enable
! VLAN :
vlan 1 enable name "VLAN 1"
vlan 4094 1x1 stp disable name "Management"
! IP :
no ip service ftp
ip service ssh
no ip service telnet
no ip service udp-relay
no ip service http
ip service network-time
ip service snmp
no ip service avlan-telnet
no ip service avlan-http
no ip service avlan-secure-http
ip service secure-http
no ip service avlan-http-proxy
ip interface "vlan4094" address 192.168.100.1 mask 255.255.255.0 vlan 4094
➥ ifindex 1
! IPMS :
ip multicast dynamic-control status enable
ip multicast dynamic-control drop-all status enable
! AAA :
aaa authentication console "local"
no aaa authentication telnet
no aaa authentication ftp
no aaa authentication http
aaa authentication snmp "local"
aaa authentication ssh "local"
user password-policy cannot contain-username enable
user password-policy min-uppercase 1
user password-policy min-lowercase 1
```

```
user password-policy min-digit 1
user password-policy min-nonalpha 1
! QOS :
qos user-port shutdown bpdu bgp ospf rip vrrp dhcp-server dvmrp isis dns-reply
policy network group management  192.168.100.253 mask 255.255.255.255
policy port group UserPorts 1/1-22
policy condition ipv6 source ipv6 Any ipv6
policy condition trusted source network group management
➥ destination network group Switch
policy condition untrusted destination network group Switch
policy action accept
policy action drop disposition drop
policy rule trusted precedence 65010 condition trusted action accept
policy rule untrusted precedence 65000 condition untrusted action drop
policy rule drop-ipv6 condition ipv6 action drop
qos apply
! Session manager :
session prompt default "OS6850E->"
command-log enable
! SNMP :
snmp security authentication all
snmp station 192.168.100.253 162 "snmp3" v3 enable
! IP multicast :
ip static-route 0.0.0.0/0 gateway 192.168.100.254 metric 1
! Netsec :
netsec group untrusted port 1/1-22
netsec group untrusted anomaly arp-addr-scan state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly arp-flood state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly arp-failure state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly icmp-addr-scan state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly icmp-flood state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly icmp-unreachable state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly tcp-port-scan state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly tcp-addr-scan state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly syn-flood state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly syn-failure state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly syn-ack-scan state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly fin-scan state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly fin-ack-diff state enable log enable trap enable
➥ quarantine enable count 200 period 5
netsec group untrusted anomaly rst-count state enable log enable trap enable
➥ quarantine enable count 200 period 5
Link Aggregate :
! Udld :
udld port 1/13 enable
udld port 1/13 mode aggressive
! Port Mapping :
! VLAN AGG:
```

```
! 802.1Q :
vlan 4093 802.1q 1/45 "TAG PORT 1/45 VLAN 4093"
vlan 4001 802.1q 1/47 "TAG PORT 1/47 VLAN 4001"
vlan 4093 802.1q 1/47 "TAG PORT 1/47 VLAN 4093"
! Spanning tree
interfaces 1/1-22 flood all rate pps 244
interfaces 1/1-22 flood all action shutdown
! 802.1Q :
vlan 4094 802.1q 1/23
vlan 4094 802.1q 1/24
! Spanning tree :
bridge mode flat
! Bridging :
! Port mirroring :
! UDP Relay :
ip helper forward delay 0
ip helper dhcp-snooping enable
ip helper dhcp-snooping binding enable
ip helper dhcp-snooping ip-source-filter port 1/1 enable
...
ip helper dhcp-snooping ip-source-filter port 1/22 enable
ip helper dhcp-snooping port 1/23 trust
ip helper dhcp-snooping port 1/24 trust
! System service :
swlog output socket 172.26.60.244
swlog console level info
! AMAP :
amap disable
! VLAN STACKING:
ethernet-service mac-tunneling disable
! WCCP :
ip wccp admin-state disable
! LLDP :
lldp chassis tlv management  port-description enable system-name enable
➥ system-description enable
lldp chassis tlv management  management-address enable
lldp 1/1 lldpdu disable
...
lldp 1/22 lldpdu disable
```

7. AOS 7 example configuration

Requirements:

- OmniSwitch 6900 running 7.3.3.505.R01
- A core device
- Management through EMP port
- All ports are used as interconnections with switches and routers
- Routing is enabled only for OSPF
- NTP, NMS and Syslog IP address is 192.168.100.253
- Auto Fabric is disabled

```
auto-fabric admin-state disable remove-global-config
! Chassis:
system name "OS6900"
system fips admin-state enable
! VLAN:
vlan 1 admin-state enable
! Spanning Tree:
spantree vlan 1 admin-state enable
! IP:
ip service port 21 admin-state disable
ip service port 23 admin-state disable
ip service port 80 admin-state disable
ip service port 123 admin-state disable
ip service port 443 admin-state disable
ip service port 3799 admin-state disable
ip interface emp address 192.168.254.1
ip interface "vlan1" address 192.168.1.254 mask 255.255.255.0 vlan 1
telnet admin-state disable
ftp admin-state disable
! AAA:
aaa authentication console "local"
aaa authentication snmp "local"
aaa authentication ssh "local"
user password-policy min-uppercase 1
user password-policy min-lowercase 1
user password-policy min-digit 1
user password-policy min-nonalpha 1
! NTP:
ntp server 192.168.100.253 key 1
ntp client admin-state enable
! QOS:
policy condition mdc-dvmrp destination ip 224.0.0.4
policy condition mdc-ipv4mc-reserved destination ip 224.0.0.0 mask 255.255.255.0
policy condition mdc-ipv6mc-reserved destination ipv6 ff02:: mask ff:ff:ff:ff::
policy condition mdc-ospf-5 destination ip 224.0.0.5 ip-protocol 89
policy condition mdc-ospf-6 destination ip 224.0.0.6 ip-protocol 89
policy condition mdc-pim destination ip 224.0.0.13
policy condition mdc-ripv2 destination ip 224.0.0.9 destination udp-port 520
policy condition mdc-vrrp destination ip 224.0.0.18 ip-protocol 112
policy action accept
policy action q17 cpu priority 17
policy rule mdc-vrrp precedence 65070 condition mdc-vrrp action q17
policy rule mdc-ripv2 precedence 65060 condition mdc-ripv2 action q17
policy rule mdc-pim precedence 65050 condition mdc-pim action q17
policy rule mdc-ospf-6 precedence 65040 condition mdc-ospf-6 action accept
policy rule mdc-ospf-5 precedence 65030 condition mdc-ospf-5 action accept
policy rule mdc-dvmrp precedence 65020 condition mdc-dvmrp action q17
```

```
policy rule mdc-ipv6mc-reserved precedence 65010 condition mdc-ipv6mc-reserved
➥ action q17
policy rule mdc-ipv4mc-reserved precedence 65000 condition mdc-ipv4mc-reserved
➥ action q17
qos apply
! LLDP:
lldp all chassis tlv management port-description enable system-name enable
➥ system-description enable
lldp all chassis tlv management management-address enable
! Session manager :
session prompt default "OS6900->"
command-log enable
! SNMP :
snmp security authentication all
snmp authentication-trap enable
snmp station 192.168.100.253 162 "snmp3" v3 enable
! Web:
webview server disable
webview access disable
! System Service:
swlog output socket 192.168.100.253
! VRRP:
ip load vrrp
! OSPF:
ip load ospf
ip ospf area 0.0.0.0
ip ospf interface "vlan1"
ip ospf interface "vlan1" area 0.0.0.0
ip ospf interface "vlan1" auth-type md5
ip ospf interface "vlan1" admin-state enable
ip ospf interface "vlan1" md5 1
ip ospf interface "vlan1" md5 1 key switch
ip ospf admin-state enable
```

8. AOS 8 example configuration

Requirements:

- OmniSwitch 6860E running 8.1.1.557.R01
- An edge device
- Management through EMP port
- Ports 1/1-24 are user ports with PCs and/or an IP phones connected
- Ports 1/25-26 are uplinks
- PCs and IP phones use DHCP for IP assignment
- Routing is enabled only for OSPF
- Security features are configured in aggressive mode – in case of a violation a port is blocked
- LLDP is enabled only on uplinks
- NTP, NMS and Syslog IP address is 192.168.100.253

```
! Chassis:
system name "OS6860"
system fips admin-state enable
! Capability Manager:
hash-control extended
! VLAN:
vlan 1 admin-state enable
vlan 100 admin-state enable
vlan 100 members port 1/1/25-26 untagged
! Spanning Tree:
spantree vlan 1 admin-state enable
spantree vlan 100 admin-state enable
! IP:
ip service port 21 admin-state disable
ip service port 23 admin-state disable
ip service port 80 admin-state disable
ip service port 123 admin-state disable
ip service port 443 admin-state disable
ip service port 3799 admin-state disable
ip interface emp address 192.168.254.1
ip interface "vlan1" address 192.168.1.254 mask 255.255.255.0 vlan 1
ip interface "vlan100" address 192.168.100.1 mask 255.255.255.0 vlan 100
telnet admin-state disable
ftp admin-state disable
! AAA:
aaa authentication console "local"
aaa authentication snmp "local"
aaa authentication ssh "local"
user password-policy min-uppercase 1
user password-policy min-lowercase 1
user password-policy min-digit 1
user password-policy min-nonalpha 1
! NTP:
ntp server 192.168.100.253 key 1
ntp client admin-state enable
! QOS:
qos user-port shutdown bpdu bgp ospf rip vrrp dhcp-server dvmrp isis dns-reply
policy port group UserPorts 1/1/1-24
policy condition mdc-dvmrp destination ip 224.0.0.4
policy condition mdc-ipv4mc-reserved destination ip 224.0.0.0 mask 255.255.255.0
policy condition mdc-ipv6mc-reserved destination ipv6 ff02:: mask ff:ff:ff:ff::
policy condition mdc-ospf-5 destination ip 224.0.0.5 ip-protocol 89
```

```
policy condition mdc-ospf-6 destination ip 224.0.0.6 ip-protocol 89
policy condition mdc-pim destination ip 224.0.0.13
policy condition mdc-ripv2 destination ip 224.0.0.9 destination udp-port 520
policy condition mdc-vrrp destination ip 224.0.0.18 ip-protocol 112
policy action accept
policy action q17 cpu priority 17
policy rule mdc-vrrp precedence 65070 condition mdc-vrrp action q17
policy rule mdc-ripv2 precedence 65060 condition mdc-ripv2 action q17
policy rule mdc-pim precedence 65050 condition mdc-pim action q17
policy rule mdc-ospf-6 precedence 65040 condition mdc-ospf-6 action accept
policy rule mdc-ospf-5 precedence 65030 condition mdc-ospf-5 action accept
policy rule mdc-dvmrp precedence 65020 condition mdc-dvmrp action q17
policy rule mdc-ipv6mc-reserved precedence 65010 condition mdc-ipv6mc-reserved
➥ action q17
policy rule mdc-ipv4mc-reserved precedence 65000 condition mdc-ipv4mc-reserved
➥ action q17
qos apply
! LLDP:
lldp all chassis tlv management port-description enable system-name enable
➥ system-description enable
lldp all chassis tlv management management-address enable
lldp all port 1/1/1-24 lldpdu disable
! Session manager :
session prompt default "OS6860E->"
command-log enable
! SNMP :
snmp security authentication all
snmp authentication-trap enable
snmp station 192.168.100.253 162 "snmp3" v3 enable
! Web:
webview server disable
webview access disable
! System Service:
swlog output socket 192.168.100.253
! VRRP:
ip load vrrp
! OSPF:
ip load ospf
ip ospf area 0.0.0.0
ip ospf interface "vlan1"
ip ospf interface "vlan1" area 0.0.0.0
ip ospf interface "vlan1" hello-interval 0
ip ospf interface "vlan1" admin-state enable
ip ospf interface "vlan100"
ip ospf interface "vlan100" area 0.0.0.0
ip ospf interface "vlan100" auth-type md5
ip ospf interface "vlan100" admin-state enable
ip ospf interface "vlan100" md5 1
ip ospf interface "vlan100" md5 1 key switch
ip ospf admin-state enable
! DA-UNP:
port-security port 1/1/1-24 maximum 2
port-security port 1/1/1-24 learn-trap-threshold 2
port-security port 1/1/1-24 admin-state enable
! DHCP Snooping:
dhcp-snooping admin-state enable
dhcp-snooping binding admin-state enable
dhcp-snooping ip-source-filter port 1/1/1-24 admin-state enable
dhcp-snooping port 1/1/25-26 trust
```

9. Summary

X.805 Dimension	Attack / Challenge	AOS Feature	AOS 6.4.X	AOS 6.6.X 6.7.1	AOS 7.3.X	AOS 8.1.1 8.2.1
Access control, Authentication and Non-repudiation	Authentication and Authorization	RADIUS	✓	✓	✓	✓
		TACACS+	✓	✓	✓	✓
		User Password policy	✓	✓	✓	✓
		FIPS	✓ [1]	×	✓	✓
	Access restriction	ACLs	✓	✓	✓	✓
		Console access restriction	✓ [2]	×	×	×
	Event logging	Command logging	✓	✓	✓	✓
		RADIUS	✓	✓	✓	✓
		TACACS+	✓	✓	✓	✓
		Syslog	✓	✓	✓	✓
Data confidentiality and Communication	Secure Socket Layer	Allowing only secure protocols	✓	✓	✓	✓
		SNMPv3	✓	✓	✓	✓
Availability	DoS attacks on well known network ranges	Multicast Dynamic Control	✓ [3]	✓ [7]	×	×
		CPU queue 17	×	×	✓	✓
	TTL 0 Flooding	A debug variable	✓ [4]	×	×	×
	IGMP Flooding	QoS rules	✓	✓ [9]	✓ [6]	✓ [6]
	DHCP Flooding	QoS rules	✓	✓ [8]	✓ [6]	✓ [6]
	Cisco proprietary MAC flooding	MAC tunneling	✓	✓	n/a	n/a
	MLD flooding	QoS rules	✓	✓ [9]	✓	✓
	ARP flooding	TAD	✓ [5]	✓ [9]	×	×
		QoS rules	✓	✓ [8]	✓ [6]	✓ [6]
	Multicast and unknown unicast flooding	Flood control	✓	✓	✓	✓
	ARP attacks on end stations and MAC spoofing	DHCP Snooping with IP Source Filter	✓	✓	×	✓
	ARP attacks on router interfaces	IP Anti-Spoofing	✓	×	×	×
	CAM overflow attack	Learned Port Security	✓	✓	✓	✓
	DHCP rogue server attack	DHCP Snooping	✓	✓	×	✓
		QoS User Port	✓	✓	✓	✓
	STP claiming root attack	QoS User Port	✓	✓	✓	✓
		STP Root Guard	✓	✓	✓	✓
	Attacks on routing protocols	Routing protocol authentication	✓	×	✓	✓

[1] – 6.4.5.GA
[2] – 6.4.6.GA
[3] – 6.4.4.707.R01, 6.4.6.218.R01
[4] - 6.4.4.658.R01
[5] – OS6850E, OS6855, OS9700E
[6] – port group split mode is not supported
[7] – 6.6.4.285.R01, 6.6.5.R02
[8] – minimum recommended version for policy port group in split mode is 6.6.4.292.R01 (with exception to AOS 6.6.5.R02)
[9] – not applicable to traffic copied to CPU