FortiSwitchOS - Administration Guide—Standalone Mode

Version 6.4.6

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FortiSwitchOS 6.4.6 Administration Guide—Standalone Mode
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Change log

Date	Change Description
February 11, 2021	Initial release for FortiSwitchOS 6.4.6
February 12, 2021	Updated the “Configuring split ports” section.
February 22, 2021	Added a note to the beginning of the “Virtual routing and forwarding,” “PIM routing,” and “IS-IS routing” sections.
February 25, 2021	Added a note to the “IGMP snooping” section.
March 1, 2021	• Added more supported FortiSwitch models to those listed in the “VLAN stacking (QinQ)” section. • Changed the description of MSTP at the beginning of the “Spanning Tree Protocol” section.
March 15, 2021	Updated the notes at the beginning of the “Quality of service” section.
March 16, 2021	Changed the “Clearing and restoring QoS statistics” section to “Resetting and restoring QoS counters.”
June 25, 2021	Updated the “Checking ARP packets” and “Configure the OSPF router” sections.
April 27, 2022	Changed the default ARP timeout value from 300 seconds to 180 seconds.
September 28, 2022	Changed tagged and untagged packets to tagged and untagged frames in the “VLANs and VLAN tagging” chapter.

Introduction

This guide provides information about configuring a FortiSwitch unit in standalone mode. In standalone mode, you manage the FortiSwitch unit by connecting directly to the unit, either using the web-based manager (also known as the GUI) or the CLI.

If you will be managing your FortiSwitch unit using a FortiGate unit, refer to the following guide: *FortiSwitch Managed by FortiOS 6.4*.

This chapter covers the following topics:

Supported models

This guide is for all FortiSwitch models that are supported by FortiSwitchOS, which includes all of the D-series, E-series, and F-series models.

What's new in FortiSwitchOS 6.4.6

Release 6.4.6 provides the following new features:

- FortiSwitchOS now supports 28 link aggregation groups (LAGs) on the FS-124F models and 52 LAGs on the FS-148F models.

Refer to Feature matrix: FortiSwitchOS 6.4.6 on page 15 for details about the features supported on each FortiSwitch model.

Feature matrix: FortiSwitchOS 6.4.6

The following table lists the FortiSwitch features in release 6.4.6 that are supported on each series of FortiSwitch models. All features are available in release 6.4.6, unless otherwise stated.

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
Management and Configuration									
CPLD software upgrade support for OS	—	—	—	—	—	—	—	1024D, 1048D	—
Firmware image rotation (dual-firmware image support)	—	✓	✓	148E, 148E-POE	✓	✓	✓	✓	✓
HTTP REST APIs for configuration and monitoring	—	✓	✓	✓	✓	✓	✓	✓	✓
Support for switch SNMP OID	✓	✓	✓	✓	✓	✓	✓	✓	✓
IP conflict detection and notification	✓	✓	✓	✓	✓	✓	✓	✓	✓
FortiSwitch Cloud configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓
Auto topology	—	✓	✓	✓	✓	✓	✓	✓	✓
Security and Visibility									
802.1x port mode	✓	✓	✓	✓	✓	✓	✓	✓	✓
802.1x MAC-based security mode	✓	✓	✓	✓	✓	✓	✓	✓	✓
User-based (802.1x) VLAN assignment	✓	✓	✓	✓	✓	✓	✓	✓	✓
802.1x enhancements, including MAB	✓	✓	✓	✓	✓	✓	✓	✓	✓

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
MAB reauthentication disabled	—	✓	✓	✓	✓	✓	✓	✓	✓
open-auth mode	✓	✓	✓	✓	✓	✓	✓	✓	✓
Support of the RADIUS accounting server	Partial	✓	✓	✓	✓	✓	✓	✓	✓
Support of RADIUS CoA and disconnect messages	—	✓	✓	✓	✓	✓	✓	✓	✓
EAP Pass-Through	✓	✓	✓	✓	✓	✓	✓	✓	✓
Network device detection	—	—	✓	—	✓	✓	✓	✓	✓
IP-MAC binding (IPv4)	✓	—	—	—	—	—	✓	✓	✓
sFlow (IPv4)	✓	✓	✓	—	✓	✓	✓	✓	✓
Flow export (IPv4)	✓	—	✓	—	✓	✓	✓	✓	✓
ACL (IPv4)	✓	—	✓	✓	✓	✓	✓	✓	✓
Multistage ACL (IPv4)	✓	—	—	—	—	—	✓	✓	✓
Multiple ingress ACLs (IPv4)	✓	—	✓	—	✓	✓	✓	✓	✓
Schedule for ACLs (IPv4)	—	—	✓	✓	✓	✓	✓	✓	✓
DHCP snooping	✓	✓	✓	✓	✓	✓	✓	✓	✓
DHCPv6 snooping	✓	—	—	—	✓	✓	✓	✓	✓
Allowed DHCP server list	✓	✓	✓	✓	✓	✓	✓	✓	✓
IP source guard (IPv4)	✓	—	✓	—	✓	✓	—	—	—
IP source-guard violation log	—	—	✓	—	✓	✓	—	—	—

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
Dynamic ARP inspection (IPv4)	✓	—	✓	✓	✓	✓	✓	✓	✓
ARP timeout value	—	✓	✓	✓	✓	✓	✓	✓	✓
Access VLANs (See Note 8.)	—	✓	✓	✓	✓	✓	✓	✓	✓
RMON group 1	—	✓	✓	✓	✓	✓	✓	✓	✓
Reliable syslog	—	✓	✓	✓	✓	✓	✓	✓	✓
Packet capture	✓	—	✓	—	✓	✓	✓	✓	✓
MACsec (See Note 7.)	—	—	—	—	—	—	✓	—	—
Layer 2									
Link aggregation group size (maximum number of ports) (See Note 2.)	✓	8	8	8	8	8	24/48	24/48	24, 64
LAG min-max-bundle	—	✓	✓	✓	✓	✓	✓	✓	✓
IPv6 RA guard	—	—	—	—	✓	✓	✓	✓	✓
IGMP snooping	✓	✓	✓	✓	✓	✓	✓	✓	✓
IGMP proxy	✓	✓	✓	✓	✓	✓	✓	✓	✓
IGMP querier	—	✓	✓	✓	✓	✓	✓	✓	✓
MLD snooping	—	—	—	—	—	—	✓	✓	✓
MLD proxy	—	—	—	—	—	—	✓	✓	✓
MLD querier	—	—	—	—	—	—	✓	✓	✓
LLDP-MED	—	✓	✓	✓	✓	✓	✓	✓	✓
LLDP-MED: ELIN support	✓	✓	✓	✓	✓	✓	✓	✓	✓
Per-port max for learned MACs	—	—	✓	✓	✓	✓	✓	—	—
MAC learning limit (See Note 4.)	—	—	✓	✓	✓	✓	✓	—	—

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
Learning limit violation log (See Note 4.)	—	—	✓	✓	✓	✓	✓	—	—
set mac-violation-timer	—	✓	✓	✓	✓	✓	✓	✓	✓
Sticky MAC	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total MAC entries	—	✓	✓	✓	✓	✓	✓	✓	✓
MSTP instances	—	0-15	0-15	0-15	0-15	0-15	0-32	0-32	0-32
STP root guard	—	✓	✓	✓	✓	✓	✓	✓	✓
STP BPDU guard	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rapid PVST interoperation	—	✓	✓	✓	✓	✓	✓	✓	✓
'forced-untagged' or 'force-tagged' setting on switch interfaces	—	✓	✓	✓	✓	✓	✓	✓	✓
Private VLANs	✓	—	✓	—	✓	✓	✓	✓	✓
Multi-stage load balancing	—	—	—	—	—	—	—	✓	✓
Priority-based flow control	—	—	—	—	—	—	✓	✓	✓
Ingress pause metering	—	—	—	—	✓	✓	✓	✓	3032D
Storm control	✓	✓	✓	✓	✓	✓	✓	✓	✓
Per-port storm control	✓	✓	✓	✓	✓	✓	✓	✓	✓
Global burst-size control	—	✓	✓	✓	✓	✓	✓	✓	✓
MAC/IP/protocol-based VLAN assignment	✓	✓	✓	✓	✓	✓	✓	✓	✓
Virtual wire	✓	—	✓	—	✓	✓	✓	✓	✓
Loop guard	✓	✓	✓	✓	✓	✓	✓	✓	✓

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
Percentage rate control	✓	—	✓	—	✓	✓	✓	✓	✓
VLAN stacking (QinQ)	—	—	✓	—	✓	✓	✓	✓	✓
VLAN mapping	—	—	✓	—	✓	✓	✓	✓	✓
SPAN	✓	✓	✓	✓	✓	✓	✓	✓	✓
RSPAN and ERSPAN (IPv4)	✓	RSPAN	✓	—	✓	✓	✓	✓	✓
Flow control	—	✓	✓	✓	✓	✓	✓	✓	✓
Layer 3									
Link monitor (IPv4)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Static routing (IPv4/IPv6)	✓	—	✓	✓	✓	✓	✓	✓	✓
Hardware routing offload (IPv4/IPv6)	✓	—	✓	—	✓	✓	✓	✓	✓
Software routing only (IPv4/IPv6)	✓	✓	—	✓	—	—	—	—	—
OSPF (IPv4/IPv6) (See Note 3.)	✓	—	—	—	✓	✓	✓	✓	✓
OSPF database overflow protection (IPv4)	—	—	—	—	✓	✓	✓	✓	✓
OSPF graceful restart (helper mode only) (IPv4)	—	—	—	—	✓	✓	✓	✓	✓
RIP (IPv4/IPv6) (See Note 3.)	✓	—	—	—	✓	✓	✓	✓	✓
VRRP (IPv4/IPv6) (See Note 3.)	✓	—	—	—	✓	✓	✓	✓	✓
BGP (IPv4/IPv6) (See Note 3.)	—	—	—	—	—	—	✓	✓	✓
IS-IS (IPv4/IPv6) (See Note 3.)	—	—	—	—	✓	✓	✓	✓	✓

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
PIM (IPv4) (See Note 3.)	—	—	—	—	—	—	✓	✓	✓
Hardware-based ECMP (IPv4)	—	—	—	—	—	—	✓	✓	✓
VRF (IPv4/IPv6)	—	—	—	—	—	—	—	✓	✓
Static BFD (IPv4/IPv6)	✓	✓	✓	✓	✓	✓	✓	✓	✓
BFD for BGPv6	—	—	—	—	—	—	✓	✓	✓
BFD for RIPng	—	—	—	—	✓	✓	✓	✓	✓
uRPF	—	—	—	—	—	—	✓	✓	✓
DHCP relay (IPv4)	✓	—	✓	✓	✓	✓	✓	✓	✓
DHCP server (IPv4)	✓	—	—	—	✓	4xx only	✓	✓	✓
High Availability									
MCLAG (multichassis link aggregation)	Partial	—	—	—	✓	✓	✓	✓	✓
STP supported in MCLAGs	—	—	—	—	✓	✓	✓	✓	✓
IGMP snooping in MCLAG	✓	—	—	—	✓	✓	✓	✓	✓
Quality of Service									
802.1p support, including priority queuing trunk and WRED	✓	—	✓	✓	✓	✓	✓	✓	✓
QoS queue counters	—	—	✓	—	✓	✓	✓	✓	✓
QoS marking (IPv4/IPv6)	—	—	✓	—	✓	✓	✓	✓	✓
Summary of configured queue mappings	✓	—	✓	✓	✓	✓	✓	✓	✓

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
Egress priority tagging (IPv4/IPv6)	—	—	✓	—	✓	✓	✓	✓	✓
ECN (IPv4/IPv6)	—	—	—	—	✓	—	✓	✓	✓
Real-time egress queue rates	—	—	—	—	—	✓	✓	✓	✓
Miscellaneous									
PoE-pre-standard detection (See Note 1.)	—	✓	✓	FS-1xxE POE	✓	✓	✓	—	—
PoE modes support: first come, first served or priority based (PoE models)	—	✓	✓	FS-1xxE POE	✓	✓	✓	—	—
Control of temperature alerts	—	✓	✓	—	✓	✓	✓	✓	✓
Split port (See Note 6.)	Partial	—	—	—	—	—	✓	1048E	✓
TDR (time-domain reflectometer)/cable diagnostics support	✓	—	✓	✓	✓	✓	✓	—	—
Auto module max speed detection and notification	✓	—	—	—	—	—	✓	✓	—
Monitor system temperature (threshold configuration and SNMP trap support)	—	✓	✓	FS-124E-POE, FS-124E-FPOE, FS-148E, FS-148E-POE	✓	✓	✓	✓	✓

Feature	GUI supported	112D-POE	FSR-124D	1xxE, 1xxF	4xxE	200 Series, 400 Series	500 Series	1024D, 1048D, 1048E	3032D, 3032E
Cut-through switching	—	—	—	—	—	—	—	✓	✓
Add CLI to show the details of port statistics	—	✓	✓	✓	✓	✓	✓	✓	✓
Configuration of the QSFP low-power mode	—	—	—	—	—	—	✓	1048D, 1048E	✓
Energy-efficient Ethernet	✓	✓	✓	✓	✓	✓	✓	—	—
PHY Forward Error Correction (See Note 5.)	—	—	—	—	—	—	—	1048E	3032E
PTP transparent clock (IPv4/IPv6) (See Note 9.)	—	—	—	—	✓	✓	✓	1048E	✓

Notes

1. PoE features are applicable only to the model numbers with a POE or FPOE suffix.
2. The 24-port LAG is applicable to FS-524D, FS-524-FPOE, FS-1024D, and FS-3032D models. The 48-port LAG is applicable to FS-548D, FS-548-FPOE, and FS-1048D models.
3. To use the dynamic layer-3 protocols, you must have an advanced features license.
4. The per-VLAN MAC learning limit and per-trunk MAC learning limit are not supported on the FS-448D, FS-448D-POE, FS-448D-FPOE, FS-248E-POE, FS-248E-FPOE, FS-248D series.
5. Supported only in 100G mode (clause 91).
6. On the FS-3032E, you can split one port at the full base speed, split one port into four sub-ports of 25 Gbps each (100G QSFP only), or split one port into four sub-ports of 10 Gbps each (40G or 100G QSFP).
7. Supported on FS-5xxD 10G ports.
8. The maximum number of access VLANs on the FS-1xxE models is 16; the maximum number of access VLANs on the FS-148F models is 32.
9. PTP is not supported on the FS-248E, FS-248E-POE, FS-248E-FPOE, FS-448D, FS-448D-POE, and FS-448D-FPOE models.

Before you begin

Before you start administrating your FortiSwitch unit, it is assumed that you have completed the initial configuration of the FortiSwitch unit, as outlined in the QuickStart Guide for your FortiSwitch model and have administrative access to the FortiSwitch unit's GUI and CLI.

How this guide is organized

This guide is organized into the following chapters:

- Management ports describes how to configure the management ports.
- Configuring administrator tasks describes how to configure the date and time, admin users, and remote authentication servers.
- Configuring SNMP describes how to monitor hardware on your network.
- Global system and switch settings describes the initial configuration of your FortiSwitch unit.
- Physical port settings describes how to configure the physical ports.
- Layer-2 interfaces describes how to configure layer-2 interfaces.
- VLANs and VLAN tagging describes how to configure VLANs and describes the packet flow for VLAN tagged and untagged packets.
- Spanning Tree Protocol describes how to configure MSTP.
- Link aggregation groups describes how to configure link aggregation groups.
- MCLAG describes how to configure MCLAG.
- Multi-stage load balance describes how to configure multi-stage load balancing on a set of FortiGate units.
- LLDP-MED describes how to configure LLDP-MED settings.
- MAC/IP/protocol-based VLANs describes how to configure MAC/IP/protocol-based VLANs.
- Mirroring describes how to configure port mirroring.
- Access control lists describes how to configure ACLs.
- Storm control describes how to configure storm control.
- DHCP snooping describes how to configure DHCP snooping.
- IP source guard describes how to configure IP source guard.
- Dynamic ARP inspection describes how to configure dynamic ARP inspection.
- IGMP snooping describes how to configure IGMP snooping.
- MLD snooping describes how to configure MLD snooping.
- Private VLANs describes how to create and manage private virtual local area networks (VLANs).
- Quality of service describes how to configure QoS.
- sFlow describes how to configure sFlow.
- Feature licensing describes feature licenses.
- Layer-3 interfaces describes how to configure routed ports, routed VLAN interfaces, switch virtual interfaces, and related features.
- DHCP server and relay describes how to configure DHCP servers and relays.
- OSPF routing describes how to configure OSPF routing.
- RIP routing describes how to configure RIP routing.
- VRRP describes how to configure VRRP.
- BGP routing describes how to configure BGP routing.
- PIM routing describes how to configure PIM routing.
- IS-IS routing describes how to configure IS-IS routing.
- Users and user groups describes how to configure users and user groups.
- MACsec describes how to configure MACsec.
- 802.1x authentication describes how to configure 802.1x authentication (to RADIUS servers).
- TACACS describes how to configure TACACS authentication.
- Troubleshooting and support describes ways to gather more details and to solve problems.

- Deployment scenario describes an example configuration.
- Appendix: FortiSwitch-supported RFCs lists RFCs that are supported by FortiSwitchOS.

Management ports

This chapter describes how to configure management ports on the FortiSwitch unit.

The following topics are covered:

Models without a dedicated management port

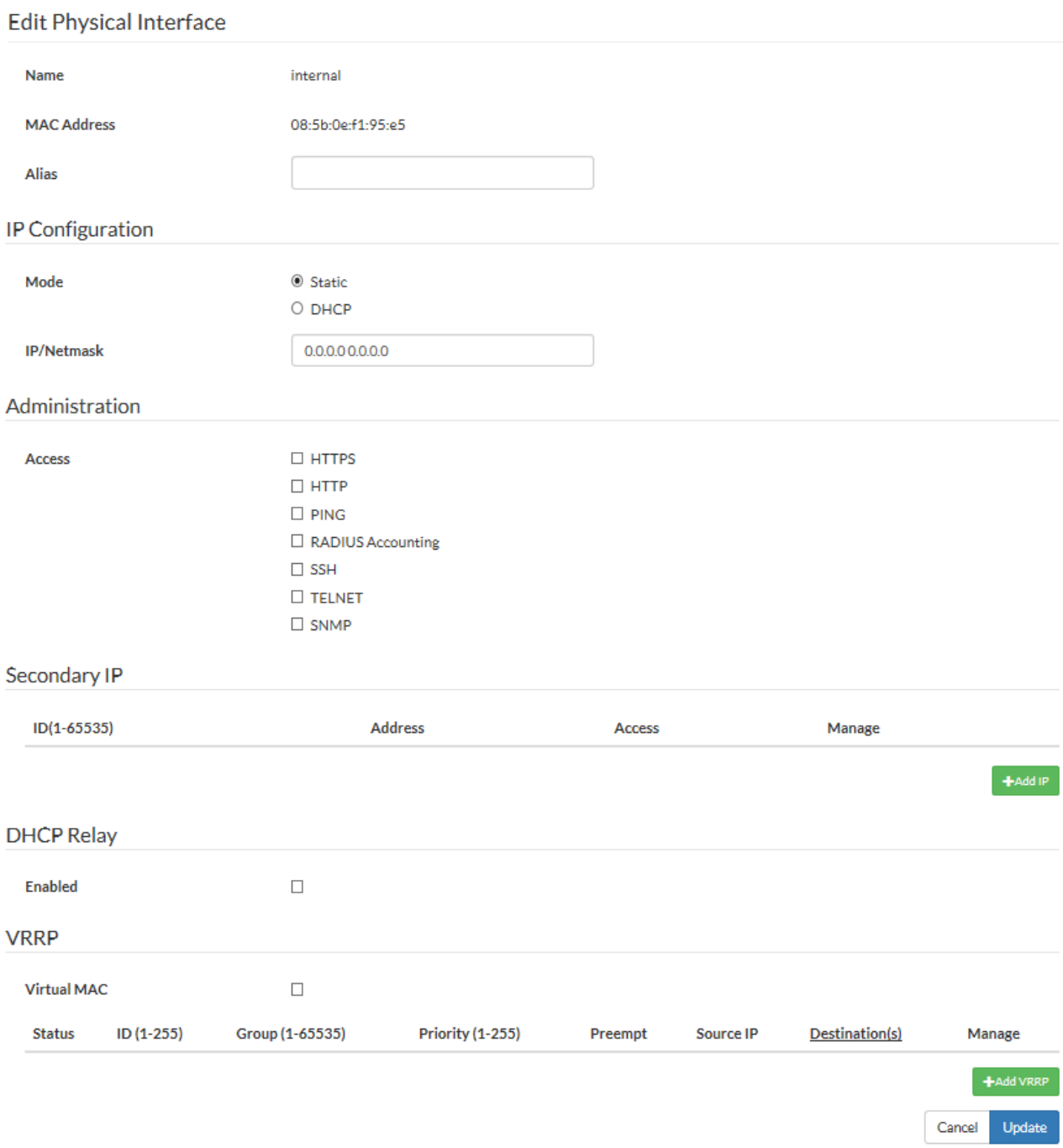
For FortiSwitch models without a dedicated management port, configure the internal interface as the management port.

NOTE: For FortiSwitch models without a dedicated management port, the internal interface has a default VLAN ID of 1.

Using the GUI:

First start by editing the default *internal* interface's configuration.

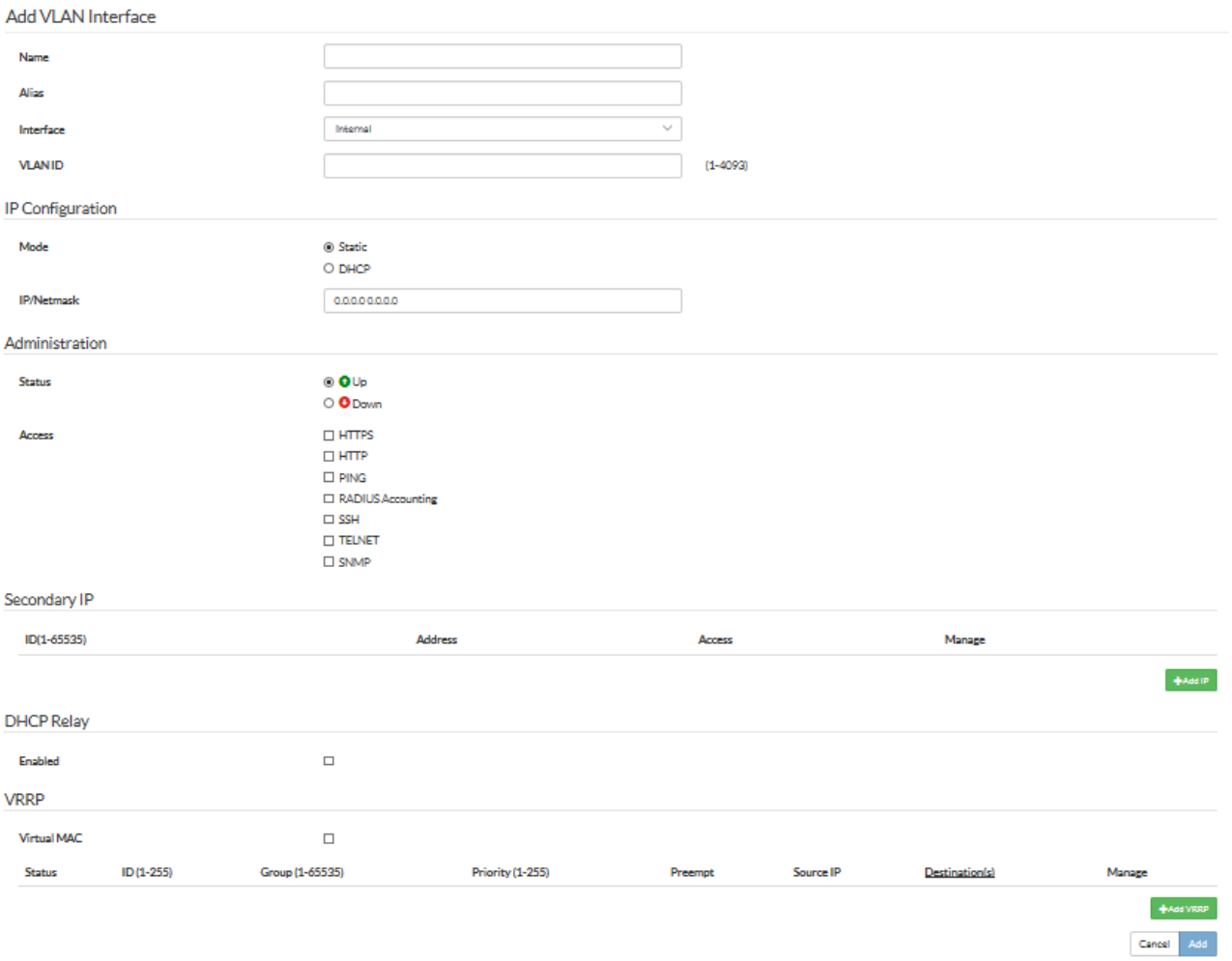
1. Go to *System* > *Network* > *Interface* > *Physical*, select *Edit* for the *internal* interface.



2. In the IP/Netmask field, enter the IP address and netmask.
3. Select the appropriate protocols to connect to the interface for administrative access.
4. Optional. Select *Add IP* to add a secondary IP address for the internal interface.
5. Select *Update* to save your changes.

Next, create a new interface to be used for management.

1. Go to *System* > *Network* > *Interface* > *VLAN* and select *Add VLAN* to create a management VLAN.



2. Give the interface an appropriate name.
3. Confirm that *Interface* is set to *internal*.
4. Set a *VLAN ID*.
5. In the IP/Netmask field, enter the IP address and netmask.
6. Select the appropriate protocols to connect to the interface for administrative access.
7. Optional. Select *Add IP* to add a secondary IP address for this VLAN.
8. Select *Add*.

Using the CLI:

```
config system interface
   edit internal
      set ip <IP_address_and_netmask>
      set allowaccess <access_types>
      set type physical
      set secondary-IP enable
         config secondaryip
            edit <id>
               set ip <IP_address_and_netmask>
               set allowaccess <access_types>
            next
```

```
      end
   next
edit <vlan name>
   set ip <IP_address_and_netmask>
   set allowaccess <access_types>
   set interface internal
   set vlanid <VLAN id>
   set secondary-IP enable
      config secondaryip
         edit <id>
            set ip <IP_address_and_netmask>
            set allowaccess <access_types>
      end
   end
```

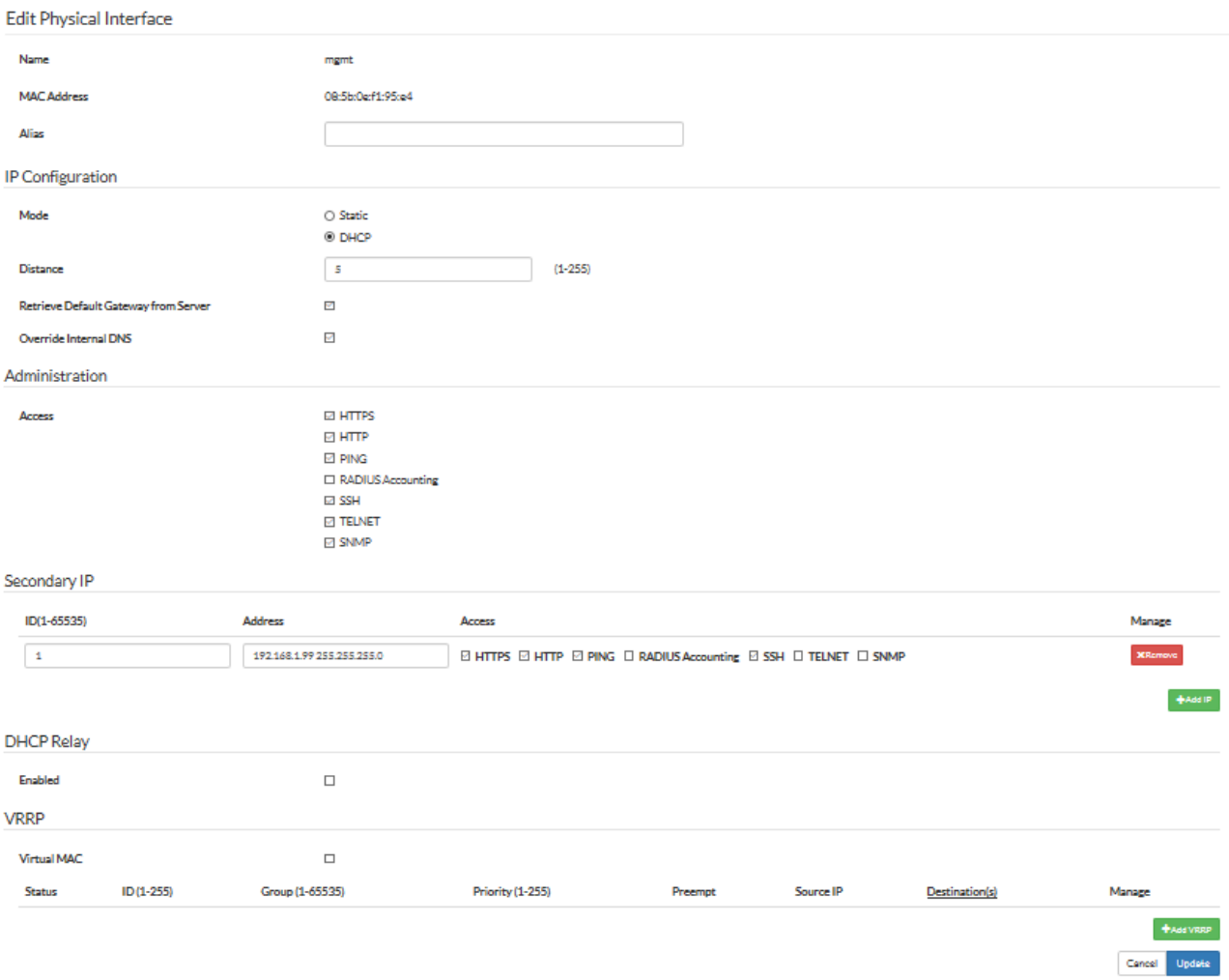
Models with a dedicated management port

For FortiSwitch models with a dedicated management port, configure the IP address and allowed access types for the management port.

NOTE: For FortiSwitch models with a dedicated management port, the internal interface has a default VLAN identifier of 4094.

Using the GUI:

1. Go to *System* > *Network* > *Interface* > *Physical*, select *Edit* for the *mgmt* interface.



2. In the ID field, enter a unique identifier from 1 to 65525.
3. In the *IP/Netmask* field, enter the IP address and netmask.
4. Select the appropriate protocols to connect to the interface for administrative access.
5. Optional. You can select *Remove* if you want to delete the default secondary IP address or select *Add IP* to add a secondary IP address for the management interface.
6. Select *Update* to save your changes.

Using the CLI:

```
config system interface
   edit mgmt
      set ip <IP_address_and_netmask>
      set allowaccess <access_types>
      set type physical
      set secondary-IP enable
         config secondaryip
            edit <id>
               set ip <IP_address_and_netmask>
               set allowaccess <access_types>
            next
         end
```

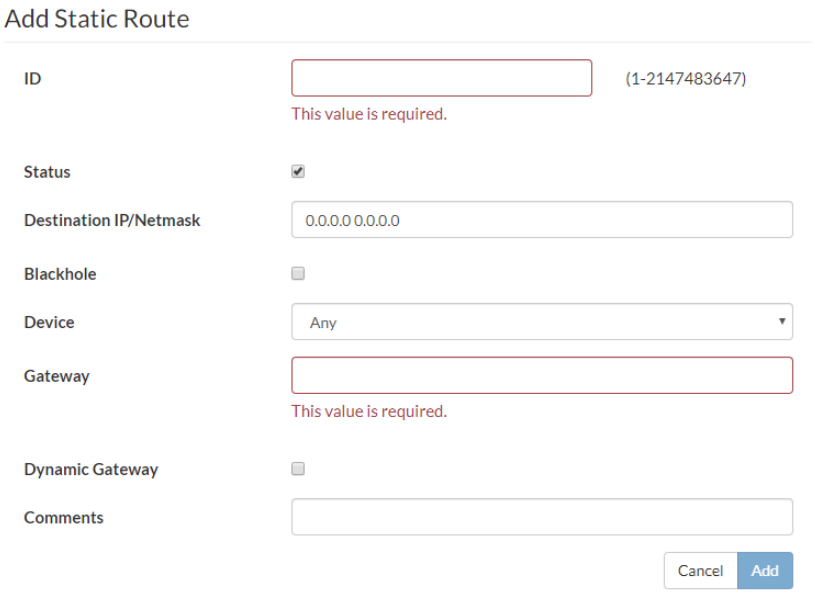
```
    next
  edit internal
    set type physical
  end
end
```

Remote access to the management port

To provide remote access to the management port, configure a static route. Set the gateway address to the IP address of the router.

Using the GUI:

1. Go to *Router* > *Config* > *Static* and select *Add Route*.



2. Enter an identifier. This is a unique number to identify the static route.
3. Select the Status checkbox if it is not selected.
4. Set the device to *mgmt*.
5. Set the gateway to the gateway router IP address.
6. Select *Add*.

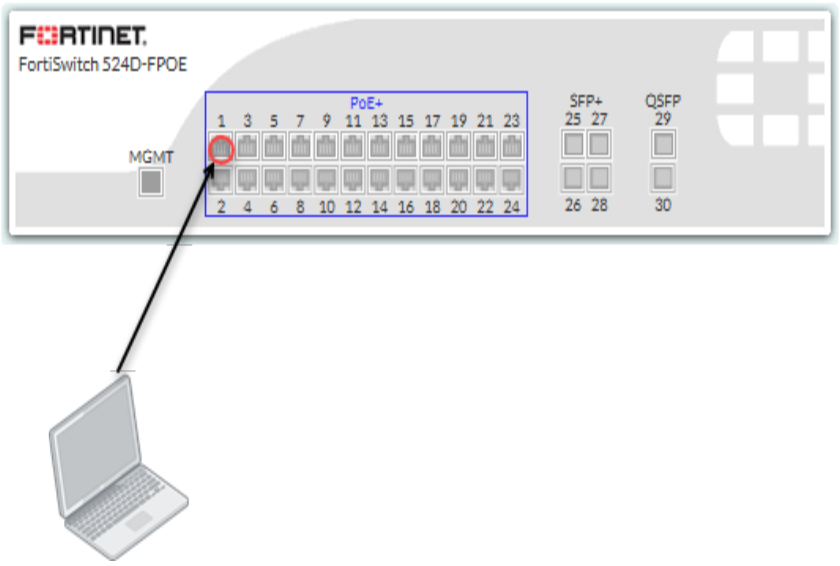
Using the CLI:

```
config router static
  edit 1
    set device mgmt
    set gateway <router IP address>
    set status enable
  end
end
```

Example configurations

In this example, the *internal* interface is used as an inbound management interface. Also, the FortiSwitch unit has a default VLAN across all physical ports and its internal port.

Using the internal interface of a FortiSwitch-524D-FPOE

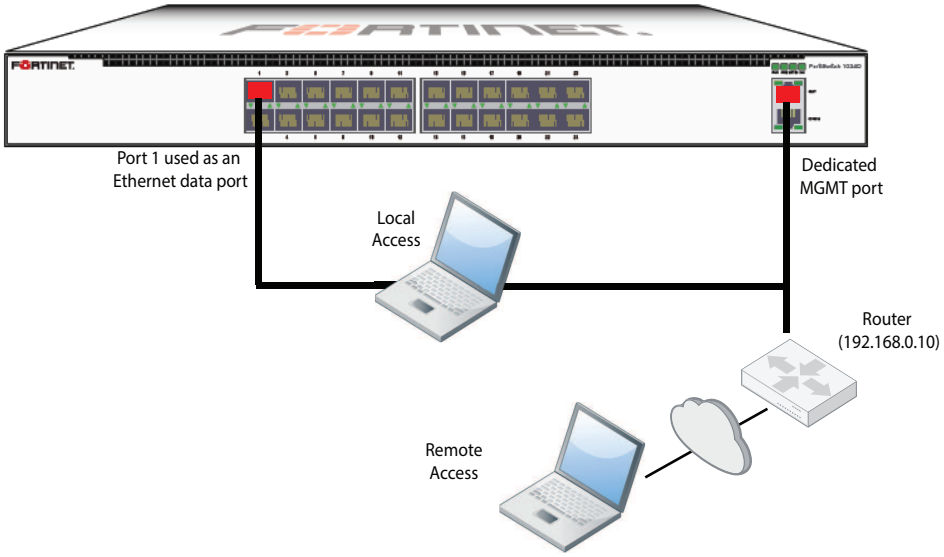


Syntax

```
config system interface
   edit internal
      set ip 192.168.1.99 255.255.255.0
      set allowaccess ping https http ssh
      set type physical
   end
end
```

In this example, an out-of-band management interface is used as the dedicated management port. You can configure the management port for local or remote access.

Out-of-band management on a FortiSwitch-1024D



Option 1: management port with static IP

```
config system interface
   edit mgmt
      set mode static
      set ip 10.105.142.19 255.255.255.0
      set allowaccess ping https http ssh snmp telnet
      set type physical
   next
   edit internal
      set type physical
   end
end
// optional configuration to allow remote access to the management port

config router static
   edit 1
      set device mgmt
      set gateway 192.168.0.10
      set status enable
   end
```

Option 2: management port with IP assigned by DHCP

```
config system interface
   edit mgmt
      set mode dhcp
      set defaultgw enable // allows remote access
```

```
    set allowaccess ping https http ssh snmp telnet
    set type physical
  next
  edit internal
    set type physical
  end
```

Configuring administrator tasks

You can use the default “admin” account to configure administrator accounts, adjust system settings, upgrade firmware, create backup files, and configure security features.

This chapter covers the following topics:

Setting the time and date

For effective scheduling and logging, the system date and time must be accurate. You can either manually set the system date and time or configure the system to automatically keep its time correct by synchronizing with a Network Time Protocol (NTP) server.

NOTE: Some FortiSwitch models do not have a battery-backup real-time clock. For FortiSwitch models without a real-time clock, the time is reset when the switch is rebooted. These models must be connected to an NTP server if you want to maintain the correct system date and time.

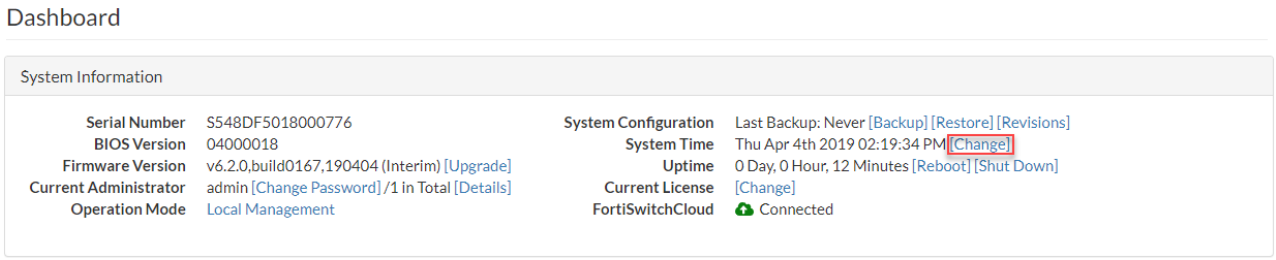
The Network Time Protocol enables you to keep the system time synchronized with other network systems. This will also ensure that logs and other time-sensitive settings are correct.

When the system time is synchronized, polling occurs every 2 minutes. When the system time is not synchronized but the NTP server can be reached, polling is attempted every 2 seconds to synchronize quickly. If the NTP server cannot be reached, polling occurs up to every 64 seconds. If DNS cannot resolve the host name, polling occurs up to every 60 seconds.

Starting in FortiSwitchOS 6.4.0, the default Sync Interval is 10 minutes. The polling interval is one-fifth of the configured Sync Interval.

To set the date and time:

1. Go to *System* > *Dashboard*.
2. Next to the *System Time* field, select *Change*.



3. Select your *Time Zone*.
4. Either select *Manual Setting* and enter the system date and time or select *Synchronize with NTP Server*. If you select synchronization, you can either use the default FortiGuard server or specify a different server. You can also set the *Sync Interval*.
5. Select *Update*.

If you use an NTP server, you can identify the IPv4 or IPv6 address for this self-originating traffic with the `set source-ip` or `set source-ip6` command. For example, you can set the source IPv4 address of NTP to be on the DMZ1 port with an IP of 192.168.4.5:

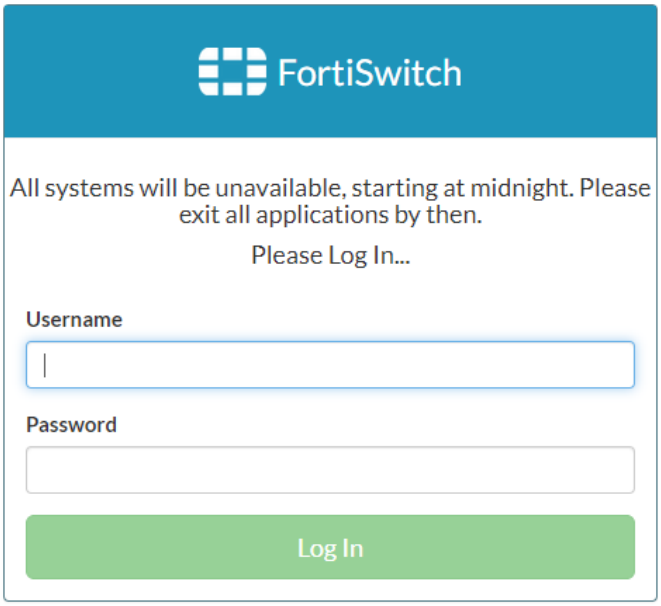
```
config system ntp
   set authentication enable
   set ntpsyn enable
   set syncinterval 5
   set source-ip 192.168.4.5
end
```

Configuring system banners

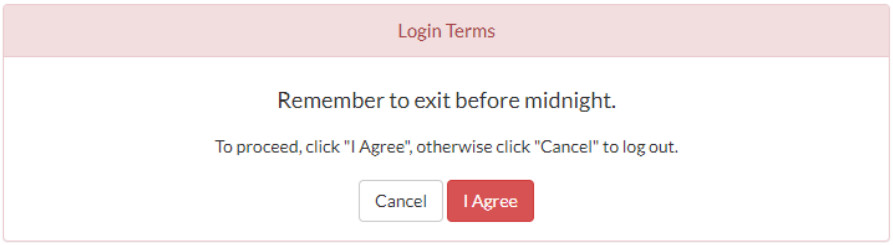
You can specify system banner messages in the CLI that will appear when users log in using either the CLI or the GUI.

You can enter up to 2,048 characters for each system banner. Currently, only text is supported. By default, no system banners are displayed.

The GUI displays the pre-login banner before you enter your user name or password:



The GUI displays the post-login banner after you enter your user name and password and select *Log In*:



You cannot finish logging in until you select *I Agree*.

The CLI displays the pre-login banner before you enter your user name. The CLI displays the post-login banner after you enter your password; you cannot finish logging in until you press `a` to accept the message.

To configure system banners:

```
config system global
   set pre-login-banner "<string>"
   set post-login-banner "<string>"
end
```

For example:

```
S548DF5018000776 # config system global
S548DF5018000776 (global) # set pre-login-banner "All systems will be unavailable,
> starting at midnight. Please exit all applications by then."
S548DF5018000776 (global) # set post-login-banner "Remember to exit before midnight."
S548DF5018000776 (global) # end
```

NOTE: For multi-line messages, just press the Return key between lines.

Configuring the temperature sensor

If your FortiSwitch unit has a temperature sensor, you can set a warning and an alarm for when the system temperature reaches specified temperatures. When these thresholds are exceeded, a log message and SNMP trap are generated. The warning threshold must be lower than the alarm threshold.

Use the following commands to set warning and alarm thresholds:

```
config system snmp sysinfo
   set status enable
   set trap-temp-warning-threshold <temperature in degrees Celsius>
   set trap-temp-alarm-threshold <temperature in degrees Celsius>
end
```

By default, the FortiSwitch unit generates an alert (in the form of an SNMP trap and a SYSLOG entry) every 30 minutes when the temperature sensor exceeds its set threshold. You can change this interval with the following commands:

```
config system global
   set alertd-relog enable
   set alert-interval <1-1440 minutes>
end
```

Upgrading the firmware

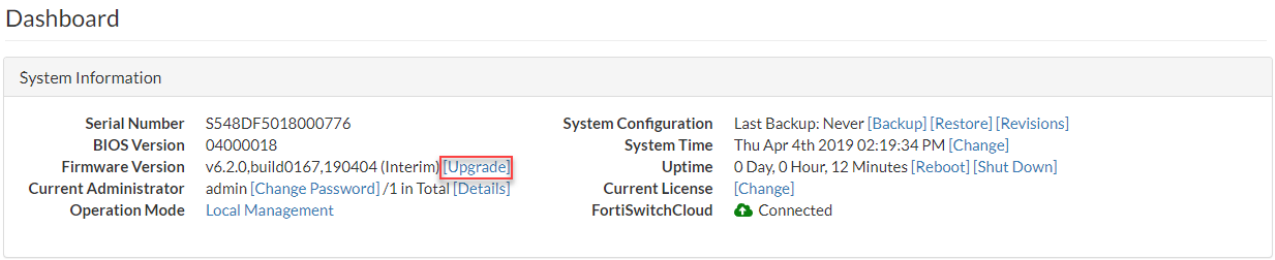
Use these procedures to upgrade your FortiSwitch firmware.

Using the GUI

You can upgrade the firmware from the dashboard or from the system configuration page.

To upgrade the firmware from the dashboard:

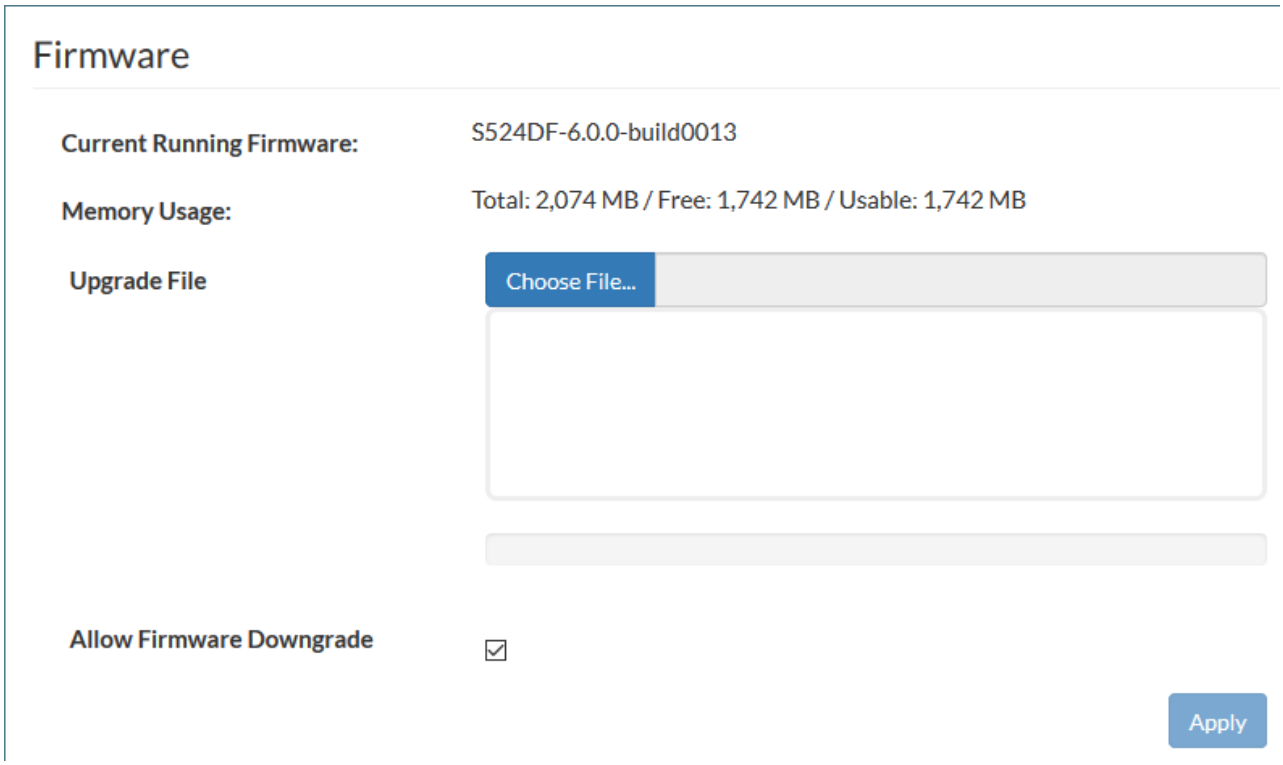
1. Go to *System* > *Dashboard*.
2. Next to the *Firmware Version* field, select *Update*.



To upgrade the firmware from the system configuration page:

1. Go to *System* > *Config* > *Firmware*.

2. Select *Choose File* and then navigate to the firmware image.



3. Select *Apply*.

Using the CLI

You can download a firmware image from an FTP server, from a FortiManager unit, or from a TFTP server. The FortiSwitch unit reboots and then loads the new firmware.

```
execute restore image ftp <filename_str> <server_ipv4[:port_int] | server_fqdn[:port_int]>
     [<username_str> <password_str>]
execute restore image management-station <version_int>
execute restore image tftp <filename_str> <server_ipv4>
```

The following example shows how to upload a configuration file from a TFTP server to the FortiSwitch unit and restart the FortiSwitch unit with this configuration. The name of the configuration file on the TFTP server is `backupconfig`. The IP address of the TFTP server is 192.168.1.23.

```
execute restore config tftp backupconfig 192.168.1.23
```

You can also load a firmware image from an FTP or TFTP server without restarting the FortiSwitch unit:

```
execute stage image ftp <string> <ftp server>[:ftp port]
execute stage image tftp <string> <ip>
```

Verifying image integrity

To verify the integrity of the images in the primary and secondary (if applicable) flash partitions, use the following commands:

```
execute verify image primary
execute verify image secondary
```

If the image is corrupted or missing, the command fails with a return code of -1.

For example:

```
execute verify image primary

Verifying the image in flash......100%
No issue found!

execute verify image secondary

Verifying the image in flash......100%
Bad/corrupted image found in flash!
Command fail. Return code -1
```

Restore or upgrade the BIOS

You can restore or upgrade the basic input/output system (BIOS) if needed. After a BIOS upgrade, passwords for all FortiSwitch local users must be reconfigured using the `config user local` setting.

CAUTION: Only restore or upgrade the BIOS if Customer Support recommends it.

To upgrade or restore the BIOS from the CLI:

```
execute restore bios tftp <filename_str> <server_ipv4[:port_int]>
```

For example:

```
execute restore bios tftp PPC/FS-3032D/04000009/FS3D323Z14000004.bin 10.105.2.201
```

The example downloads the BIOS file from the TFTP server at the specified IPv4 address.

NOTE: If the BIOS upgrade fails, do not restart the FortiSwitch unit. Instead, try the CLI command again. If repeating the CLI command does not work, the FortiSwitch unit might require a return merchandise authorization (RMA).

Setting the boot partition

You can specify the flash partition for the next reboot. The system can use the boot image from either the primary or the secondary flash partition:

```
execute set-next-reboot <primary | secondary>
```

NOTE: You must disable image rotation before you can use the `execute set-next-reboot` command.

If your FortiSwitch model has dual flash memory, you can use the primary and backup partitions for image rotation. By default, this feature is enabled.

```
config system global
   set image-rotation <enable | disable>
end
```

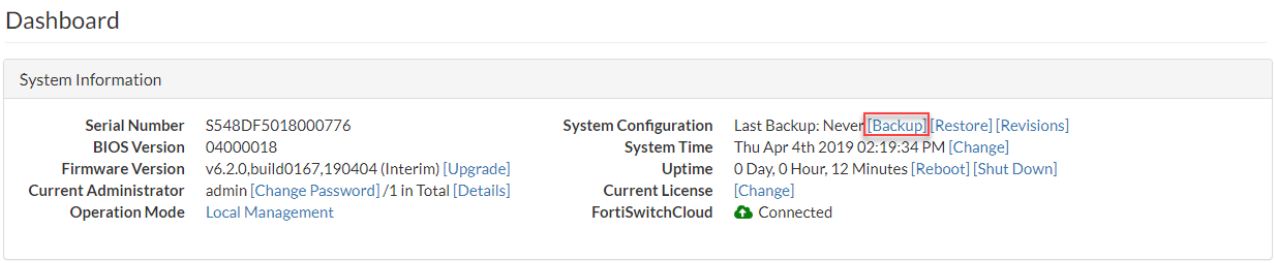
To list all of the flash partitions:

```
diagnose sys flash list
```

Backing up the system configuration

To back up the configuration from the dashboard:

1. Go to *System* > *Dashboard*.
2. Next to the *System Configuration* field, select *Backup*.
   You can enter a password to encrypt the backup file. Passwords can be up to 15 characters in length.



Remote authentication servers

If you are using remote authentication for administrators or users, you need to configure one of the following:

- RADIUS server
- TACACS+ server

RADIUS server

The information you need to configure the system to use a RADIUS server includes:

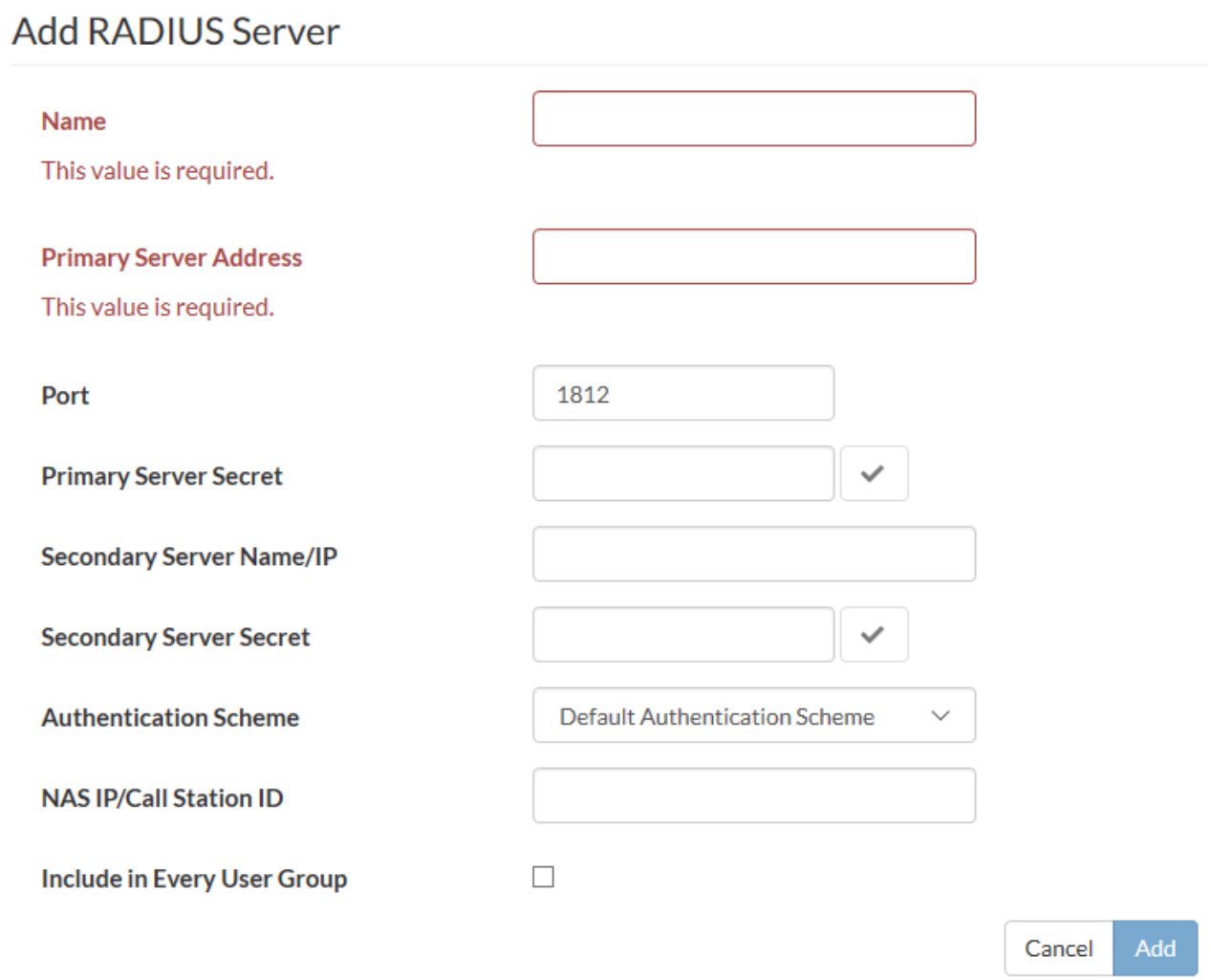
- the RADIUS server's domain name or IP address
- the RADIUS server's shared secret key

The default port for RADIUS traffic is 1812. Some RADIUS servers use port 1645. You can configure the FortiSwitch unit to use port 1645:

```
config system global
   set radius-port 1645
end
```

To configure RADIUS authentication with the GUI:

1. Go to *System* > *Authentication* > *RADIUS* and select *Add Server*.



2. Enter the following information and select *Add*.

Field	Description
Name	Enter a name to identify the RADIUS server on the FortiSwitch unit.
Primary Server Address	Enter the domain name (such as fgt.example.com) or the IP address of the RADIUS server.
Primary Server Secret	Enter the server secret key, such as radiusSecret. This key can be a maximum of 16 characters long. This value must match the secret on the RADIUS primary server.
Secondary Server Name/IP	Optionally enter the domain name (such as fgt.example.com) or the IP address of the secondary RADIUS server.

Field	Description
Secondary Server Secret	Optionally, enter the secondary server secret key, such as radiusSecret2. This key can be a maximum of 16 characters long. This value must match the secret on the RADIUS secondary server.
Authentication Scheme	If you know the RADIUS server uses a specific authentication protocol, select *Specify Authentication Protocol* and select the protocol from the list. Otherwise, select *Use Default Authentication Scheme*. The default authentication scheme will usually work.
NAS IP/Called Station ID	Enter the IP address to be used as an attribute in RADIUS access requests. The NAS IP address is a RADIUS setting or IP address of the FortiSwitch interface used to talk to the RADIUS server, if not configured. The Called Station ID is the same value as the NAS IP address but in text format.
Include in every User Group	When this option is enabled, this RADIUS server is automatically included in all user groups. This option is useful if all users will be authenticating with the remote RADIUS server.

To configure the FortiSwitch unit for RADIUS authentication, see 802.1x authentication on page 290.

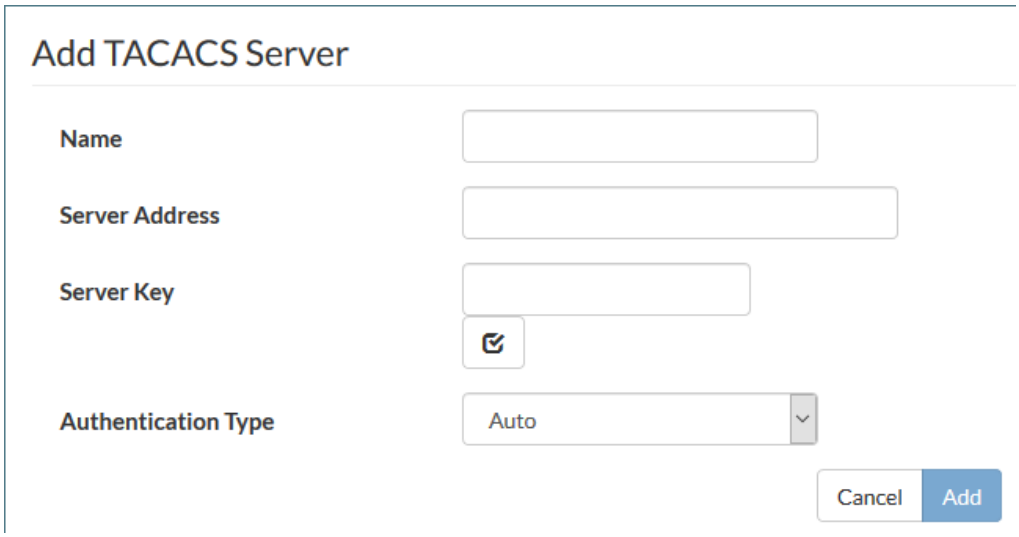
TACACS+ server

TACACS+ is a remote authentication protocol that provides access control for routers, network access servers, and other networked computing devices using one or more centralized servers. TACACS+ allows a client to accept a user name and password and send a query to a TACACS+ authentication server. The server host determines whether to accept or deny the request and sends a response back that allows or denies the user access to the network.

TACACS+ offers fully encrypted packet bodies and supports both IP and AppleTalk protocols. TACACS+ uses TCP port 49, which is seen as more reliable than RADIUS's UDP protocol.

To configure TACACS+ authentication using the GUI:

1. Go to *System* > *Authentication* > *TACACS* and select *Add Server*.



2. Enter the following information and select *Add*.

Field	Description
Name	Enter a name to identify the TACACS server on the FortiSwitch unit.
Server Address	Enter the domain name (such as fgt.example.com) or the IP address of the TACACS server.
Server Key	Enter the server key for the TACACS server.
Authentication Type	Select the authentication type to use for the TACACS+ server. *Auto* tries PAP, MSCHAP, and CHAP (in that order).

To configure the FortiSwitch unit for TACACS+ authentication, see TACACS on page 320.

Configuring system administrators

In addition to the default “admin” account, you might want to set up other administrators with different levels of system access.

This section covers the following topics:

Administrator profiles

Administer profiles define what the administrator user can do when logged into the FortiSwitch unit. When you set up an administrator user account, you also assign an administrator profile, which dictates what the administrator user will see. Depending on the nature of the administrator's work, access level, or seniority, you can allow them to view and configure as much, or as little, as required.

The super_admin administrator is the administrative account that the primary administrator should have to log into the FortiSwitch unit. The profile cannot be deleted or modified to ensure there is always a method to administer the FortiSwitch unit. This user profile has access to all components of the system, including the ability to add and remove other system administrators. For some administrative functions, such as backing up and restoring the configuration using SCP, super_admin access is required.

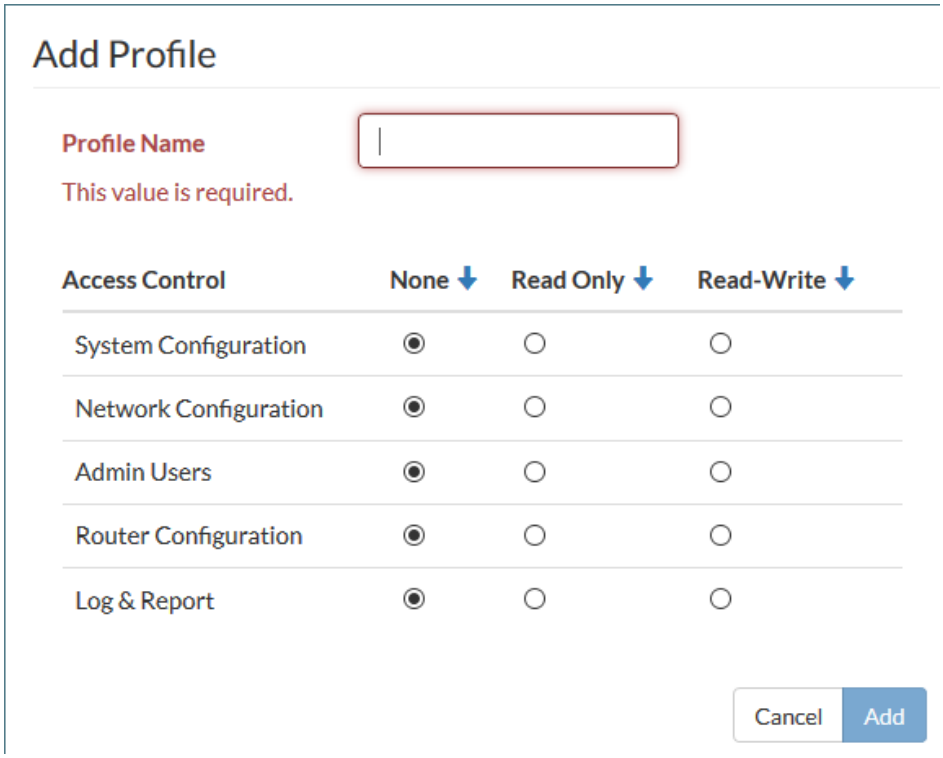
Creating administrator profiles

To configure administrator profiles, go to *System* > *Admin* > *Profiles*. You can only assign one profile to each administrator user.

On the *Add Profile* page, you define the components of the FortiSwitch unit that will be available to view and/or edit. For example, if you configure a profile so that the administrator can only access System Configuration, this admin will not be able to change Network settings. For more detail about what is covered by each access control, see Access control on page 45.

Using the GUI:

1. Go to *System* > *Admin* > *Profiles* and select *Add Profile*.



2. Give the profile an appropriate name.

3. Set *Access Control* as required, selecting *None*, *Read Only*, or *Read-Write* for each line.
4. Select *Add*.

Using the CLI:

```
config system accprofile
   edit <name>
      set admingrp {none | read | read-write}
      set loggrp {none | read | read-write}
      set netgrp {none | read | read-write}
      set routegrp {none | read | read-write}
      set sysgrp {none | read | read-write}
   end
end
```

Access control

The *System Configuration* access control applies to the following menus:

- *System > Dashboard*
- *System > Network > DNS*
- *System > Network > Settings*
- *System > Config > SNMP > Communities*
- *System > Config > SNMP > Users*
- *System > Config > SNMP > Settings*
- *System > Config > Firmware*
- *System > Config > Backup*
- *System > Config > Revisions*
- *System > Config > Licenses*
- *System > Config > Time*
- *System > Config > SSL*
- *System > User > Definition*
- *System > User > Group*
- *System > Authentication > LDAP*
- *System > Authentication > RADIUS*
- *System > Authentication > TACACS*
- *System > Certificate > Local*
- *System > Certificate > Remote*
- *System > Certificate > Authorities*
- *System > Certificate > CRLs*

The *Network Configuration* access control applies to the follow menus:

- *System > Network > Interface > Physical*
- *System > Network > Interface > VLAN*
- *System > Network > Interface > Loopback*
- *Switch > Port > Physical*
- *Switch > Port > Trunk*
- *Switch > Interface > Physical*

- *Switch > Interface > Trunk*
- *Switch > Interface > Port Security*
- *Switch > STP > Settings*
- *Switch > STP > Instances*
- *Switch > Flap Guard*
- *Switch > LLDP-MED > Profiles*
- *Switch > LLDP-MED > Settings*
- *Switch > POE*
- *Switch > sFlow*
- *Switch > Mirror*
- *Switch > VLAN*
- *Switch > Virtual Wires*
- *Switch > Storm Control*
- *Switch > MAC Entries*
- *Switch > IP-MAC Binding*
- *Switch > QoS > 802.1p*
- *Switch > QoS > IP/DSCP*
- *Switch > QoS > Egress Policy*
- *Switch > Monitor > Forwarding Table*
- *Switch > Monitor > Port Stats*
- *Switch > Monitor > Spanning Tree*
- *Switch > Monitor > Modules*
- *Switch > Monitor > LLDP*
- *Switch > Monitor > Loop Guard*
- *Switch > Monitor > Flap Guard*
- *Switch > Monitor > 802.1x Status*

The *Admin Users* access control applies to the following menus:

- *System > Admin > Administrators*
- *System > Admin > Profiles*
- *System > Admin > Monitor*
- *System > Admin > Settings*

The *Router Configuration* access control applies to the following menus:

- *Router > Config > OSPF > Settings*
- *Router > Config > OSPF > Areas*
- *Router > Config > OSPF > Networks*
- *Router > Config > OSPF > Interfaces*
- *Router > Config > RIP > Settings*
- *Router > Config > RIP > Distances*
- *Router > Config > RIP > Networks*
- *Router > Config > RIP > Interfaces*
- *Router > Config > Static*
- *Router > Config > Interface*
- *Router > Config > Link Probes*

- *Router > Monitor > Routing*
- *Router > Monitor > Link*

The *Log & Report* access control applies to the follow menus:

- *Log > Event Log > Link*
- *Log > Event Log > POE*
- *Log > Event Log > Spanning Tree*
- *Log > Event Log > Switch*
- *Log > Event Log > Switch Controller*
- *Log > Event Log > System*
- *Log > Event Log > Router*
- *Log > Event Log > User*
- *Log > Config*

Adding administrators

Only the default “admin” account can create a new administrator account. If required, you can add an additional account with read-write access control to add new administrator accounts.

If you log in with an administrator account that does not have the super_admin admin profile, the administrators list will show only the administrators for the current virtual domain.

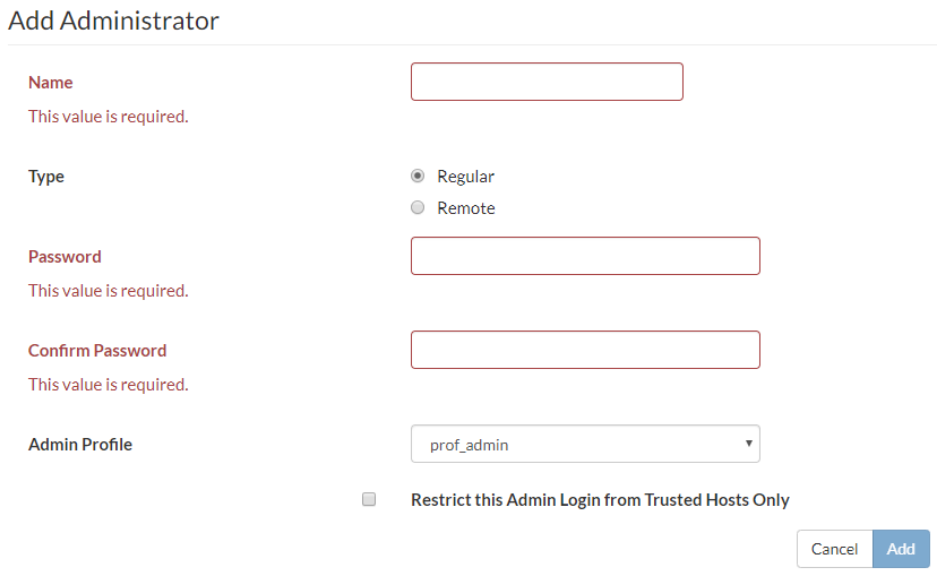
When adding administrators, you are setting up the administrator’s user account. An administrator account comprises an administrator’s basic settings as well as their access profile. The access profile is a definition of what the administrator is capable of viewing and editing.

Follow one of these procedures to add an administrator.

Using the GUI:

1. Go to *System > Admin > Administrators*.

2. Select *Add Administrator*.



3. Enter the administrator name.
4. Select the type of account. If you select *Remote*, the system can reference a RADIUS or TACACS+ server.
5. If you selected *Remote*, select the *User Group* the account will access, whether wildcards are accepted, and whether the access profile group can be overridden.
6. Enter the password for the user. Passwords can be up to 64 characters in length.
7. Select *Add*.

Using the CLI:

```
config system admin
   edit <admin_name>
      set password <password>
      set accprofile <profile_name>
   end
```

Monitoring administrators

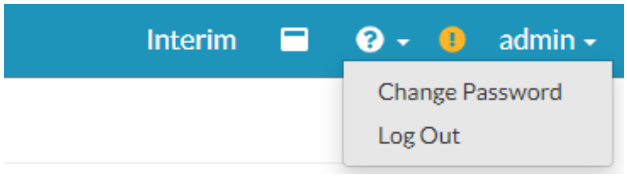
You can find out which administrators are logged in by looking at the *System Information* section of the *Dashboard*. The *Current Administrator* row shows the administrators logged in and the total logged in. Selecting *Details* displays the information for each administrator: where they are logging in from and how and when they logged in.

Setting the default administrator password

By default, your system has an administrator account set up with the user name `admin` and no password. On your first login to the GUI or CLI of a new FortiSwitch unit, you must create a password. You are also forced to create a password after resetting the FortiSwitch configuration to the factory default settings with the `execute factory reset` or `execute factoryresetfull` command.

To change the default password:

1. From the admin menu in the page banner, select *Change Password*.



2. Enter the new password in the *Password* and *Confirm Password* fields. Passwords can be up to 64 characters in length.
3. Select *Change*.

Setting the password retries and lockout time

By default, the system includes a set number of three password retries, allowing the administrator a maximum of three attempts to log into their account before they are locked out for a set amount of time (by default, 60 seconds).

The number of attempts can be set to an alternate value, as well as the default wait time before the administrator can try to enter a password again. You can also change this value to make it more difficult to hack. Both settings are must be configured with the CLI

To configure the lockout options:

```
config system global
   set admin-lockout-threshold <failed_attempts>
   set admin-lockout-duration <seconds>
end
```

For example, to set the lockout threshold to one attempt and the duration before the administrator can try again to log in to five minutes, enter these commands:

```
config system global
   set admin-lockout-threshold 1
   set admin-lockout-duration 300
end
```

Setting the idle timeout

By default, the GUI disconnects administrative sessions if no activity occurs for five minutes. This prevents someone from using the GUI if the management PC is left unattended.

To change the idle timeout:

1. Go to *System* > *Admin* > *Settings*.
2. Enter the time in minutes in the *Idle Timeout (Minutes)* field.
3. Update other settings as required:
   - TCP/UDP port values for HTTP, HTTPS, Telnet, SSH
   - Display language

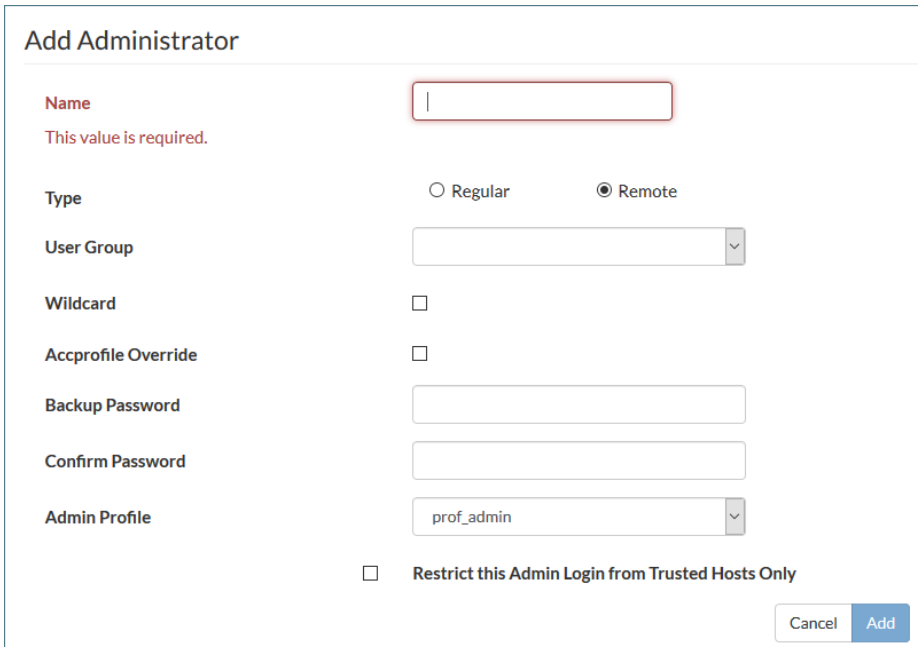
4. Select *Apply*.

Configuring administrative logins

You can configure the RADIUS server to set the access profile. This process uses RADIUS vendor-specific attributes (VSAs) passed to the FortiSwitch unit for authorization. The RADIUS access profile override is mainly used for administrative logins.

Using the GUI:

1. Go to *System* > *Admin* > *Administrators*.
2. Select *Add Administrator*.
3. Select *Remote*.



4. In the Administrator field, enter a name for the RADIUS system administrator.
5. Select the user group.
6. Select *Wildcard*.
7. Select *Accprofile Override*.
8. Select *Add*.

Using the CLI:

The following code creates a RADIUS-system admin group with accprofile-override enabled:

```
config system admin
  edit "RADIUS_Admins"
     set remote-auth enable
     set accprofile no_access
     set wildcard enable
```

```
      set remote-group "RADIUS_Admins"
      set accprofile-override enable
   next
```

Ensure that the RADIUS server is configured to send the appropriate VSA.

To send an appropriate group membership and access profile, set VSA 1 and VSA 6, as in the following code:

```
VENDOR fortinet 12356
ATTRIBUTE Fortinet-Group-Name 1 <admin profile>
ATTRIBUTE Fortinet-Access-Profile 6 <access profile>
```

The value of VSA 1 must match the remote group, and VSA 6 must match a valid access profile.

Using PKI

You can use Public Key Infrastructure (PKI) to require administrators to provide a valid certificate when logging in with HTTPS.

Use the following steps to configure PKI:

1. Configure a peer user.
2. Add the peer user to a user group.
3. Configure the administrator account.
4. Configure the global settings.

To configure a peer user:

```
config user peer
   edit <peer_name>
      set ca <name_of_certificate_authority>
   next
end
```

For example:

```
config user peer
   edit pki_peer_1
      set ca Fortinet_CA
   next
end
```

To add the peer user to a user group:

```
config user group
   edit <group_name>
      set member <peer_name>
   next
end
```

For example:

```
config user group
   edit pki_group_1
      set member pki_peer_1
   next
end
```

To configure the administrator account:

```
config system admin
   edit <admin_name>
      set peer-auth enable
      set peer-group <group_name>
   next
end
```

For example:

```
config system admin
   edit pki_admin_1
      set peer-auth enable
      set peer-group pki_group_1
   next
end
```

To configure the global settings:

```
config system gobal
   set admin-https-pki-required enable
   set clt-cert-req enable
end
```

Configuring security checks

You can enable various security checks for incoming TCP/UDP packets. The packet is dropped if the system detects the specified condition. Use the appropriate syntax for your FortiSwitch model:

- Syntax (for model FS-112D-POE) on page 52
- Syntax (for all other FortiSwitch models) on page 53

Syntax (for model FS-112D-POE)

```
config switch security-feature
   set tcp-syn-data {enable | disable}
   set tcp-udp-port-zero {enable | disable}
   set tcp_flag_zero {enable | disable}
   set tcp_flag_FUP {enable | disable}
   set tcp_flag_SF {enable | disable}
   set tcp_flag_SR {enable | disable}
   set tcp_frag_ipv4_icmp {enable | disable}
   set tcp_arp_mac_mismatch {enable | disable}
```

Variable	Description	Default
tcp-syn-data	TCP SYN packet contains additional data (possible DoS attack).	disable
tcp-udp-port-zero	TCP or UDP packet has source or destination port set to zero.	disable
tcp_flag_zero	TCP packet with all flags set to zero.	disable
tcp_flag_FUP	TCP packet with FIN, URG and PSH flag set.	disable
tcp_flag_SF	TCP packet with SYN and FIN flag set.	disable
tcp_flag_SR	TCP packet with SYN and RST flag set.	disable
tcp_frag_ipv4_icmp	Fragmented ICMPv4 packet.	disable
tcp_arp_mac_mismatch	ARP packet with MAC source address mismatch between the layer- 2 header and the ARP packet payload.	disable

Syntax (for all other FortiSwitch models)

```
config switch security-feature
   set sip-eq-dip {enable | disable}
   set tcp-flag {enable | disable}
   set tcp-port-eq {enable | disable}
   set tcp-flag-FUP {enable | disable}
   set tcp-flag-SF {enable | disable}
   set v4-first-frag {enable | disable}
   set udp-port-eq {enable | disable}
   set tcp-hdr-partial {enable | disable}
   set macsa-eq-macda {enable | disable}
```

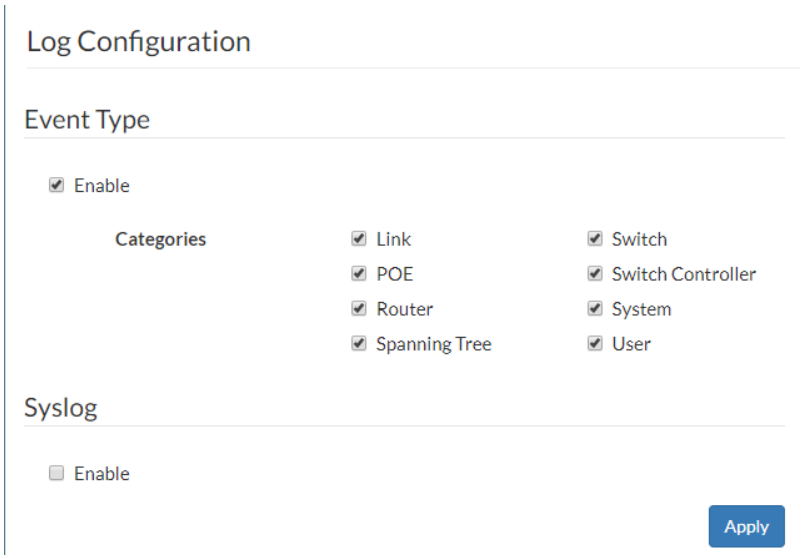
Variable	Description	Default
sip-eq-dip	TCP packet with source IP equal to destination IP.	disable
tcp_flag	DoS attack checking for TCP flags.	disable
tcp-port-eq	TCP packet with source and destination TCP port equal.	disable
tcp-flag-FUP	TCP packet with FIN, URG, and PSH flags set, and sequence number is zero.	disable
tcp-flag-SF	TCP packet with SYN and FIN flag set.	disable
v4-first-frag	DoS attack checking for IPv4 first fragment.	disable
udp-port-eq	IP packet with source and destination UDP port equal.	disable
tcp-hdr-partial	TCP packet with partial header.	disable
macsa-eq-macda	Packet with source MAC equal to destination MAC.	disable

Logging

FortiSwitchOS provides a robust logging environment that enables you to monitor, store, and report traffic information and FortiSwitch events, including attempted log ins and hardware status. Depending on your requirements, you can log to a number of different hosts.

To configure event logging using the GUI:

1. Go to *Log* > *Config*.



2. Under *Event Type*, select *Enable*.
3. Under *Event Type*, select the categories of events that you want logged.
4. Select *Apply*.

To configure event logging using the CLI:

```
config log eventfilter
   set event {enable | disable}
   set link {enable | disable}
   set poe {enable | disable}
   set router {enable | disable}
   set spanning_tree {enable | disable}
   set switch {enable | disable}
   set switch_controller {enable | disable}
   set system {enable | disable}
   set user {enable | disable}
end
```

To view the event logs in the GUI:

1. Go to *Log* > *Entries*.
2. From the *Subtype* dropdown list, select the type of log entries to view.
3. From the *Level* dropdown list, select the severity of events to view.

4. From the *User* dropdown list, select which user or process generated the log entry.
5. From the *User Interface* dropdown list, select the IP network service that applies to the log entry.
6. From the *Action* dropdown list, select the event to view.
7. From the *Status* dropdown list, select the event result to view.

To view the event logs in the CLI:

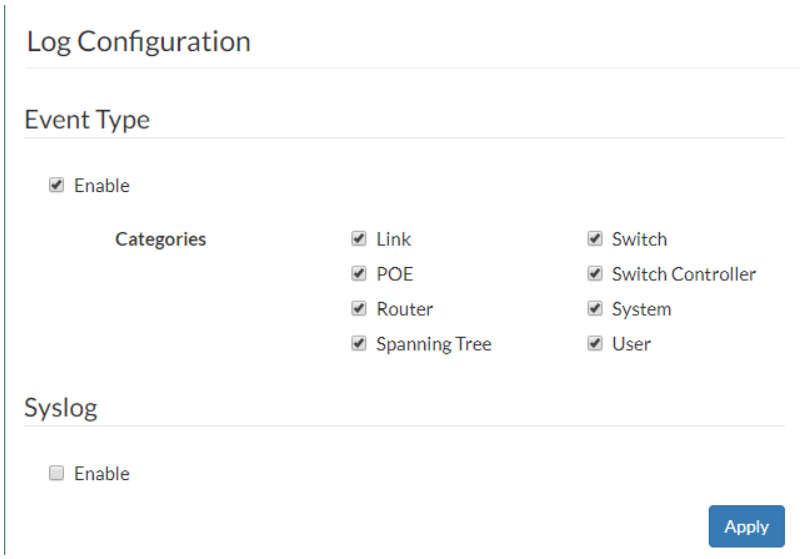
```
show log eventfilter
```

Syslog server

Sysog is an industry standard for collecting log messages for off-site storage. You can send logs to a single syslog server. The syslog server can be configured in the GUI or CLI. Reliable syslog (RFC 6587) can be configured only in the CLI.

To configure a syslog server in the GUI:

1. Go to *Log* > *Config*.



2. Under *Syslog*, select *Enable*.
3. Select the severity of events to log.
4. Enter the IP address or fully qualified domain name in the *Server* field.
5. Enter the port number that the syslog server will use. By default, port 514 is used.
6. Select *Apply*.

To configure a syslog server in the CLI:

```
config log syslogd setting
   set status enable
   set server <IP address or FQDN of the syslog server>
   set port <port number that the syslog server will use for logging traffic>
   set facility <facility used for remote syslog>
   set source-ip <source IP address of the syslog server>
```

```
end
```

For example, to set the source IP address of a syslog server to have an IP address of 192.168.4.5:

```
config log syslogd setting
   set status enable
   set source-ip 192.168.4.5
end
```

To configure a reliable syslog server in the CLI:

```
config log syslogd setting
   set status enable
   set server <IP address or FQDN of the syslog server>
   set mode reliable
   set port <port number that the syslog server will use for logging traffic>
   set enc-algorithm {high | high-medium | low}
   set certificate <certificate_used_to_communicate_with_syslog_server>
end
```

For example:

```
config log syslogd setting
   set status enable
   set source-ip 192.168.4.5
   set mode reliable
   set port 6514 // This is the default port used for reliable syslog.
   set enc-algorithm high-medium
   set certificate "155-sub-client"
end
```

Fault relay support

Fault relays are normally closed relays. When the FSR-112D-POE loses power, the relay contact is in a closed state, and the alarm circuit is triggered.

Using SSH and the Telnet client

Starting in FortiSwitchOS 6.2.0, you can use both IPv4 and IPv6 addresses with SSH and Telnet. If the IPv6 address is a link-local address, you must specify an output interface using %. For example:

```
execute ssh admin@fe80::926c:acff:fe7b:e059%vlan20 // vlan20 is the output interface.
execute ssh admin@172.20.120.122
execute ssh 1002::21
execute ssh 12.345.6.78
execute telnet fe80::926c:acff:fe7b:e059%vlan20 // vlan20 is the output interface.
execute telnet 1002::21
execute telnet 12.345.6.78
```

Configuring SNMP

Simple Network Management Protocol (SNMP) enables you to monitor hardware on your network.

The FortiSwitch SNMP implementation is read-only. SNMP v1-compliant and v2c-compliant SNMP managers have read-only access to FortiSwitch system information through queries and can receive trap messages from the FortiSwitch unit.

To monitor FortiSwitch system information and receive FortiSwitch traps, you must first compile the Fortinet and FortiSwitch management information base (MIB) files. A MIB is a text file that describes a list of SNMP data objects that are used by the SNMP manager. These MIBs provide information that the SNMP manager needs to interpret the SNMP trap, event, and query messages sent by the FortiSwitch SNMP agent.

FortiSwitch core MIB files are available for download by going to *System* > *Config* > *SNMP* > *Settings* and selecting the *FortiSwitch MIB File* download link.

This chapter covers the following topics:

SNMP access

Ensure that the management VLAN has SNMP added to the access-profiles.

Using the GUI:

1. Go to *System* > *Network* > *Interface* > *Physical*.
2. Select *Edit* for the *mgmt* interface.
3. Select *SNMP* in the access section.
4. Select *Update*.

Using the CLI:

```
config system interface
   edit <name>
      set allowaccess <access_types>
   end
end
```

NOTE: Re-enter the existing allowed access types and add `snmp` to the list.

SNMP agent

Create the SNMP agent.

Using the GUI:

1. Go to *System* > *Config* > *SNMP* > *Settings*.
2. Select *Agent Enabled*.
3. Enter a descriptive name for the agent.
4. Enter the location of the FortiSwitch unit.
5. Enter a contact or administrator for the SNMP agent or FortiSwitch unit.
6. Select *Apply*.

Using the CLI:

```
config system snmp sysinfo
   set status enable
   set contact-info <contact_information>
   set description <description_of_FortiSwitch>
   set location <FortiSwitch_location>
end
```

SNMP community

An SNMP community is a grouping of devices for network administration purposes. Within that SNMP community, devices can communicate by sending and receiving traps and other information. One device can belong to multiple communities, such as one administrator terminal monitoring both a FortiGate SNMP and a FortiSwitch SNMP community.

Add SNMP communities to your FortiSwitch unit so that SNMP managers can connect to view system information and receive SNMP traps.

You can add up to three SNMP communities. Each community can have a different configuration for SNMP queries and traps. Each community can be configured to monitor the FortiSwitch unit for a different set of events. You can also add the IP addresses of up to eight SNMP managers for each community.

Adding an SNMP v1/v2c community

Using the GUI:

1. Go to *System* > *Config* > *SNMP* > *Communities*.
2. Select *Add Community*.
3. Enter a community name and identifier.
4. Select *Add Host* and enter the identifier, IP address and netmask, and interface for each host.
5. Select *V1*, *V2C*, or both and enter the port number that the SNMP managers in this community use for SNMP v1 and SNMP v2c queries to receive configuration information from the FortiSwitch unit.

6. Select *V1*, *V2C*, or both and enter the local and remote port numbers that the FortiSwitch unit uses to send SNMP v1 and SNMP v2c traps to the SNMP managers in this community.
7. Select which events to report.
8. Select *Add*.

Using the CLI:

```
config system snmp community
   edit <index_number>
      set events <events_list>
      set name <community_name>
      set query-v1-port <port_number>
      set query-v1-status {enable | disable}
      set query-v2c-port <port_number>
      set query-v2c-status {enable | disable}
      set status {enable | disable}
      set trap-v1-lport <port_number>
      set trap-v1-rport <port_number>
      set trap-v1-status {enable | disable}
      set trap-v2c-lport <port_number>
      set trap-v2c-rport <port_number>
      set trap-v2c-status {enable | disable}
```

Adding an SNMP v3 user

Using the GUI:

1. Go to *System* > *Config* > *SNMP* > *Users*.
2. Select *Add User*.
3. Enter a user name.
4. Select a security level to specify the authentication and privacy settings.
5. Enter the port number that the SNMP managers in this community use to receive configuration information from the FortiSwitch unit.
6. Make certain that *Enable Queries* is enabled.
7. Select *Add*.

Using the CLI:

```
config system snmp user
   edit <index_number>
      set queries enable
      set query-port <port_number>
      set security-level [auth-priv | auth-no-priv | no-auth-no-priv}
         set auth-proto {md5 | sha1 | sha224 | sha256 | sha384 | sha512}
         set auth-pwd <password>
         set priv-proto {aes128 | aes192 | aes192c | aes256 | aes256c | des}
         set priv-pwd <password>
      end
```

Global system and switch settings

This chapter covers the following topics:

Configuration file settings

You can set preferences for saving configuration files:

1. Go to *System* > *Config* > *Backup*.
2. Select one of the Configuration Save options:
   - *Automatically Save*—The system automatically saves the configuration after each change.
   - *Manually Save*—You must manually save configuration changes from the *Backup* link on the *System* > *Dashboard*.
   - *Manually Save and Revert Upon Timeout*—You must manually save configuration changes. The system reverts to the saved configuration after a timeout. You can set the timeout using the CLI:
     ```
     config system global
     set cfg-revert-timeout <integer>
     ```
3. If you select *Revision Backup on Logout*, the FortiSwitch unit creates a configuration file each time a user logs out.
4. If you select *Revision Backup on Upgrade*, the FortiSwitch unit creates a configuration file before starting a system upgrade.
5. Select *Update*.

SSL configuration

You can set strong cryptography and select which certificates are used by the FortiSwitch unit.

Using the GUI:

1. Go to *System* > *Config* > *SSL*.
2. Select *Strong Crypto* to use strong cryptography for HTTPS and SSH access.
3. Select one of the 802.1x certificate options:
   - *Entrust_802.1x*—This certificate is embedded in the firmware and is the same on every unit (not unique). It has been signed by a public CA. This is the default certificate for 802.1x authentication.
   - *Fortinet_Factory*—This certificate is embedded in the hardware at the factory and is unique to this unit. It has been signed by a proper CA.
   - *Fortinet_Factory2*—This certificate is embedded in the hardware at the factory and is unique to this unit. It has been signed by a proper CA.
   - *Fortinet_Firmware*—This certificate is embedded in the firmware and is the same on every unit (not unique). It has been signed by a proper CA. It is not recommended to use it for server-type functionality since any other unit could use this same certificate to spoof the identity of this unit.
4. Select one of the 802.1x certificate authority (CA) options:
   - *Entrust_802.1x_CA*—Select this CA if you are using 802.1x authentication.
   - *Entrust_802.1x_G2_CA*—Select this CA if you want to use the Google Internet Authority G2.
   - *Entrust_802.1x_L1K_CA*—Select this CA if you want to use http://ocsp.entrust.net.
   - *Fortinet_CA*—Select this CA if you want to use the factory-installed certificate.
   - *Fortinet_CA2*—Select this CA if you want to use the factory-installed certificate.
5. Select one of the GUI HTTPS certificate options:
   - *Entrust_802.1x*—This certificate is embedded in the firmware and is the same on every unit (not unique). It has been signed by a public CA.
   - *Fortinet_Factory*—This certificate is embedded in the hardware at the factory and is unique to this unit. It has been signed by a proper CA.
   - *Fortinet_Factory2*—This certificate is embedded in the hardware at the factory and is unique to this unit. It has been signed by a proper CA.
   - *Fortinet_Firmware*—This certificate is embedded in the firmware and is the same on every unit (not unique). It has been signed by a proper CA. It is not recommended to use it for server-type functionality since any other unit could use this same certificate to spoof the identity of this unit.
6. Select *Update*.

Using the CLI:

```
config system global
   set strong-crypto {enable | disable}
   set 802.1x-certificate {Entrust_802.1x | Fortinet_Factory | Fortinet_Factory2 | Fortinet_
        Firmware}
   set 802.1x-ca-certificate {Entrust_802.1x_CA | Entrust_802.1x_G2_CA | Entrust_802.1x_L1K_
        CA | Fortinet_CA | Fortinet_CA2}
   set admin-server-cert {self-sign | Entrust_802.1x | Fortinet_Factory | Fortinet_Factory2
        | Fortinet_Firmware}
end
```

Configuration file revisions

You can select a configuration file revision to revert to.

Using the GUI:

1. Go to *System* > *Config* > *Revisions*.
   The system displays a new page with an entry for each configuration file revision.
2. When you select a revision, the following commands are available:
   - *Deselect All*—deselect all selected revisions.
   - *Delete*—deletes the selected revision file.
   - *Revert*—reverts the system configuration to the selected revision.
   - *Upload*—uploads the selected revision file to your local machine.
3. If you select two revision files, you can select *Diff* to display the differences between the two files.

Using the CLI:

Use the following command to display the list of configuration file revisions:

```
execute revision list config
```

The FortiSwitch unit assigns a numerical ID to each configuration file. To display a particular configuration file contents, use the following command and specify the ID of the configuration file:

```
execute revision show config id <ID number>
```

The following example displays the list of configuration file revisions:

```
# execute revision list config

ID TIME ADMIN FIRMWARE VERSION COMMENT
1 2015-08-31 11:11:00 admin V3.0.0-build117-REL0 Automatic backup (session expired)
2 1969-12-31 16:06:29 admin V3.0.0-build150-REL0 baseline
3 2015-08-31 15:19:31 admin V3.0.0-build150-REL0 baseline
4 2015-08-31 15:28:00 admin V3.0.0-build150-REL0 with admin timeout
```

The following example displays the configuration file contents for revision ID 62:

```
# execute revision show config id 62

#config-version=FS1D24-3.04-FW-build171-160201:opmode=0:vdom=0:user=admin
#conf_file_ver=1784779075679102577
#buildno=0171
#global_vdom=1
config system global
   set admin-concurrent enable
       ...
   (output truncated)
```

IP conflict detection

IP conflicts can occur when two systems on the same network are using the same IP address. The FortiSwitch unit monitors the network for conflicts and raises a system log message and an SNMP trap when it detects a conflict.

The IP conflict detection feature provides two methods to detect a conflict. The first method relies on a remote device to send a broadcast ARP (Address Resolution Protocol) packet claiming ownership of a particular IP address. If the IP address in the source field of that ARP packet matches any of the system interfaces associated with the receiving FortiSwitch system, the system logs a message and raises an SNMP trap.

For the second method, the FortiSwitch unit actively broadcasts gratuitous ARP packets when any of the following events occurs:

- System boot-up
- Interface status changes from down to up
- IP address change

If a system is using the same IP address, the FortiSwitch unit receives a reply to the gratuitous ARP. If it receives a reply, the system logs a message.

Configuring IP conflict detection

IP conflict detection is enabled on a global basis. The default setting is enabled.

Using the GUI:

1. Go to *Network* > *Settings*.
2. Select *Enable IP Conflict Detection*.
3. Select *Apply*.

Using the CLI:

```
config system global
   set detect-ip-conflict <enable|disable>
```

Viewing IP conflict detection

If the system detects an IP conflict, the system generates the following log message:

```
IP Conflict: conflict detected on system interface mgmt for IP address 10.10.10.1
```

Port flap guard

A flapping port is a port that changes status rapidly from up to down. A flapping port can create instability in protocols such as STP. If a port is flapping, STP must continually recalculate the role for each port. Flap guard also prevents unwanted access to the physical ports.

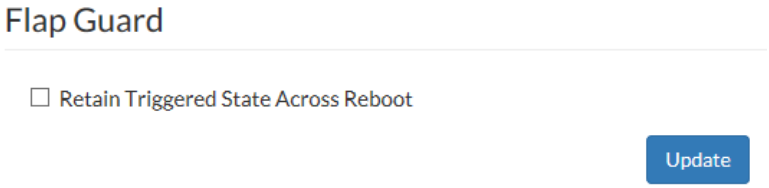
The port flap guard detects how many times a port changes status during a specified number of seconds, and the system shuts down the port if necessary. You can manually reset the port and restore it to the active state.

Retaining the triggered state

When the flap guard is triggered, the status for the port is shown as “triggered” in the output of the `diagnose flapguard status` command. By default, rebooting the switch resets the state of the flap guard and removes the “triggered” state. You can change the setting so that the triggered state remains after a switch is rebooting until the port is reset. See Resetting a port on page 65.

Using the GUI:

1. Go to *Switch* > *Flap Guard*.



2. Select *Retain Triggered State Across Reboot*.
3. Select *Update* to save the change.

Using the CLI:

```
config switch global
   set flapguard-retain-trigger enable
end
```

Configuring the port flap guard

The port flap guard is configured and enabled on each port. The default setting is disabled.

The flap rate counts how many times a port changes status during a specified number of seconds. The range is 1 to 30 with a default setting of 5.

The flap duration is the number of seconds during which the flap rate is counted. The range is 5 to 300 seconds with a default setting of 30 seconds.

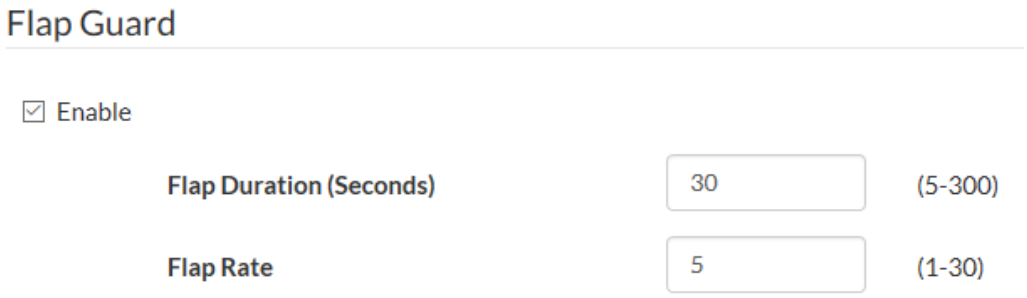
The flap timeout (CLI only) is the number of minutes before the flap guard is reset. The range is 0 to 120 minutes. The default setting of 0 means that there is no timeout.

NOTE:

- If a triggered port times out while the switch is in a down state, the port is initially in a triggered state until the switch has fully booted up and calculated that the timeout has occurred.
- The following models do not store time across reboot; therefore, any triggered port is initially in a triggered state until the switch has fully booted up—at which point the trigger is cleared:
  - FS-1xxE
  - FS-2xxD/E
  - FS-4xxD
  - FS-4xxE

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select a port.
3. Select *Edit*.
4. Under Flap Guard, select *Enable*.



5. Enter values for *Flap Duration (Seconds)* and *Flap Rate*.
6. Select *Update* to save the changes.

Using the CLI:

```
config switch physical-port
   edit <port_name>
      set flapguard {enabled | disabled}
      set flap-rate <1-30>
      set flap-duration <5-300 seconds>
      set flap-timeout <0-120 minutes>
   end
```

For example:

```
config switch physical-port
   edit port10
      set flapguard enabled
      set flap-rate 15
      set flap-duration 100
      set flap-timeout 30
   end
```

Resetting a port

After the flap guard detects that a port is changing status rapidly and the system shuts down the port, you can reset the port and restore it to service.

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select the port that was shut down.
3. Select *Reset*.

Using the CLI:

```
execute flapguard reset <port_name>
```

For example:

```
execute flapguard reset port15
```

Viewing the port flap guard configuration

Use the following command to check if the flap guard is enabled on a specific port:

```
show switch physical-port <port_name>
```

For example:

```
show switch physical-port port10
```

Use the following command to display the port flap guard information for all ports:

```
diagnose flapguard status
```

Link monitor

You can monitor the link to a server. The FortiSwitch unit sends periodic ping messages to test that the server is available. In the CLI, you can use both IPv4 and IPv6 addresses.

Configuring the link monitor

Using the GUI:

1. Go to *Router* > *Config* > *Link Probes*.
2. Select *Add Probe* to create a new probe.
3. Enter an IP address for the *Gateway IP*.
4. Configure the other fields as required (see the table in this section for field descriptions).
5. Select *Add* to create the probe.

Using the CLI:

```
config system link-monitor
   edit <link monitor name>
      set addr-mode {ipv4 | ipv6}
      set srcintf <string>
      set protocol {arp | ping}
      set gateway-ip <IPv4 address>
      set gateway-ip6 <IPv6 address>
      set source-ip <IPv4 address>
      set source-ip6 <IPv6 address>
      set interval <integer>
```

```
      set timeout <integer>
      set failtime <integer>
      set recoverytime <integer>
      set update-static-route {enable | disable}
      set status {enable | disable}
   next
end
```

Variable	Description
<link monitor name>	Enter the link monitor name.
addr-mode {ipv4 | ipv6}	Select whether to use IPv4 or IPv6 addresses. The default is IPv4 addresses.
srcintf <string>	Interface where the monitor traffic is sent.
protocol {arp | ping}	Protocols used to detect the server. Select ARP or ping.
gateway-ip <IPv4 address>	Gateway IPv4 address used to PING the server. This option is available only when `addr-mode` is set to `ipv4`.
gateway-ip6 <IPv6 address>	Gateway IPv6 address used to PING the server. This option is available only when `addr-mode` is set to `ipv6`.
source-ip <IPv4 address>	Source IPv4 address used in packet to the server. This option is available only when `addr-mode` is set to `ipv4`.
source-ip6 <IPv6 address>	Source IPv6 address used in packet to the server. This option is available only when `addr-mode` is set to `ipv6`.
interval <integer>	Detection interval in seconds. The range is 1-3600.
timeout <integer>	Detect request timeout in seconds. The range is 1-255.
failtime <integer>	Number of retry attempts before bringing the server down. The range is 1-10.
recoverytime <integer>	Number of retry attempts before bringing the server up. The range is 1-10.
update-static-route {enable | disable}	Enable or disable update static route. The default is enabled.
status {enable | disable}	Enable or disable link monitor administrative status. The default is enabled.

Unicast hashing

You can configure the trunk hashing algorithm for unicast packets to use the source port:

```
config switch global
   set trunk-hash-unicast-src-port {enable | disable}
end
```

Cut-through switching mode

By default, all FortiSwitch models use the store-and-forward technique to forward packets. This technique waits until the entire packet is received, verifies the content, and then forwards the packet.

The FS-1024D, FS-1048D, and FS-3032D models also have a cut-through switching mode to reduce latency. This technique forwards the packet as soon as the switch receives it.

NOTE: For the FS-3032D model, the cut-through switching mode is not supported on split ports.

To change the switching mode for the main buffer for these three models, use the following commands:

```
config switch global
   set packet-buffer-mode {store-forward | cut-through}
end
```

NOTE: Changing the switching mode might stop traffic on all ports during the change.

Enabling packet forwarding

NOTE: These commands apply only to the 200 Series and 400 Series.

If you want to use layer-3 interfaces and IGMP snooping on certain FortiSwitch models, you must enable the forwarding of reserved multicast packets and IPv6 neighbor-discovery packets to the CPU. These features are enabled by default.

```
config switch global
   set reserved-mcast-to-cpu {enable | disable}
   set neighbor-discovery-to-cpu {enable | disable}
end
```

ARP timeout value

By default, ARP entries in the cache are removed after 180 seconds. Use the following commands to change the default ARP timeout value:

```
config system global
   set arp-timeout <seconds>
end
```

For example, to set the ARP timeout to 1,000 seconds:

```
config system global
   set arp-timeout 1000
end
```

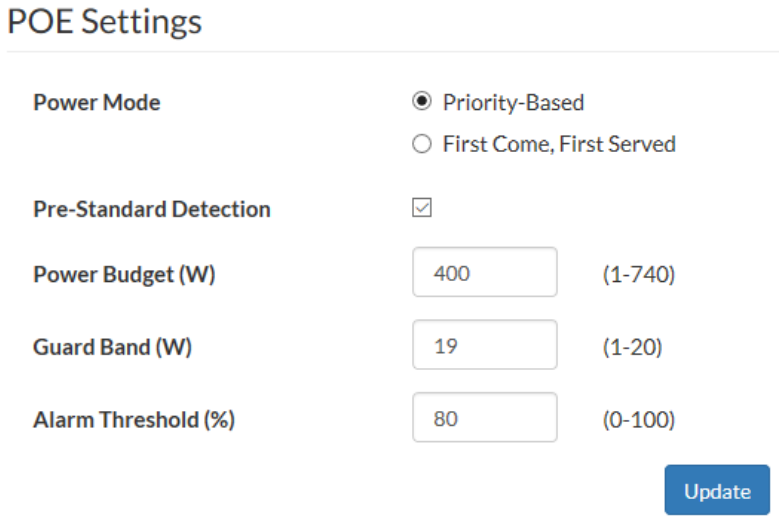
Power over Ethernet configuration

Power over Ethernet (PoE) describes any system that passes electric power along with data on twisted pair Ethernet cabling. Doing this allows a single cable to provide both data connection and electric power to devices (for example, wireless access points, IP cameras, and VoIP phones).

PoE is only available on models with the POE suffix in the model number (for example, FS-108E-POE).

Using the GUI:

1. Go to *Switch* > *POE*.



2. Set the PoE power mode to priority based or first-come, first-served.
   When power to PoE ports is allocated by priority, lower numbered ports have higher priority so that port 1 has the highest priority. When more power is needed than is available, higher numbered ports are disabled first.
   When power to PoE ports is allocated by first-come, first-served (FCFS), connected PoE devices receive power, but new devices do not receive power if there is not enough power.
   If both priority power allocation and FCFS power allocation are selected, the physical port setting takes precedence over the global setting.
3. Enable or disable PoE pre-standard detection.

   PoE pre-standard detection is a global setting for the following FortiSwitch models:
   FSR-112D-POE, FS-548D-FPOE, FS-524D-FPOE, FS-108D-POE, FS-224D-POE, FS-108E-POE, FS-108E-FPOE, FS-124E-POE, and FS-124E-FPOE.
   For the other FortiSwitch PoE models, PoE pre-standard detection is set on each port.

4. Set the maximum power budget in Watts.

5. Enter the power in Watts to reserve in case of a spike in PoE consumption.
6. Enter the threshold (a specified percentage of the total power budget) above which an alarm event is generated. If your FortiSwitch unit has a PoE sensor, you can set an alarm for when the current power budget exceeds a specified percentage of the total power budget. When this threshold is exceeded, log messages and SNMP traps are generated. The default threshold is 80 percent.
7. Select *Update*.

Using the CLI:

```
config switch global
   set poe-alarm-threshold <0-100 percent>
   set poe-power-mode {first-come-first-serverved | priority}
   set poe-guard-band <1-20 Watts>
   set poe-pre-standard-detect {disable | enable}
   set poe-power-budget <1-740 Watts>
end
```

Creating a schedule

Use schedules to control when policies are enforced. For example, you can use a schedule to control when an access control list policy is enforced.

NOTE: If the status of an ACL policy is inactive, the schedule is ignored.

You can create a one-time schedule, a recurring schedule, or a group schedule:

- Use a one-time schedule when you want a policy enforced for a specified period.
- Use a recurring schedule when you want a policy enforced for specified hours and days every week.
- Use a group schedule to combine one-time schedules and recurring schedules.

To create a one-time schedule:

```
config system schedule onetime
   edit <schedule_name>
      set start <time_date>
      set end <time_date>
   end
```

For example:

```
config system schedule onetime
   edit schedule1
      set start 07:00 2019/03/22
      set end 07:00 2019/03/29
   end
```

To create a recurring schedule:

```
config system schedule recurring
   edit <schedule_name>
      set day {monday | tuesday | wednesday | thursday | friday | saturday | sunday}
```

```
      set start <time>
      set end <time>
   end
```

For example:

```
config system schedule recurring
   edit schedule2
      set day monday wednesday friday
      set start 07:00
      set end 08:00
   end
```

To create a group schedule:

```
config system schedule group
   edit <schedule_group_name>
      set member <schedule_name1> <schedule_name2> ...
   end
```

For example:

```
config system schedule group
   edit group1
      set member schedule1 schedule2
   end
```

Overlapping subnets

You can use the `set allow-subnet-inteface` command to allow two interfaces to include the same IP address in the same subnet. The command applies only between the mgmt interface and an internal interface.

NOTE: Different interfaces cannot have overlapping IP addresses or subnets. The same IP address can be used on different switches.

For example:

```
config system global
   set admintimeout 480
   set allow-subnet-overlap enable
   set auto-isl enable
end
config system interface
   edit "mgmt"
      set ip 172.16.86.112 255.255.255.0
      set allowaccess ping https http ssh snmp telnet
      set type physical
      set alias "test"
      set snmp-index 27
   next
   edit "internal"
      set ip 10.0.1.112 255.255.255.0
      set allowaccess ping
      set type physical
```

```
      set alias "testing-2"
      set snmp-index 26
   next
end
```

Configuring PTP transparent-clock mode

Use Precision Time Protocol (PTP) transparent-clock mode to measure the overall path delay for packets in a network to improve the time precision. There are two transparent-clock modes:

- End-to-end measures the path delay for the entire path
- Peer-to-peer measures the path delay between each pair of nodes

Use the following steps to configure PTP transparent-clock mode:

1. Configure the global PTP settings.
   By default, PTP is disabled.
2. Enable the PTP policy.
   By default, the PTP policy is disabled.
3. Apply the PTP policy to a port.

To configure the global PTP settings:

```
config switch ptp settings
   set mode {disable | transparent-e2e | transparent-p2p}
end
```

To enable the PTP policy:

```
config switch ptp policy
   edit {default | <policy_name>}
      set status {enable | disable}
   next
end
```

To apply the PTP policy to a port:

```
config switch interface
   edit <port_name>
      set ptp-policy {default | <policy_name>}
   next
end
```

For example:

```
config switch ptp settings
   set mode transparent-e2e
end

config switch ptp policy
   edit default
```

```
      set status enable
   next
end

config switch interface
   edit port12
      set ptp-policy default
   next
end
```

Configuring auto topology

Use the auto topology feature to automatically form an inter-switch link (ISL) between two switches. You need to enable the feature and specify the mgmt-vlan. The mgmt-vlan is the VLAN to use for the native VLAN on ISL ports and the native VLAN on the internal switch interface.

NOTE: Do not use the same VLAN for the mgmt-vlan and an existing switch virtual interface (SVI).

```
config switch auto-network
   set mgmt-vlan <1-4094>
   set status {enable | disable}
end
```

For example:

```
config switch auto-network
   set mgmt-vlan 101
   set status enable
end

config switch interface
   edit "internal"
      set native-vlan 101
      set allowed-vlans 100-102,4094
      set stp-state disabled
      set snmp-index 53
   next
end
```

Physical port settings

The following sections describe the configuration settings that are associated with FortiSwitch physical ports:

Configuring general port settings

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select the port to update and then select *Edit*.
3. Enter an optional description of the port in the *Description* field.
4. Select *Up* or *Down* for the *Administrative Status*.
5. Select *Update* to save your changes.

Using the CLI:

```
config switch physical-port
   edit <port_name>
      set status {up | down}
      set description <string>
      set max-frame-size <bytes_int>
   end
```

General port settings include:

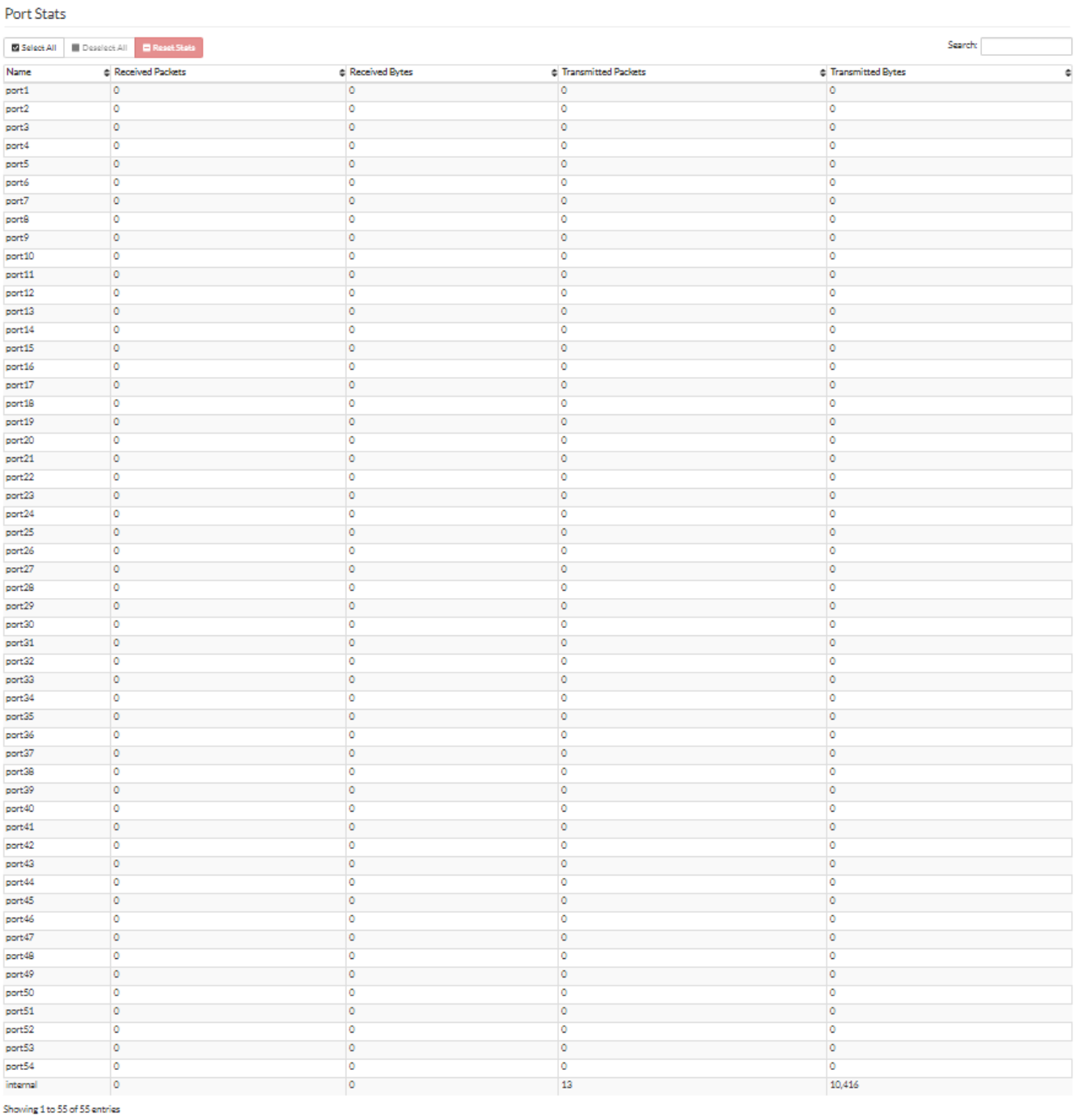
- `status`—Administrative status of the port
- `description`—Text description for the port
- `max-frame-size`—Maximum frame size in bytes (between 68 and 9216)

NOTE: For the eight models in the FS-1xxE series, the `max-frame-size` command is under the `config switch global` command.

Viewing port statistics

Using the GUI:

Go to *Switch* > *Monitor* > *Port Stats*.


Port Stats

Select All | Deselect All | Reset Stats | Search:

Name	Received Packets	Received Bytes	Transmitted Packets	Transmitted Bytes
port1	0	0	0	0
port2	0	0	0	0
port3	0	0	0	0
port4	0	0	0	0
port5	0	0	0	0
port6	0	0	0	0
port7	0	0	0	0
port8	0	0	0	0
port9	0	0	0	0
port10	0	0	0	0
port11	0	0	0	0
port12	0	0	0	0
port13	0	0	0	0
port14	0	0	0	0
port15	0	0	0	0
port16	0	0	0	0
port17	0	0	0	0
port18	0	0	0	0
port19	0	0	0	0
port20	0	0	0	0
port21	0	0	0	0
port22	0	0	0	0
port23	0	0	0	0
port24	0	0	0	0
port25	0	0	0	0
port26	0	0	0	0
port27	0	0	0	0
port28	0	0	0	0
port29	0	0	0	0
port30	0	0	0	0
port31	0	0	0	0
port32	0	0	0	0
port33	0	0	0	0
port34	0	0	0	0
port35	0	0	0	0
port36	0	0	0	0
port37	0	0	0	0
port38	0	0	0	0
port39	0	0	0	0
port40	0	0	0	0
port41	0	0	0	0
port42	0	0	0	0
port43	0	0	0	0
port44	0	0	0	0
port45	0	0	0	0
port46	0	0	0	0
port47	0	0	0	0
port48	0	0	0	0
port49	0	0	0	0
port50	0	0	0	0
port51	0	0	0	0
port52	0	0	0	0
port53	0	0	0	0
port54	0	0	0	0
internal	0	0	13	10,416

Showing 1 to 55 of 55 entries

To clear the statistics on all ports, select *Select All* and then select *Reset Stats*.

To clear the statistics on some of the ports, select the ports and then select *Reset Stats*.

Using the CLI:

```
diagnose switch physical-ports port-stats list [<list_of_ports>]
```

For example:

```
diagnose switch physical-ports port-stats list 1,3,4-6
```

To clear all hardware counters (except for QoS, SNMP, and web GUI counters) on the specified ports:

```
diagnose switch physical-ports set-counter-zero [<list_of_ports>]
```

To restore hardware counters (except for QoS, SNMP, and web GUI counters) on the specified ports:

```
diagnose switch physical-ports set-counter-revert [<list_of_ports>]
```

Configuring flow control, priority-based flow control, and ingress pause metering

Flow control allows you to configure a port to send or receive a “pause frame” (that is, a special packet that signals a source to stop sending flows for a specific time interval because the buffer is full). By default, flow control is disabled on all ports.

```
config switch physical-port
   edit <port_name>
      set flow-control {both | rx | tx | disable}
   end
```

Parameters enable flow control to do the following:

- `rx`—receive pause control frames
- `tx`—transmit pause control frames
- `both`—transmit and receive pause control frames

Priority-based flow control allows you to avoid frame loss by stopping incoming traffic when a queue is congested.

After you enable priority-based flow control, you then configure whether a port sends or receives a priority-based control frame:

```
config switch physical-port
   edit <port_name>
      set priority-based-flow-control enable
      set flow-control {both | rx | tx | disable}
   end
```

When priority-based flow control is disabled, 802.3 flow control can be used.

NOTE: Priority-based flow control does not support half-duplex speed. When FortiSwitch ports are set to autonegotiate the port speed (the default), priority-based flow control is available if the FortiSwitch model supports it. Lossless buffer management and traffic class mapping are not supported.

If you enable flow control to transmit pause control frames (with the `set flow-control tx` command), you can also use ingress pause metering to limit the input bandwidth of an ingress port. Because ingress pause metering stops the traffic temporarily instead of dropping it, ingress pause metering can provide better performance than policing when the port is connected to a server or end station. To use ingress pause metering, you need to set the ingress metering rate in kilobits and set the percentage of the threshold for resuming traffic on the ingress port.

```
config switch physical-port
   edit <port_name>
      set flow-control tx
      set pause-meter-rate <64-2147483647; set to 0 to disable>
      set pause-resume {25% | 50% | 75%}
   next
end
```

For example:

```
config switch physical-port
   edit port29
      set flow-control tx
      set pause-meter-rate 900
      set pause-resume 50%
   next
end
```

Auto-module speed detection

When you enable auto-module speed detection, the system reads information from the module and sets the port speed to the maximum speed that is advertised by the module. If the system encounters a problem when reading from the module, it sets the default speed (default value is platform specific).

When auto-module sets the speed, the system creates a log entry noting this speed.

NOTE: Auto-speed detection is supported on 1/10G ports, but not on higher speed ports (such as 40G).

Setting port speed (autonegotiation)

By default, all of the FortiSwitch user ports are set to autonegotiate the port speed. You can also manually set the port speed. The port speeds available differ, depending on the port and switch.

Using the GUI:

1. Go to *Switch* > *Port* > *Physical* and select the port.
2. Select *Edit*.
3. Select *Auto-Negotiation* or the appropriate port speed.
4. Select *Update*.

Using the CLI:

```
config switch physical-port
   edit <port>
      set speed {1000auto | 100full | 100half | 10full | 10half | auto | 10000cr | 10000full
           | 10000sr | 1000full | auto-module}
   end
```

Viewing auto-module configuration

Display the status of auto-module using following command:

```
config switch physical-port
   edit port47
      show
   end
config switch physical-port
   edit "port47"
      set max-frame-size 16360
      set speed 10000full
   get
      name : port47
      description : (null)
      flow-control : both
      link-status : down
      lldp-transmit : disable
      max-frame-size : 16360
      port-index : 47
      speed : 10000full
      status : up
   end
```

Link-layer discovery protocol

The Fortinet data center switches support LLDP (transmission and reception). The link layer discovery protocol (LLDP) is a vendor-neutral layer-2 protocol that enables devices on a layer-2 segment to discover information about each other.

For details, refer to LLDP-MED on page 126.

Configuring power over Ethernet on a port

You can enable PoE, configure dynamic guard band, and set the priority power allocation for a specific port.

The dynamic guard band is set automatically to the expected power of a port before turning on the port. So, when a PoE device is plugged in, the dynamic guard band is set to the maximum power of the device type based on the AF or AT mode. The AF mode DGB is 15.4 W, and the AT mode DGB is 36 W. When the FortiSwitch unit is fully loaded, the dynamic guard band prevents a new PoE device from turning on.

When power to PoE ports is allocated by priority, lower numbered ports have higher priority so that port 1 has the highest priority. When more power is needed than is available, higher numbered ports are disabled first.

When power to PoE ports is allocated by first-come, first-served (FCFS), connected PoE devices receive power, but new devices do not receive power if there is not enough power.

If both priority power allocation and FCFS power allocation are selected, the physical port setting takes precedence over the global setting.

Enabling or disabling PoE in the GUI

1. Go to *Switch* > *Port* > *Physical*.
2. Select a port and then select *Edit*.
3. For the POE Status, select *Enable* or *Disable*.
4. Select a power priority for the port. You can select *High Priority*, *Critical Priority*, or *Low Priority*. If there is not enough power, power is allotted first to Critical Priority ports, then to High Priority ports, and then to Low Priority ports.
5. Select *Update*.

Configuring PoE in the CLI

```
config switch physical-port
   edit <port>
      set poe-status {enable | disable}
      set poe-port-mode {IEEE802_3AF | IEEE802_3AT}
      set poe-port-priority {critical-priority | high-priority | low-priority}
      set poe-pre-standard-detect {disable | enable}
   end
```

PoE pre-standard detection is a global setting for the following FortiSwitch models: FSR-112D-POE, FS-548D-FPOE, FS-524D-FPOE, FS-108D-POE, FS-224D-POE, FS-108E-POE, FS-108E-FPOE, FS-124E-POE, and FS-124E-FPOE.

For the other FortiSwitch PoE models, PoE pre-standard detection is set on each port.

Determining the PoE power capacity

Using the GUI:

Go to *Switch* > *Port* > *Physical*. The Power column displays the power capacity for each PoE port.

Using the CLI:

```
get switch poe inline
```

Resetting the PoE power

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select a port and then select *POE Reset*.
3. In the confirmation dialog box, select *Reset*.

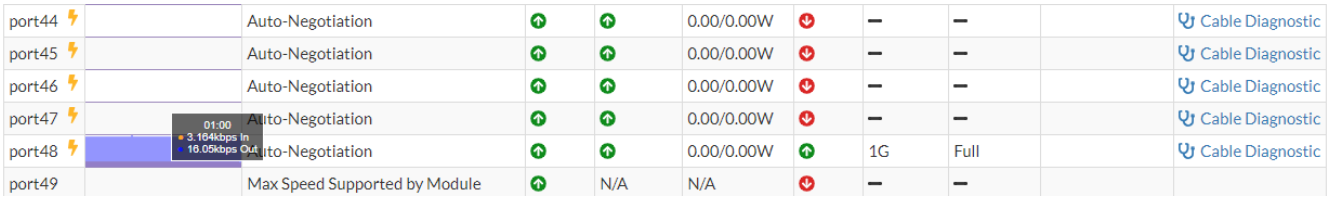
Using the CLI:

```
execute poe-reset <port>
```

Displaying PoE information

Using the GUI:

Go to *Switch* > *Port* > *Physical* to see information about each PoE port. Hover over the traffic column to get specific values.



Using the CLI:

```
diagnose switch poe status <port>
```

The following example displays the information for port 6:

```
diagnose switch poe status port6

Port(6) Power:4.20W, Power-Status: Delivering Power
Power-Up Mode: Normal Mode
Remote Power Device Type: IEEE802.3AT PD
Power Class: 4
Defined Max Power: 30.0W, Priority:3
Voltage: 54.00V
Current: 71mA
```

Energy-efficient Ethernet

When no data is being transferred through a port, energy-efficient Ethernet (EEE) puts the data link in sleep mode to reduce the power consumption of the FortiSwitch unit. When data flows through the port, the port resumes using the normal amount of power. EEE works over standard twisted-pair copper cables and supports 10 Mbps, 100 Mbps, 1 Gps, and 10 Ge. EEE does not reduce bandwidth or throughput.

If you are using the CLI, you can also specify the number of microseconds that circuits are turned off to save power and the number of microseconds during which no data is transmitted while the circuits that were turned off are being restarted.

In addition, you can use the LLDP 802.3 TLV to advertise the EEE configuration.

NOTE: EEE is not supported on SFP and QSFP modules.

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select a port and then select *Edit*.
3. Under Energy-Efficient Ethernet, select *Enable*.
4. To save your changes, select *Update*.

To check which ports have EEE enabled, go to *Switch* > *Port* > *Physical*. A green arrow in the EEE column indicates that EEE is enabled for that port. A red arrow in the EEE column indicates that EEE is disabled for that port.

Using the CLI:

NOTE: When you change the `eee-tx-wake-time` value, the port resets, and the connection is lost briefly.

```
config switch physical-port
   edit <port_name>
      set energy-efficient-ethernet {enable | disable}
      set eee-tx-idle-time <0-2560>
      set eee-tx-wake-time <0-2560>
   end
```

For example, to use EEE on port 7:

```
config switch physical-port
   edit port7
      set energy-efficient-ethernet enable
      set eee-tx-idle-time 500
      set ee-tx-wake-time 200
   end
```

To check that EEE is enabled on port 7:

```
   diagnose switch physical-ports eee-status port7
```

To check which ports have EEE enabled:

```
   diagnose switch physical-ports eee-status
```

To advertise the EEE configuration in the LLDP 802.3 TLV:

```
config switch lldp profile
   edit <profile_name>
      set 802.3-tlvs eee-config
   next
end
```

To check that the EEE configuration is being advertised:

```
diagnose switch physical-ports eee-status
```

Diagnostic monitoring interface module status

With diagnostic monitoring interface (DMI), you can view the following information

- Module details (detail)
- Eeprom contents (eeprom)
- Module limits (limit)
- Module status (status)
- Summary information of all a port's modules (summary)

Using the GUI:

Go to *Switch* > *Monitor* > *Modules*.

Using the CLI:

Use the following commands to enable or disable DMI status for the port. If you set the status to `global`, the port setting will match the global setting:

```
config switch physical-port
   edit <interface>
      set dmi-status {disable | enable | global}
   end
```

Use the `get switch modules detail/status` command to display DMI information:

```
FS108E3W14000720 # get switch modules detail port10
_____________________________________________________________
Port(port10)
identifier SFP/SFP+
connector Unk (0x00)
transceiver 1000-Base-T
encoding 8B/10B
Length Decode Common
length_smf_1km N/A
length_cable 100 meter
SFP Specific
length_smf_100m N/A
length_50um_om2 N/A
length_62um_om1 N/A
length_50um_om3 N/A
vendor FINISAR CORP.
vendor_oid 0x009065
vendor_pn FCLF-8521-3
vendor_rev A
vendor_sn PBR1X35
manuf_date 06/20/2007
```

The following is an example of the output for the `switch modules status` command:

```
FS108E3W14000720 # get switch modules status port9

_____________________________________________________________
Port(port9)
alarm_flags 0x0040
warning_flags 0x0040
temperature 18.792969 C
voltage 3.315100 volts
laser_bias 0.750800 mAmps
tx_power -2.502637 dBm
rx_power -40.000000 dBm
options 0x000F ( TX_DISABLE TX_FAULT RX_LOSS TX_POWER_LEVEL1 )
options_status 0x000C ( RX_LOSS TX_POWER_LEVEL1 )
```

Configuring split ports

On FortiSwitch models that provide 40G QSFP (quad small form-factor pluggable) interfaces, you can install a breakout cable to convert one 40G interface into four 10G interfaces.

Notes

- Splitting ports is supported on the following FortiSwitch models:
  - 3032D (ports 5 to 28 are splittable)
  - 3032E (Ports can be split into 4 x 25G when configured in 100G QSFP28 mode or can be split into 4 x 10G when configured in 40G QSFP mode. Use the `set <port-name>-phy-mode disabled command` to disable some 100G ports to allow up to sixty-two 100G/25G/10G ports.
  - 524D, 524D-FPOE (ports 29 and 30 are splittable)
  - 548D, 548D-FPOE (ports 53 and 54 are splittable)
  - 1048E (In the 4 x 100G configuration, ports 49, 50, 51, and 52 are splittable as 4 x 25G, 4 x 10G, 4 x 1G, or 2 x 50G. Only two of the available ports can be split.)
  - 1048E (In the 4 x 4 x 25G configuration, ports 49, 50, 51, and 52 are splittable as 4 x 4 x 25G or 2 x 50G. All four ports can be split, but ports 47 and 48 are disabled.)
  - 1048E (In the 6 x 40G configuration, ports 49, 50, 51, 52, 53, 54 are splittable as 4 x 10G or 4 x 1G.)

  Use the `set port-configuration ?` command to check which ports are supported for each model.
- Currently, the maximum number of ports supported in software is 64 (including the management port). Therefore, only 10 QSFP ports can be split. This limitation applies to all of the models, but only the 3032D, the 3032E, and the 1048E models have enough ports to encounter this limit.
- Starting in FortiOS 6.2.0, splitting ports is supported in FortiLink mode (that is, the FortiSwitch unit managed by a FortiGate unit).
- Starting in FortiSwitchOS 6.4.0, FC-FEC (cl74) is enabled as the default setting for ports that have been split to 4x25G. Use the following commands to change the setting:

```
config switch physical-port
   edit <split_port_name>
      set fec-state {cl74 | disabled}
   end
```

- Starting in FortiSwitchOS 6.4.0, FC-FEC (cl74) is enabled as the default setting for ports that have been split to 4x100G. Use the following commands to change the setting:

```
config switch physical-port
   edit <split_port_name>
      set fec {cl74 | disabled}
   end
```

- Use `10000full` for the general 10G interface configuration. If that setting does not work, use `10000cr` for copper connections (with copper cables such as 10GBASE-CR) or use `10000sr` for fiber connections (fiber optic transceivers such as 10GBASE-SR/-LR/-ER/-ZR).

Configuring a split port

Use the following commands to configure a split port:

```
config switch phy-mode
   set port-configuration {default | disable-port54 | disable-port41-48 | 4x100G | 6x40G |
        4x4x25G}
   set {<port-name>-phy-mode <single-port| 4x25G | 4x10G | 4x1G | 2x50G}
   ...
   (one entry for each port that supports split port)
end
```

The following settings are available:

- `disable-port54`—For 548D and 548D-FPOE, only port53 is splittable; port54 is unavailable.
- `disable-port41-48`—For 548D and 548D-FPOE, port41 to port48 are unavailable, but you can configure port53 and port54 in split-mode.
- `4x100G`—For 1048E, enable the maximum speed (100G) of ports 49 through 52. Ports 53 and 54 are disabled.
- `6x40G`—For 1048E, enable the maximum speed (40G) of ports 49 through 54.
- `4x4x25G`—For 1048E, enable the maximum speed (100G) of ports 49 through 52; each split port has a maximum speed of 25G. Ports 47 and 48 are disabled.
- `single-port`—Use the port at the full base speed without splitting it.
- `4x25G`—For 100G QSFP only, split one port into four subports of 25 Gbps each.
- `4x10G`—For 40G or 100G QSFP only, split one port into four subports of 10Gbps each.
- `4x1G`—For 40G or 100G QSFP only, split one port into four subports of 1 Gbps each.
- `2x50G`—For 100G QSFP only, split one port into two subports of 50 Gbps each.

In the following example, a FortiSwitch 3032D model is configured with ports 10, 14, and 28 set to 4x10G:

```
config switch phy-mode
   set port5-phy-mode 1x40G
   set port6-phy-mode 1x40G
   set port7-phy-mode 1x40G
   set port8-phy-mode 1x40G
   set port9-phy-mode 1x40G
   set port10-phy-mode 4x10G
   set port11-phy-mode 1x40G
   set port12-phy-mode 1x40G
   set port13-phy-mode 1x40G
   set port14-phy-mode 4x10G
   set port15-phy-mode 1x40G
   set port16-phy-mode 1x40G
   set port17-phy-mode 1x40G
```

```
   set port18-phy-mode 1x40G
   set port19-phy-mode 1x40G
   set port20-phy-mode 1x40G
   set port21-phy-mode 1x40G
   set port22-phy-mode 1x40G
   set port23-phy-mode 1x40G
   set port24-phy-mode 1x40G
   set port25-phy-mode 1x40G
   set port26-phy-mode 1x40G
   set port27-phy-mode 1x40G
   set port28-phy-mode 4x10G
end
```

In the following example, a FortiSwitch 1048E model is configured so that each port is split into four subports of 25 Gbps each.

```
config switch phy-mode
   set port-configuration 4x4x25G
   set port49-phy-mode 4x25G
   set port50-phy-mode 4x25G
   set port51-phy-mode 4x25G
   set port52-phy-mode 4x25G
end
```

The system applies the configuration only after you enter the `end` command, displaying the following message:

```
This change will cause a ports to be added and removed, this will cause loss of
     configuration on removed ports. The system will have to reboot to apply this change.
Do you want to continue? (y/n)y
```

To configure one of the split ports, use the notation ".x" to specify the split port:

```
config switch physical-port
   edit "port1"
      set lldp-profile "default-auto-isl"
      set speed 40000full
   next
   edit "port2"
      set lldp-profile "default-auto-isl"
      set speed 40000full
   next
   edit "port3"
      set lldp-profile "default-auto-isl"
      set speed 40000full
   next
   edit "port4"
      set lldp-profile "default-auto-isl"
      set speed 40000full
   next
   edit "port5.1"
      set speed 10000full
   next
   edit "port5.2"
      set speed 10000full
   next
   edit "port5.3"
      set speed 10000full
```

```
   next
   edit "port5.4"
      set speed 10000full
   next
end
```

Configuring QSFP low-power mode

On FortiSwitch models with QSFP (quad small form-factor pluggable) ports, you can enable or disable the low-power mode with the following CLI commands:

```
config switch physical-port
   edit <port_name>
      set qsfp-low-power-mode {enabled | disabled}
   end
```

For example:

```
config switch physical-port
   edit port12
      set qsfp-low-power-mode disabled
   end
```

Configuring physical port loopbacks

You can use the CLI to loop a physical port back on itself, either locally or remotely:

- The local loopback is a physical-layer loopback. If the hardware does not support a physical-layer loopback, a MAC-address loopback is used instead.
- The remote loopback is a physical-layer lineside loopback.

By default this feature is disabled.

To configure a physical port loopback:

```
config switch physical-port
   edit <port_name>
      set loopback {disable | local | remote}
   next
end
```

Layer-2 interfaces

This chapter covers the following topics:

Switched interfaces

Default configuration will suffice for regular switch ports. By default, VLAN is set to 1, STP is enabled, and all other optional capabilities are disabled.

You can configure optional capabilities such as Spanning Tree Protocol, sFlow , 802.1x authentication, and Private VLANs. These capabilities are covered in subsequent sections of this document.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select one or more interfaces to update and select *Edit*.
   If you selected more than one port, the port names are displayed in the name field, separated by commas.
3. Enter new values as required for the *Native VLAN* and *Allowed VLANs* fields.
4. Select *OK* to save your changes.

Using the CLI:

```
config switch interface
   edit <port>
      set native-vlan <vlan>
      set allowed-vlans <vlan> [<vlan>] [<vlan> - <vlan>]
      set untagged-vlans <vlan> [<vlan>] [<vlan> - <vlan>]
      set stp-state {enabled | disabled}
      set edge-port {enabled | disabled}
```

Viewing interface configuration

Using the GUI:

Go to *Switch* > *Interface* > *Physical*.

Using the CLI:

```
show switch interface <port>
```

Display port settings using following command:

```
config switch interface
   edit <port>
      get
```

Dynamic MAC address learning

You can enable or disable dynamic MAC address learning on a port. The existing dynamic MAC entries are deleted when you change this setting. If you disable MAC address learning, you can set the behavior for an incoming packet with an unknown MAC address (to drop or forward the packet).

You can limit the number of learned MAC addresses on an interface or VLAN. The limit ranges from 1 to 128. If the learning limit is set to zero (the default), no limit exists. When the limit is exceeded, the FortiSwitch unit adds a warning to the system log.

Configuring dynamic MAC address learning

Use the following CLI commands to configure dynamic MAC address learning:

```
config switch physical-port
   edit <port>
      set l2-learning (enable | disable)
      set l2-unknown (drop | forward)
   end
config switch interface
   edit <port>
      set learning-limit <0-128>
   end
config switch vlan
   edit <VLAN_ID>
      set learning {enable | disable}
      set learning-limit <0-128>
   end
```

NOTE: If you enable 802.1x MAC-based authorization on a port, you cannot change the `l2-learning` setting.

Changing when MAC addresses are deleted

By default, each learned MAC address is deleted after 300 seconds. The value ranges from 10 to 1000,000 seconds. Set the value to zero to not delete learned MAC addresses.

Use the following command to change this value:

```
config switch global
   set mac-aging-interval 200
end
```

Logging dynamic MAC address events

By default, dynamic MAC address events are not logged. When you enable logging for an interface, the following events are logged:

- When a dynamic MAC address is learned
- When a dynamic MAC address is moved
- When a dynamic MAC address is deleted

NOTE: Some dynamic MAC address events might take a long time to be logged. If too many events happen within a short period of time, some events might not be logged.

To enable the logging of dynamic MAC address events:

```
config switch interface
   edit <interface_name>
      set log-mac-event enable
   end
```

To view the log entries:

```
execute log display
```

Using the learning-limit violation log

If you want to see the first MAC address that exceeded a learning limit for an interface or VLAN, you can enable the learning-limit violation log for a FortiSwitch unit. Only one violation is recorded per interface or VLAN.

To enable or disable the learning-limit violation log, use the following commands. By default, the learning-limit violation log is disabled. The most recent violation that occurred on each interface or VLAN is logged. After that, no more violations are logged until the log is reset for the triggered interface or VLAN. Only the most recent 128 violations are displayed in the console.

NOTE: The `set log-mac-limit-violations` command is only displayed if your FortiSwitch model supports it.

```
config switch global
   set log-mac-limit-violations {enable | disable}
end
```

To view the content of the learning-limit violation log, use one of the following commands:

- `get switch mac-limit-violations all`—to see the first MAC address that exceeded the learning limit on any interface or VLAN. An asterisk by the interface name indicates that the interface-based learning limit was exceeded. An asterisk by the VLAN identifier indicates the VLAN-based learning limit was exceeded.
- `get switch mac-limit-violations interface <interface_name>`—to see the first MAC address that exceeded the learning limit on a specific interface
- `get switch mac-limit-violations vlan <VLAN_ID>`—to see the first MAC address that exceeded the learning limit on a specific VLAN. This command is only displayed if your FortiSwitch model supports it.

To reset the learning-limit violation log, use one of the following commands:

- `execute mac-limit-violation reset all`—to clear all learning-limit violation logs
- `execute mac-limit-violation reset interface <interface_name>`—to clear the learning-limit violation log for a specific interface

- `execute mac-limit-violation reset vlan <VLAN_ID>`—to clear the learning-limit violation log for a specific VLAN

You can also specify how often the learning-limit violation log is reset, use the following commands:

```
config switch global
   set log-mac-limit-violations enable
   set mac-violation-timer <0-1500>
end
```

For example:

```
config switch global
   set log-mac-limit-violations enable
   set mac-violation-timer 60
end
```

Persistent (sticky) MAC addresses

You can make dynamically learned MAC addresses persistent when the status of a FortiSwitch port changes (goes down or up). By default, MAC addresses are not persistent.

NOTE:

- You cannot use persistent MAC addresses with 802.1x authentication.
- If you move a device within your network that has a sticky MAC address entry on the switch, remove the sticky MAC address entry from the interface. If you move the device and do not clear the sticky MAC address from the original port it was learned on, the new port will not learn the MAC address of the device.

Using the GUI:

1. Go to *Switch* > *MAC Entries*.
2. Select *Add MAC Entry* to create a new item.
3. Select an interface and enter a value for *MAC Address* and *VLAN*.
4. Select *Sticky*.
5. Select *Add* to create the MAC entry.

To delete the persistent MAC addresses instead of saving them in the FortiSwitch configuration file:

1. Go to *Switch* > *Monitor* > *Forwarding Table*.
2. In the *Unsaved sticky MACs on* field, select an interface or select *All*.
3. Select *Delete*.

Using the CLI:

Use the following command to configure the persistence of MAC addresses on an interface:

```
config switch interface
   edit <port>
      set sticky-mac <enable | disable>
   next
end
```

You can also save persistent MAC addresses to the FortiSwitch configuration file so that they are automatically loaded when the FortiSwitch unit is rebooted. By default, persistent entries are lost when a FortiSwitch unit is rebooted. Use the following command to save persistent MAC addresses for a specific interface or all interfaces:

```
execute sticky-mac save {all | interface <interface_name>}
```

Use the following command to delete the persistent MAC addresses instead of saving them in the FortiSwitch configuration file:

```
execute sticky-mac delete-unsaved {all | interface <interface_name>}
```

Static MAC addresses

You can configure one or more static MAC addresses on an interface.

Using the GUI:

1. Go to *Switch* > *MAC Entries*.
2. Select *Add MAC Entry* to create a new item.
3. Select an interface and enter a value for *MAC Address* and *VLAN*.
4. Select *Add* to create the MAC entry.

Using the CLI:

```
config switch static-mac
   edit <sequence_number>
      set description <optional_string>
      set interface <interface_name>
      set mac <static_MAC_address>
      set type {sticky | static}
      set vlan-id <VLAN_ID>
   end
```

For example:

```
config switch static-mac
   edit 1
      set description "first static MAC address"
      set interface port10
      set mac d6:dd:25:be:2c:43
      set type static
      set vlan-id 10
   end
```

Loop guard

A loop in a layer-2 network results in broadcast storms that have far-reaching and unwanted effects. Loop guard helps to prevent loops. When loop guard is enabled on a switch port, the port monitors its subtending network for any downstream loops.

The loop guard feature is designed to work in concert with STP rather than as a replacement for STP. Each port that has loop guard enabled will periodically broadcast loop guard data packets (LGDP) packets to its network. If a broadcast packet is subsequently received by the sending port, a loop exists downstream.

You can also have the port check for a high rate of MAC address moves per second, which indicates a physical loop only when the rate exceeds the threshold for 6 consecutive seconds.

NOTE: If a port detects a loop, the system takes the port out of service to protect the overall network. The port returns to service after a configured timeout duration. If the timeout value is zero, you must manually reset the port.

By default, loop guard is disabled on all ports. When loop guard is enabled, the default `loop-guard-timeout` is 45 minutes, and the default `loop-guard-mac-move-threshold` is 0, which means that the traditional loop guard is used instead of the MAC-move loop guard.

Configuring loop guard

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical* or *Switch* > *Interface* > *Trunk*.
2. Select one or more interfaces to update and then select *Edit*.
   If you selected more than one port, the port names are displayed in the name field, separated by commas.
3. Select *Enable Loop Guard*.
4. Select *OK* to save your changes.

Using the CLI:

```
config switch interface
   edit port <number>
      set loop-guard <enabled | disabled>
      set loop-guard-timeout <0-120 minutes>
      set loop-guard-mac-move-threshold <0-100 MAC address moves per second>
```

When loop guard takes a port out of service, the system creates the following log messages:

```
Loop Guard: loop detected on <port_name>. Shutting down <port_name>
```

Use the following command to reset a port that detected a loop:

```
execute loop-guard reset <port>
```

Viewing the loop guard configuration

Using the GUI:

Go to *Switch* > *Interface* > *Physical* and check the *Loop Guard* column.

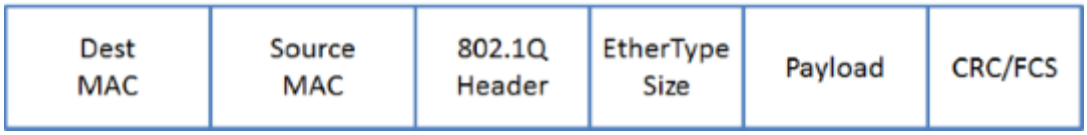
Using the CLI:

```
diagnose loop-guard status
```

VLANs and VLAN tagging

FortiSwitch ports process tagged and untagged Ethernet frames. Untagged frames do not carry any VLAN information.

Tagged frames include an additional header (the 802.1Q header) after the Source MAC address. This header includes a VLAN ID. This allows the VLAN value to be transmitted between switches.



The FortiSwitch unit provides port parameters to configure and manage VLAN tagging.

This chapter covers the following topics:

Native VLAN

You can configure a native VLAN for each port. The native VLAN is like a default VLAN for untagged incoming frames. Outgoing frames for the native VLAN are sent as untagged frames.

The native VLAN is assigned to any untagged frame arriving at an ingress port.

At an egress port, if the frame tag matches the native VLAN, the frame is sent out without the VLAN header.

Allowed VLAN list

The allowed VLAN list for each port specifies the VLAN tag values for which the port can transmit or receive frames.

For a tagged frame arriving at an ingress port, the tag value must match a VLAN on the allowed VLAN list or the native VLAN.

At an egress port, the frame tag must match the native VLAN or a VLAN on the allowed VLAN list.

Untagged VLAN list

The untagged VLAN list on a port specifies the VLAN tag values for which the port will transmit frames without the VLAN tag. Any VLAN in the untagged VLAN list must also be a member of the allowed VLAN list.

The untagged VLAN list applies only to egress traffic on a port.

Frame processing

Ingress processing ensures that the port accepts only frames with allowed VLAN values (untagged frames are assigned the native VLAN, which is implicitly allowed). At this point, all frames are now tagged with a valid VLAN.

The frame is sent to each egress port that can send the frame (because the frame tag value matches the native VLAN or an Allowed VLAN on the port).

Ingress port

For an untagged frame:

- The frame is tagged with the native VLAN and allowed to proceed.
- The Allowed VLAN list is ignored.

For a tagged frame:

- The tag VLAN value must match an Allowed VLAN or the native VLAN.
- The frame retains the VLAN tag and is allowed to proceed.

To control what types of frames are accepted by the port, use the following commands:

```
config switch interface
   edit <interface>
      set discard-mode <all-tagged | all-untagged | none>
   end
```

Variable	Description
all-tagged	Tagged frames are discarded, and untagged frames can enter the switch.
all-untagged	Untagged frames are discarded, and tagged frames can enter the switch.
none	By default, all frames can enter the switch, and no frames are discarded.

Egress port

All frames that arrive at an egress port are tagged frames.

If the frame tag value is on the Allowed VLAN list, the frame is sent out with the existing tag.

If the frame tag value is the native VLAN or on the Untagged VLAN list, the tag is stripped, and then the frame is sent out.

Otherwise, the frame is dropped.

Configuring VLANs

Use the following steps to add VLANs to a physical port interface.

Using the GUI:

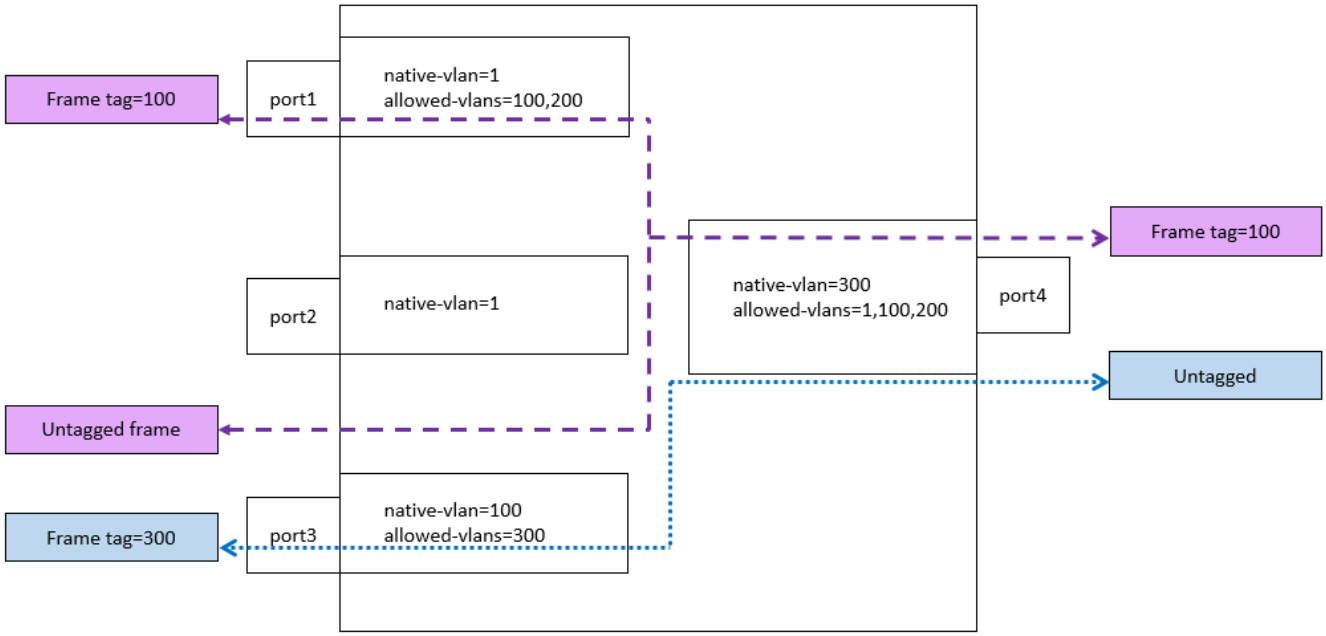
1. Go to *Switch* > *Interface* > *Physical*.
2. On the Physical Port Interfaces page, select a port and then select *Edit*.
3. Give the VLAN an appropriate name.
4. In the Native VLAN field, enter the identifier for the native VLAN of the port.
5. In the Allowed VLANs field, enter one or more identifiers for the allowed VLANs for the port. Separate multiple numbers with commas without any space. For example, `2,4,8-10`.
6. In the Untagged VLANs field, enter one or more identifiers for the untagged VLANs for the port. Separate multiple numbers with commas without any space. For example, `2,4,8-10`.
7. Select *OK*.

Using the CLI:

```
config switch interface
   edit <port>
      set native-vlan <vlan>
      set allowed-vlans <vlan> [<vlan>] [<vlan> - <vlan>]
      set untagged-vlans <vlan> [<vlan>] [<vlan> - <vlan>]
   end
```

Example 1

The following example shows the flows for tagged and untagged frames.



Purple (dashed) flow

An untagged frame arriving at port3 is assigned VLAN 100 (the native VLAN) and flows to all egress ports that will send VLAN 100 (port1 and port4).

A tagged frame (VLAN 100) arriving at port4 is allowed (VLAN 100 is allowed). The frame is sent out from port1 and port3. On port3, VLAN 100 is the native VLAN, so the frame is sent without a VLAN tag.

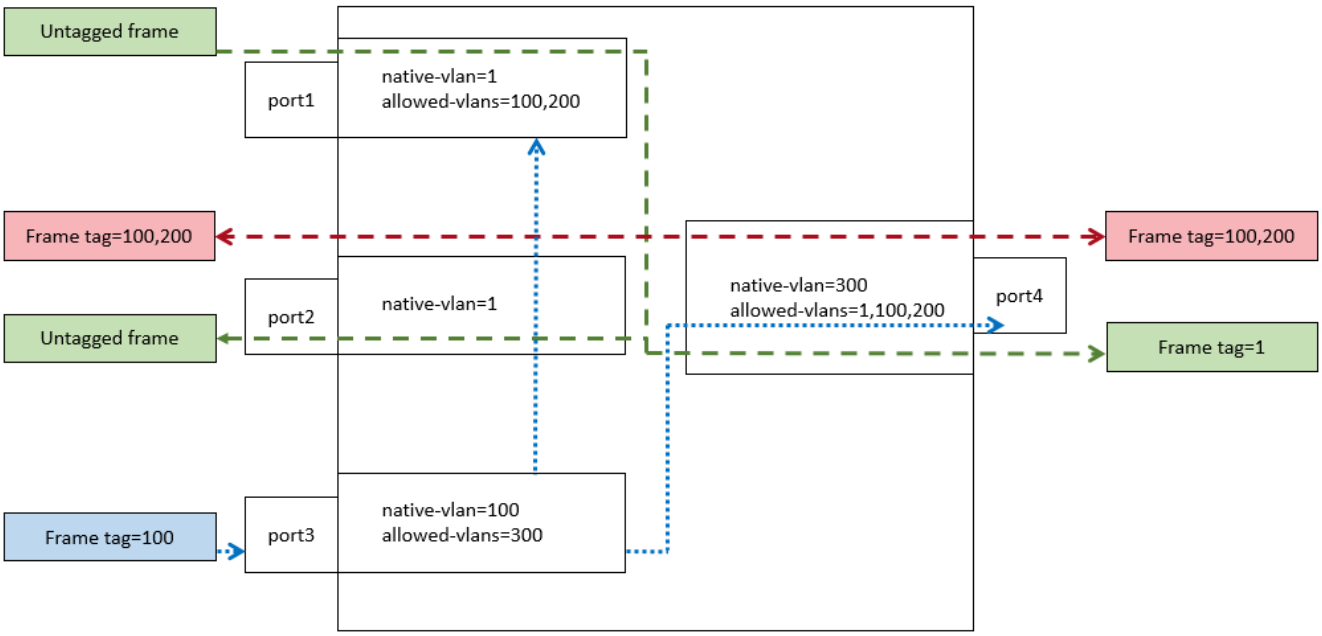
Blue (dotted) flow

An untagged frame arriving at port4 is assigned VLAN 300 (the native VLAN). Then it flows out all ports that will send VLAN 300 (port3).

A tagged frame (VLAN 300) arriving at port3 is allowed. The frame is sent to egress from port4. VLAN 300 is the native VLAN on port4, so the frame is sent without a VLAN tag.

Example 2

The following is an example of an invalid tagged VLAN.



Green (dashed) flow

Between port1 and port2, frames are assigned to VLAN 1 at ingress, and then the tag is removed at egress.

Blue (dotted) flow

Incoming on port3, a tagged frame with VLAN value 100 is allowed because 100 is the port3 native VLAN (the hardware VLAN table accepts a tagged or untagged match to a valid VLAN).

The frame will be sent on port1 and port4 (with frame tag 100).

VLAN stacking (QinQ)

VLAN stacking allows you to have multiple VLAN headers in an Ethernet frame. The value of the EtherType field specifies where the VLAN header is placed in the Ethernet frame.

Use the VLAN TPID profile to specify the value of the EtherType field. The FortiSwitch unit supports a maximum of four VLAN TPID profiles, including the default (0x8100). The default VLAN TPID profile (0x8100) cannot be deleted or changed.

NOTE: The following FortiSwitch models support VLAN stacking:

FS-124D, FS-224D-FPOE, FS-224E, FS-224E-POE, FS-248D, FS-248E-POE, FS-248E-FPOE, FS-424D, FS-424D-POE, FS-424D-FPOE, 424E, 424E-POE, 424E-FPOE, FS-424E-Fiber, 426E-MG-FPOE, FS-448D, FS-448D-POE, FS-448D-FPOE, 448E, 448E-POE, 448E-FPOE, FS-524D, FS-524D-FPOE, FS-548D, FS-548D-FPOE, FS-1024D, FS-1048D, FS-1048E, FS-3032D, and FS-3032E

NOTE: The following features are not supported with VLAN stacking:

- DHCP relay
- DHCP snooping
- IGMP snooping
- IP source guard
- PVLAN
- STP

NOTE: Settings under `config qnq` are for customer VLANs (C-VLANs). Other settings such as `set allowed-vlans`, `set native-vlan`, and `set vlan-tpid` are for service-provider VLANs (S-VLANs).

To configure VLAN stacking (asterisks indicate the default setting):

```
config switch interface
   edit <interface_name>
      set vlan-tpid <default | string>
      config qnq
         set status {enable | *disable}
            set vlan-mapping-miss-drop {enable | *disable}
            set add-inner <1-4095>
            set edge-type customer
            set priority {follow-c-tag | *follow-s-tag}
            set remove-inner {enable | *disable}
            set s-tag-priority <0-7>
            config vlan-mapping
               edit <id>
                  set description <string>
                  set match-c-vlan <1-4094>
                  set new-s-vlan <1-4094>
               next
            end
         end
      next
   end
```

Variable	Description	Default
<interface_name>	Enter the name of the interface.	No default
vlan-tpid <default | string>	Select which VLAN TPID profile to use. The default VLAN TPID profile has a value of 0x8100 and cannot be deleted or changed. This setting is only for service-provider VLANs (S-VLANs). **NOTE:** If you are not using the default VLAN TPID profile, you must have already defined the VLAN TPID profile with the `config switch vlan-tpid` command.	default
config qnq		
status {enable | *disable}	Enable or disable VLAN stacking (QinQ) mode.	disable

Variable	Description	Default
vlan-mapping-miss-drop {enable | *disable}	If the QinQ mode is enabled, enable or disable whether a frame is dropped if the VLAN ID in the frame's tag is not defined in the vlan-mapping configuration.	disable
add-inner <1-4095>	If the QinQ mode is enabled, add the inner tag for untagged frames upon ingress.	No default
edge-type customer	If the QinQ mode is enabled, the edge type is set to customer.	customer
priority {follow-c-tag | *follow-s-tag}	If the QinQ mode is enabled, select whether to follow the priority of the S-tag (service tag) or C-tag (customer tag). **NOTE:** This command is not available on the 224D-FPOE, 248D, 424D, 424D-POE, 424D-FPOE, 448D, 448D-POE, 448D-FPOE, 224E, 224E-POE, 248E-POE and 248E-FPOE models.	follow-s-tag
remove-inner {enable | *disable}	If the QinQ mode is enabled, enable or disable whether the inner tag is removed upon egress.	disable
s-tag-priority <0-7>	If frames follow the priority of the S-tag (service tag), enter the priority value. This option is available only when the priority is set to `follow-s-tag`. **NOTE:** This command is not available on the 224D-FPOE, 248D, 424D, 424D-POE, 424D-FPOE, 448D, 448D-POE, 448D-FPOE, 224E, 224E-POE, 248E-POE and 248E-FPOE models.	0
<id>	Enter a mapping entry identifier.	No default
description <string>	Enter a description of the mapping entry.	No default
match-c-vlan <1-4094>	Enter a matching customer (inner) VLAN.	0
new-s-vlan <1-4094>	Enter a new service (outer) VLAN. **NOTE:** The VLAN must be in the port's allowed VLAN list. This option is only available after you set the value for `match-c-vlan`.	No default

To configure VLAN mapping on an interface (asterisks indicate the default setting):

```
config switch interface
   edit <interface_name>
      set vlan-tpid <default | string>
      set vlan-mapping-miss-drop {enable | *disable}
      config vlan-mapping
         edit <id>
            set description <string>
            set direction ingress // ingress example
            set match-c-vlan <1-4094>
            set action {add | replace}
            set new-s-vlan <1-4094>
```

```
        next
        edit <id>
           set description <string>
           set direction egress // egress example
           set match-s-vlan <1-4094>
           set action {delete | replace}
           set new-s-vlan <1-4094>
        next
     end
  next
end
```

Variable	Description	Default
<interface_name>	Enter the name of the interface.	No default
vlan-tpid <default | string>	Select which VLAN TPID profile to use. The default VLAN TPID profile has a value of 0x8100 and cannot be deleted or changed. This setting is only for service-provider VLANs (S-VLANs). **NOTE:** If you are not using the default VLAN TPID profile, you must have already defined the VLAN TPID profile with the `config switch vlan-tpid` command.	default
vlan-mapping-miss-drop {enable | *disable}	Enable or disable whether a frame is dropped if the VLAN ID in the frame's tag is not defined in the vlan-mapping configuration.	disable
config vlan-mapping		
<id>	Enter an identifier for the VLAN mapping entry.	No default
description <string>	Enter a description of the VLAN mapping entry.	No default
direction {egress | ingress}	Select the ingress or egress direction.	No default
match-s-vlan <1-4094>	If the direction is set to egress, enter the service (outer) VLAN to match.	0
match-c-vlan <1-4094>	If the direction is set to ingress, enter the customer (inner) VLAN to match.	0
action {add | delete | replace}	Select what happens when the frame is matched: - `add`—When the frame is matched, add the service VLAN. You cannot set the `action` to `add` for the egress direction. - `delete`—When the frame is matched, delete the service VLAN. You cannot set the `action` to `delete` for the ingress direction. - `replace`—When the frame is matched, replace the customer VLAN or service VLAN.	No default

Variable	Description	Default
	This option is only available after you set a value for `match-c-vlan` or `match-s-vlan`.	
new-s-vlan <1-4094>	Set the new service (outer) VLAN. This option is only available after you set the action to `add` or `replace` for the ingress direction or after you set the `action` to `replace` for the egress direction.	No default

To configure the VLAN TPID profile:

```
config switch vlan-tpid
   edit <VLAN_TPID_profile_name>
      set ether-type <0x0001-0xfffe>
   next
end
```

Variable	Description	Default
<VLAN_TPID_profile_name>	Enter a name for the VLAN TPID profile name.	No default
ether-type <0x0001-0xfffe>	Enter a hexadecimal value for the EtherType field.	0x8100

To check the VLAN stacking (QinQ) configuration:

```
diagnose switch qnq dtag-cfg
```

Spanning Tree Protocol

The FortiSwitch unit supports the following:

- Spanning Tree Protocol, a link-management protocol that ensures a loop-free layer-2 network topology
- Multiple Spanning Tree Protocol (MSTP), which is based on the IEEE 802.1s standard
- Per-VLAN Rapid Spanning Tree Protocol (also known as Rapid PVST or RPVST); RSTP is defined in the IEEE 802.1w standard

This chapter covers the following topics:

MSTP overview and terminology

MSTP supports multiple spanning tree instances, where each instance carries traffic for one or more VLANs (the mapping of VLANs to instances is configurable).

MSTP is backward-compatible with STP and Rapid Spanning Tree Protocol (RSTP). A layer-2 network can contain switches that are running MSTP, STP, or RSTP.

MSTP is built on RSTP, so it provides fast recovery from network faults and fast convergence times.

Regions

A region is a set of interconnected switches that have the same multiple spanning tree (MST) configuration (region name, MST revision number, and VLAN-to-instance mapping). A network can have any number of regions. Regions are independent of each other because the VLAN-to-instance mapping is different in each region.

The FortiSwitch unit supports 15 MST instances in a region. Multiple VLANs can be mapped to each MST instance. Each switch in the region must have the identical mapping of VLANs to instances.

The MST region acts like a single bridge to adjacent MST regions and to non-MST STPs.

IST

Instance 0 is a special instance, called the internal spanning-tree instance (IST). IST is a spanning tree that connects all of the MST switches in a region. All VLANs are assigned to the IST.

IST is the only instance that exchanges bridge protocol data units (BPDUs). The MSTP BPDU contains information for each MSTP instance (captured in an M-record). The M-records are added to the end of a regular RSTP BPDU. This allows MSTP region to inter-operate with an RSTP switch.

CST

The common spanning tree (CST) interconnects the MST regions and all instances of STP or RSTP that are running in the network.

Hop count and message age

MST does not use the BPDU message age within a region. The message-age and maximum-age fields in the BPDU are propagated unchanged within the region.

Within the region, a hop-count mechanism is used to age out the BPDU. The IST root sends out BPDUs with the hop count set to the maximum number of hops. The hop count is decremented each time the BPDU is forwarded. If the hop count reaches zero, the switch discards the BPDU and ages out the information on the receiving port.

STP port roles

STP assigns a port role to each switch port. The role is based on configuration, topology, relative position of the port in the topology, and other considerations. Based on the port role, the port either sends or receives STP BPDUs and forwards or blocks the data traffic. Here is a brief summary of each STP port role:

- **Designated**—One designated port is elected per link (segment). The designated port is the port closest to the root bridge. This port sends BPDUs on the link (segment) and forwards traffic towards the root bridge. In an STP converged network, each designated port is in the STP forwarding state.
- **Root**—The bridge can have only one root port. The root port is the port that leads to the root bridge. In an STP converged network, the root port is in the STP forwarding state.
- **Alternate**—Alternate ports lead to the root bridge but are not root ports. The alternate ports maintain the STP blocking state.
- **Backup**—This is a special case when two or more ports of the same switch are connected together (either directly or through shared media). In this case, one port is designated, and the remaining ports are backup (in the STP blocking state).

STP loop protection

When an STP blocking port in a redundant topology starts to incorrectly forward traffic, a layer-2 forwarding loop might form. You can use STP loop protection to help prevent these STP loops, but they still might be formed in unique cases.

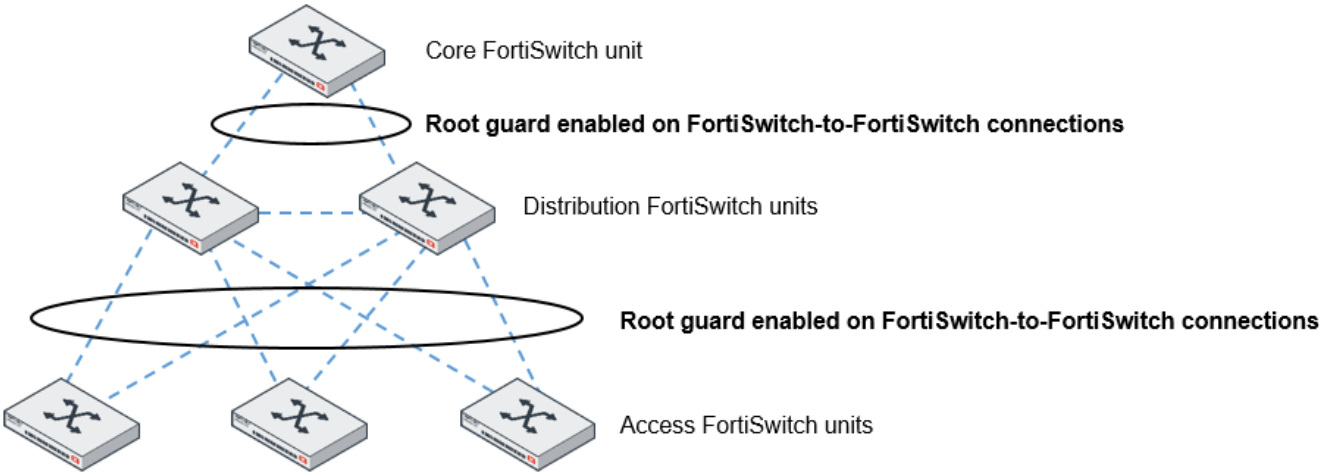
A port remains in blocking state only if it continues to receive BPDU messages. If it stops receiving BPDUs (for example, due to unidirectional link failure), the blocking port (alternate or backup port) becomes designated and transitions to a forwarding state. In a redundant topology, this situation may create a loop.

If the loop-protection feature is enabled on a port, that port is forced to remain in blocking state, even if the port stops receiving BPDU messages. It will not transition to forwarding state and does not forward any user traffic.

The loop-protection feature is enabled on a per-port basis. Fortinet recommends that you enable loop protection on all nondesignated ports (all root, alternate, and backup ports).

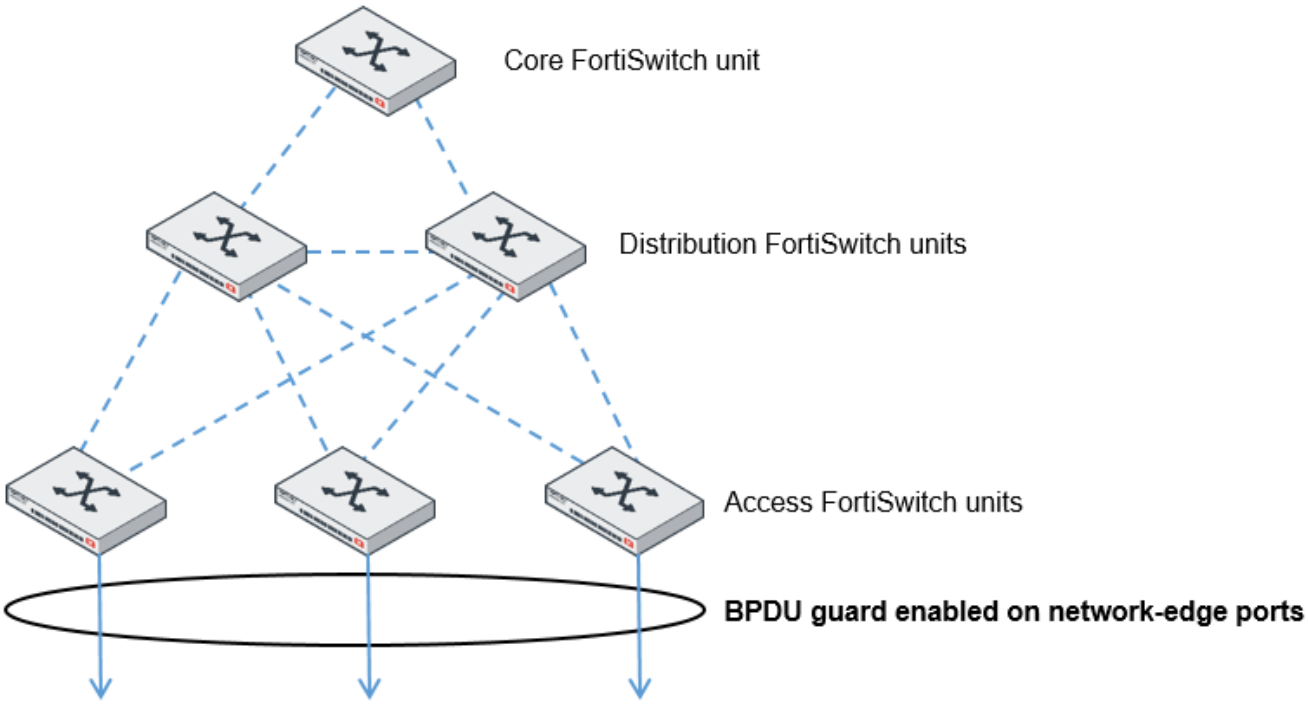
STP root guard

Root guard protects the interface on which it is enabled from becoming the path to root. When enabled on an interface, superior BPDUs received on that interface are ignored or dropped. Without using root guard, any switch that participates in STP maintains the ability to reroute the path to root. Rerouting might cause your network to transmit large amounts of traffic across suboptimal links or allow a malicious or misconfigured device to pose a security risk by passing core traffic through an insecure device for packet capture or inspection. By enabling root guard on multiple interfaces, you can create a perimeter around your existing paths to root to enforce the specified network topology.



STP BPDU guard

Similar to root guard, BPDU guard protects the designed network topology. When BPDU guard is enabled on STP edge ports, any BPDUs received cause the ports to go down for a specified number of minutes. The BPDUs are not forwarded, and the network edge is enforced.



MSTP configuration

MSTP configuration consists of the following steps:

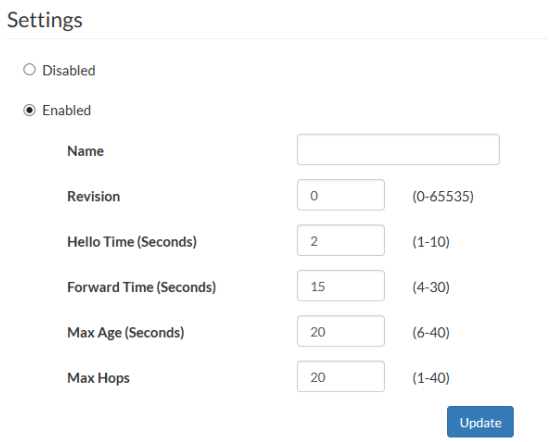
1. Configure STP settings that are common to all MST instances.
2. Configure settings that are specific to each MST instance.
3. Configure loop-protection on all nondesignated ports.

Configuring STP settings

Some STP settings (region name and MST revision number) are common to all MST instances. Also, protocol timers are common to all instances because only the IST sends out BPDUs.

Using the GUI:

1. Go to *Switch* > *STP* > *Settings*.



2. Update the settings as described in the following table.
3. Select *Update* to save the settings.

Settings	Guidelines
Disabled	Disables MSTP for this switch.
Flood BPDU Packets	Select this checkbox if you want the STP packets arriving at any port to pass through the switch without being processed. If you do not select this checkbox, STP packets arriving at any port are blocked. This option is only available when MSTP is disabled.
Enabled	Enables MSTP for this switch.
Name	Region name. All switches in the MST region must have the identical name.
Revision	The MSTP revision number. All switches in the region must have the same revision number. The range of values is 0 to 65535. The default value is 0.
Hello Time (Seconds)	Hello time is how often (in seconds) that the switch sends out a BPDU. The range of values is 1 to 10. The default value is 2.
Forward Time (Seconds)	Forward time is how long (in seconds) a port will spend in the listening-and-learning state before transitioning to forwarding state. The range of values is 4 to 30. The default value is 15.
Max Age (Seconds)	The maximum age before the switch considers the received BPDU information on a port to be expired. Max-age is used when interworking with switches outside the region. The range of values is 6 to 40. The default value is 20.

Settings	Guidelines
Max Hops	Maximum hops is used inside the MST region. Hop count is decremented each time the BPDU is forwarded. If max-hops reaches zero, the switch discards the BPDU and ages out the information on the receiving port. The range of values is 1 to 40. The default value is 20.

Using the CLI:

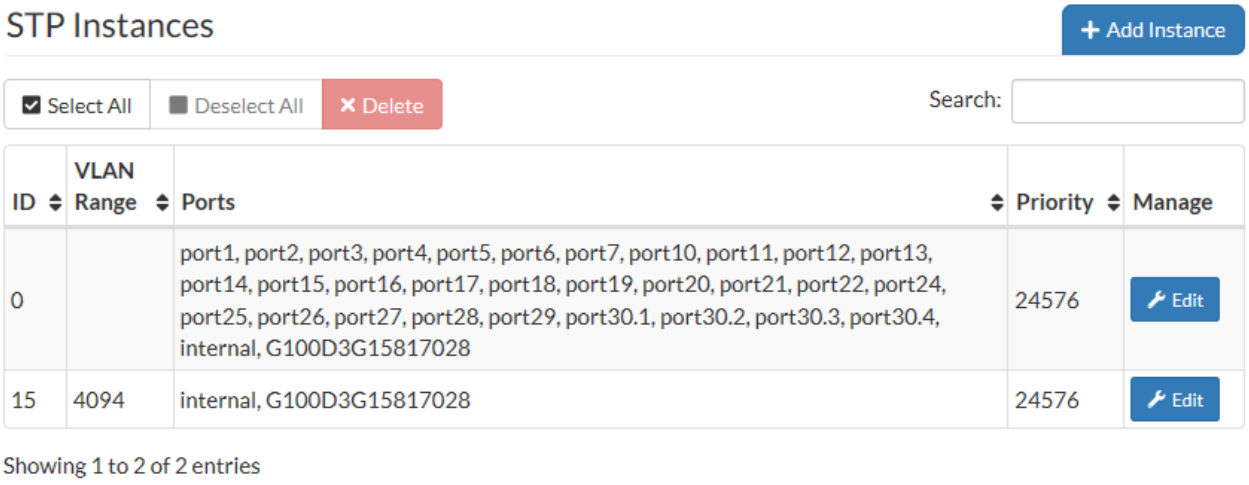
```
config switch stp settings
   set flood {enable | disable}
   set forward-time <fseconds_int>
   set hello-time <hseconds_int>
   set max-age <age>
   set max-hops <hops_int>
   set mclag-stp-bpdu {both | single}
   set name <name_str>
   set revision <rev_int>
   set status {enable | disable}
end
```

Configuring an MST instance

The STP topology is unique for each MST instance in the region. You can configure a different bridge priority and port parameters for each instance.

Using the GUI:

1. Go to *Switch* > *STP* > *Instances*.



2. Select *Add Instance* to create a new MST instance or select an existing instance and then select *Edit*.
3. Update the instance parameters as described in the following table.
4. Select *Add* or *Update* to save the settings.

Settings	Guidelines
ID	Instance identifier. The range is 0-32 for 5xx models and higher. For all other models, the range is 0 - 15.
Priority	Priority is a component of bridge ID. The switch with the lowest bridge ID becomes the root switch for this MST instance. Allowed values: 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440. The default value is 32768.
VLAN Range	The VLANs that map to this MST instance. You can specify individual VLAN numbers or a range of numbers. **NOTE:** Do not assign any VLAN to more than one MST instance. Each VLAN number is in the range 1-4094.
Port Configuration	
Name	Port that will participate in this MST instance.
Cost	The switch uses port cost to select designated ports. Port cost is added to the received BPDU root cost in any BPDU sent on this port. A lower value is preferred. The range of values is 1 to 200,000,000. The default value depends on the interface speed: - 10 Gigabit Ethernet: 2,000 - Gigabit Ethernet: 20,000 - Fast Ethernet: 200,000 - Ethernet: 2,000,000
Priority	The switch uses port priority to choose among ports of the same cost. The port with the lowest priority is put into forwarding state. The valid values are: 0, 32, 64, 96, 128, 160, 192, and 224. The default value is 128.

Using the CLI:

```
config switch stp instance
   edit <instance number>
      set priority <>
      config stp-port
         edit <port name>
            set cost <>
            set priority <>
         next
      set vlan-range <vlan range>
   end
```

Example:

```
config switch stp instance
   edit "1"
      set priority 8192
      config stp-port
         edit "port18"
            set cost 0
            set priority 128
         next
         edit "port19"
            set cost 0
            set priority 128
         next
      end
      set vlan-range 5 7 11-20
   end
```

Configuring an STP edge port

You can use the edge-port setting when a device connected to a FortiSwitch port is not an STP bridge. When this setting is enabled, the FortiSwitch port immediately moves to a forwarding state rather than passing through listening and learning states.

By default, STP (and edge port) is enabled on all ports.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. On the Physical Port Interfaces page, select a port and then select *Edit*.
3. Under Edge Port, select *Enable*.
4. Select *OK* to save the settings.

Using the CLI:

```
config switch interface
   edit <port_name>
      set edge-port <enabled | disabled>
   next
end
```

Configuring STP loop protection

By default, STP loop protection is disabled on all ports.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. On the Physical Port Interfaces page, select a port and then select *Edit*.
3. Under Loop Guard, select *Enable*.
4. Select *OK* to save the settings.

Using the CLI:

```
config switch interface
   edit <port_name>
      set stp-loop-protection <enabled | disabled>
   next
end
```

Configuring STP root guard

Enable root guard on all ports that should not be root bridges. Do not enable root guard on the root port. You must have STP enabled to be able to use root guard.

Using the CLI:

```
config switch interface
   edit <port_name>
      set stp-root-guard <enable | disable>
   next
end
```

For example, to enable root guard on port 20:

```
config switch interface
   edit port20
      set stp-state enabled
      set stp-root-guard enable
   next
end
```

Configuring STP BPDU guard

There are three prerequisites for using BPDU guard:

- You must define the port as an edge port with the `set edge-port enabled` command.
- You must enable STP on the switch interface with the `set stp-state enabled` command.
- You must enable STP on the global level with the `set status enable` command.

You can set how long the port will go down for when a BPDU is received for a maximum of 120 minutes. The default port timeout is 5 minutes. If you set the timeout value to 0, the port will not go down when a BPDU is received, but you will have manually reset the port.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. On the Physical Port Interfaces page, select a port and then select *Edit*.
3. Under Edge Port, select *Enable* and *BPDU Guard*.
4. In the Timeout (Minutes) field, enter how many minutes the port will go down for when a BPDU is received.
5. Select *OK* to save the settings.

To check if BPDU guard has been triggered and on which ports, go to *Switch* > *Monitor* > *BPDU Guard*.

Using the CLI:

```
config switch interface
   edit <port_name>
      set stp-bpdu-guard <enabled | disabled>
      set stp-bpdu-guard-timeout <0-120>
   next
end
```

For example, to enable BPDU guard on port 30 with a timeout value of 1 hour:

```
config switch stp settings
   set status enable
end
config switch interface
   edit port30
      set stp-state enabled
      set edge-port enabled
      set stp-bpdu-guard enabled
      set stp-bpdu-guard-timeout 60
   next
end
```

If you set the port timeout to 0, you will need to reset the port after it receives BPDUs and goes down. Use the following command to reset the port:

```
execute bpdu-guard reset <port_name>
```

To check if BPDU guard has been triggered and on which ports, use the following command:

```
diagnose bpdu-guard display status

Portname              State      Status       Timeout(m)    Count    Last-Event
____________________  ________   __________   ___________   ______   ____________________

port1               disabled     -              -             -            -
port2               disabled     -              -             -            -
port3               disabled     -              -             -            -
port4               disabled     -              -             -            -
port5               disabled     -              -             -            -
port6               disabled     -              -             -            -
port7               disabled     -              -             -            -
port8               disabled     -              -             -            -
port9               disabled     -              -             -            -
port10              disabled     -              -             -            -
port11              disabled     -              -             -            -
port12              disabled     -              -             -            -
port13              disabled     -              -             -            -
port14              disabled     -              -             -            -
port15              disabled     -              -             -            -
port16              disabled     -              -             -            -
port17              disabled     -              -             -            -
port18              disabled     -              -             -            -
port19              disabled     -              -             -            -
```

```
port20              disabled     -              -              -              -
port21              disabled     -              -              -              -
port22              disabled     -              -              -              -
port23              disabled     -              -              -              -
port25              disabled     -              -              -              -
port26              disabled     -              -              -              -
port27              disabled     -              -              -              -
port28              disabled     -              -              -              -
port29              disabled     -              -              -              -
port30              enabled      -              60             0              -
__FoRtI1LiNk0__     disabled     -              -              -              -
```

You can also check BPDU guard by going to the *Monitor* > *BPDU Guard* page.

Interactions outside of the MSTP region

A boundary port on an MST switch is a port that receives an STP (version 0) BPDU, an RSTP (version 2) BPDU, or a BPDU from a different MST region.

If the port receives a version 0 BPDU, it will only send version 0 BPDUs on that port. Otherwise, it will send version 3 (MST) BPDUs because the RSTP switch will read this as an RSTP BPDU.

Viewing the MSTP configuration

To view the MSTP configuration details, use the following commands:

```
get switch stp instance
get switch stp settings
```

Use the following commands to display information about the MSTP instances in the network:

```
diagnose stp instance list
diagnose stp vlan list
diagnose stp mst-config list
```

Support for interoperation with Rapid per-VLAN RSTP (Rapid PVST+ or RPVST+)

Starting in FortiSwitchOS 6.2.2, FortiSwitch units can now interoperate with a network that is running RPVST+. The existing network's configuration can be maintained while adding FortiSwitch units as an extended region.

When an MSTP domain is connected with an RPVST+ domain, FortiSwitch interoperation with the RPVST+ domain works in two ways:

- If the root bridge for the CIST is within an MSTP region, the boundary FortiSwitch unit of the MSTP region duplicates instance 0 information, creates one BPDU for every VLAN, and sends the BPDUs to the RPVST+ domain.

In this case, follow this rule: If the root bridge for the CIST is within an MSTP region, VLANs other than VLAN 1 defined in the RPVST+ domains must have their bridge priorities worse (numerically greater) than that of the CIST root bridge within MSTP region.

- If the root bridge for the CIST is within an RPVST+ domain, the boundary FortiSwitch unit processes only the VLAN 1 information received from the RPVST+ domain. The other BPDUs (VLANs 2 and above) sent from the connected RPVST+ domain are used only for consistency checks.

  In this case, follow this rule: If the root bridge for the CIST is within the RPVST+ domain, the root bridge priority of VLANs other than VLAN 1 within that domain must be better (numerically less) than that of VLAN 1.

Configuring Rapid PVST or RPVST+ interoperation support

Using the CLI:

Enable the RPVST+ interoperation support on the appropriate switch port or trunk.

```
config switch interface
   edit <interface_name>
      set allowed-vlans <one or more VLANs> // The VLANs must be configured for RSTP.
      set rpvst-port enabled
   next
end
```

For example, to enable RPVST+ interoperation support on port 9:

```
config switch interface
   edit "port9"
      set allowed-vlans 10,20
      set rpvst-port enabled
   next
end
```

For example, to enable RPVST+ interoperation support on trunk 1:

```
config switch interface
   edit "trunk1"
      set allowed-vlans 10,20
      set rpvst-port enabled
   next
end
```

Note: A maximum of 16 VLANs is supported; the maximum number of VLANs includes native VLANs. You must configure the same VLANs as those used in the RPVST+ domain.

Viewing the configuration

Use one of the following commands to check your configuration and to diagnose any problems.

- `diagnose stp instance list`

  If either rule is violated, the RPVST port is flagged with “IC” in the command output, and the port is in the Discard

state.

If the VLANs used by the RPVST+ domain are not all within the VLAN range configured on the RPVST port, an “MV” flag is displayed in the command output. **NOTE:** Only the ports in instance 0 show this flag.

- `diagnose stp rapid-pvst-port list`

  This command shows the status of one port or all ports. If any of the ports is in the “IC” state, the command output gives the reason: VLAN priority inconsistent, VLAN configuration mismatch, or both.

- `diagnose stp rapid-pvst-port clear`

  This command clears all flags and timers on the RPVST+ port.

Link aggregation groups

This section provides information on how to configure a link aggregation group (LAG). For LAG control, the FortiSwitch unit supports the industry-standard Link Aggregation Control Protocol (LACP). The FortiSwitch unit supports LACP in active and passive modes. In active mode, you can optionally specify the minimum and maximum number of active members in a trunk group.

If the trunk is in LACP mode and has ports with different speeds, the ports of the same negotiated speed are grouped in an aggregator.

If multiple aggregators exist, one and only one of the aggregators is used by the trunk.

You can use the CLI to specify how the aggregator is selected:

- When the `aggregator-mode` is set to `bandwidth`, the aggregator with the largest bandwidth is selected. This mode is the default.
- When the `aggregator-mode` is set to `count`, the aggregator with the largest number of ports is selected.

The FortiSwitch unit supports flap-guard protection for switch ports in a LAG.

This section covers the following topics:

Configuring the trunk and LAG ports

It is important to configure the trunk to prevent loops.

Using the GUI:

1. Go to *Switch* > *Port* > *Trunk* and select *Add Trunk*.
2. Give the trunk an appropriate name.
3. For the mode, select *Static*, *LACP Active*, *LACP Passive*, or *Fortinet Trunk*.
4. Add the required ports to the *Included* list.
5. Select *Create*.

Using the CLI:

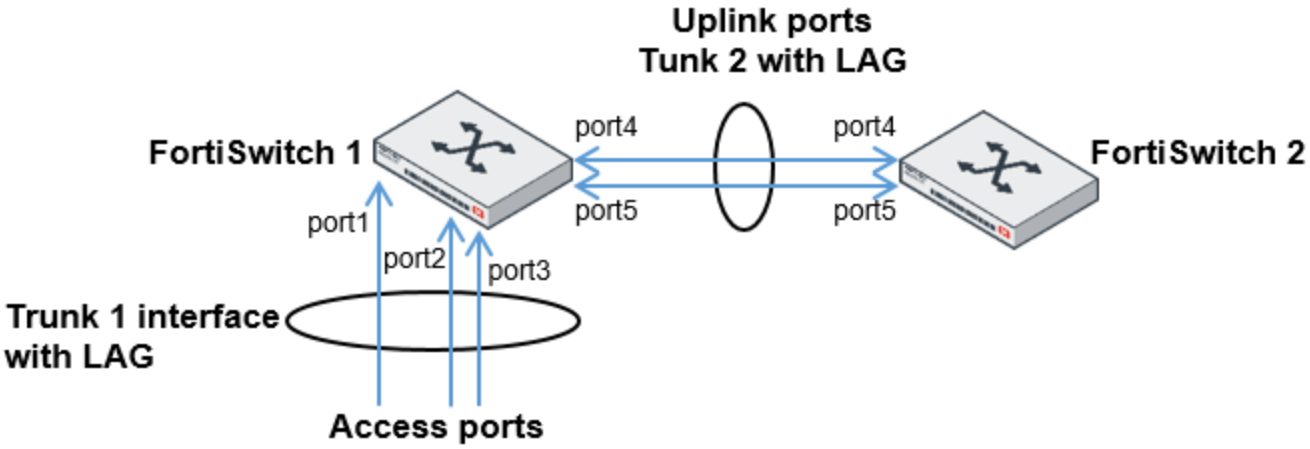
```
config switch trunk
   edit <trunk name>
      set aggregator-mode {bandwidth | count}
      set description <description_string>
      set members <ports>
```

```
      set mode {lacp-active | lacp-passive | static}
      set member-withdrawal-behavior {block | forward}
      set lacp-speed {fast | slow}
      set bundle [enable|disable]
         set min_bundle <integer>
         set max_bundle <integer>
      set port-selection-criteria
           {src-ip | src-mac | dst-ip |dst-mac | src-dst-ip |src-dst-mac}
   end
end
```

Example configuration

The following is an example CLI configurations for trunk/LAG ports:

Trunk/LAG ports



1. Configure the trunk 1 interface and assign member ports as a LAG group:

```
config switch trunk
   edit trunk1
      set members "port1" "port2" "port3"
      set description test
      set mode lacp-passive
      set port-selection-criteria src-dst-ip
   end
```

2. Configure the switch ports to have native VLAN assignments and allow those VLANs on the port that will be the uplink port:

```
config switch interface
   edit port1
      set native-vlan 1
   next
   edit port2
      set native-vlan 2
```

```
    next
    edit port3
      set native-vlan 3
    next
    edit port4
      set native-vlan 4
      set allowed vlans 1 2 3
    next
    edit port5
      set native-vlan 5
      set allowed-vlans 1 2 3
    end
end
```

3. Configure the trunk 2 interface and assign member ports as a LAG group:

```
config switch trunk
   edit trunk2
      set members "port4" "port5"
      set description test
      set mode lacp-passive
      set port-selection criteria src-dst-ip
   end
end
```

Checking the trunk configuration

Using the GUI:

Go to *Switch* > *Port* > *Trunk* or *Switch* > *Monitor* > *Trunks*.

Using the CLI:

```
diagnose switch trunk list
```

MCLAG

A link aggregation group (LAG) provides link-level redundancy. A multichassis LAG (MCLAG) provides node-level redundancy by grouping two FortiSwitch models together so that they appear as a single switch on the network. If either switch fails, the MCLAG continues to function without any interruption, increasing network resiliency and eliminating the delays associated with the Spanning Tree Protocol (STP).

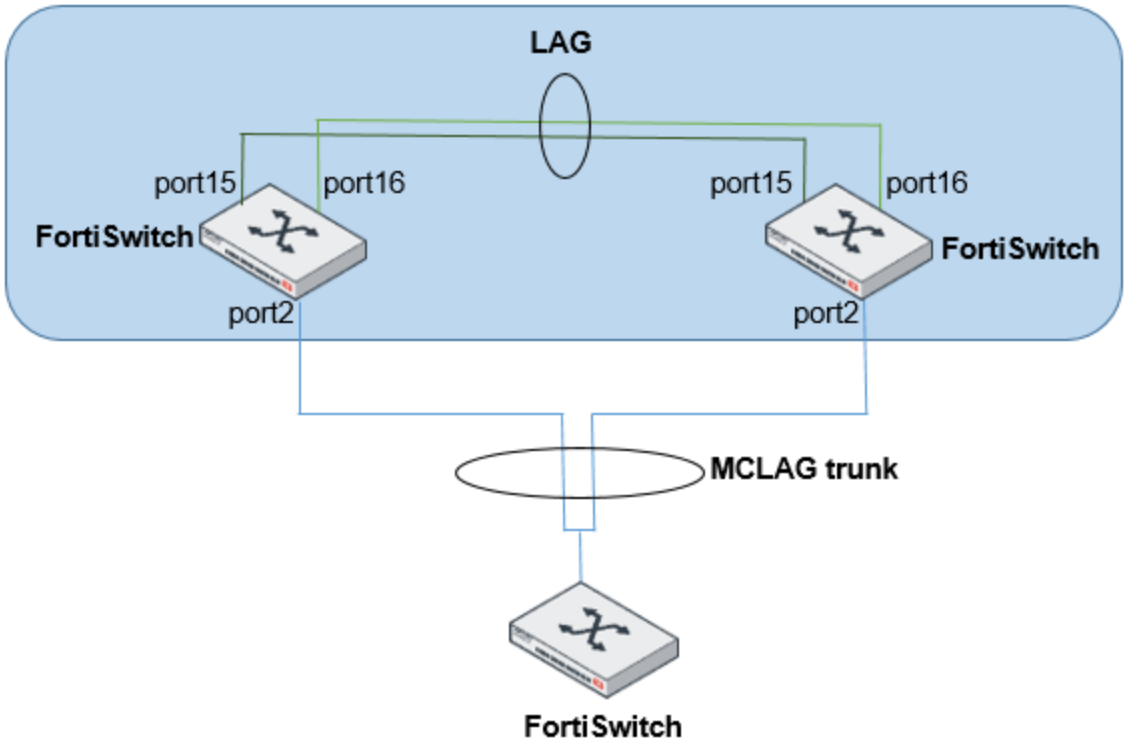
This chapter covers the following topics:

Notes

- When min_bundle or max_bundle is combined with MCLAG, the bundle limit properties are applied only to the local aggregate interface.
- Fortinet recommends that both peer switches be of the same hardware model and same software version. Mismatched configurations might work but are unsupported.
- There is a maximum of two FortiSwitch models per MCLAG.
- The routing feature is not available within a MCLAG.
- Starting in FortiSwitchOS 3.6.4, by default, the MCLAG can use the STP.
- To use static MAC addresses within a MCLAG, you need to configure MAC addresses on both switches that form the LAG.
- When you run an MCLAG, Fortinet recommends but does not require that peers use the same hardware and software versions. Some hosts might not be dual-home supported when MCLAG peers have different hardware; administrators need to size the layer-2 network to the MCLAG peer with the lowest capacity.

Example configuration

The following is an example CLI configurations for a MCLAG:



1. Create a LAG by configuring the ports for each FortiSwitch unit:

```
config switch trunk
   edit "MCLAG-ICL-trunk"
      set mclag-icl enable
      set members "port15" "port16"
      set mode lacp-active
   next
end
```

2. Set up the MCLAG:

```
config switch trunk
   edit "first-mclag"
      set mclag enable
      set members "port2"
   next
end
```

3. If you do not want the MCLAG to use the STP:

```
config switch global
   set mclag-stp-aware disabled
end
```

Detecting a split-brain state

When the split-brain state occurs, one of switches in the MCLAG goes dormant. Any devices connected to the dormant switch will lose network connectivity. The switch that goes dormant is the switch with the lowest numerical MAC address between the two peers.

Starting in FortiSwitchOS 6.2.2, you can use the CLI to detect when an MCLAG is in a split-brain state when the MCLAG ICL trunk is down. When the LACP is up again, the MCLAG trunk is reestablished. You can use this command in both one-tier and two-tier MCLAG topologies.

By default, split-brain detection is disabled. To enable the detection of the split-brain state:

```
config switch global
   set mclag-split-brain-detect enable
end
```

NOTE:

- Enabling split-brain detection can cause some traffic loss while the LACP is renegotiated.
- You can configure only one mclag-split-brain-detect at a time on a tier one or tier two of a two-tier MCLAG topology.
- Only one failure in a system is supported.

Viewing the configured trunk

Using the GUI:

Go to *Switch* > *Monitor* > *Trunks*.

Using the CLI:

```
   diagnose switch mclag icl
   diagnose switch mclag list
```

Configuring an MCLAG with IGMP snooping

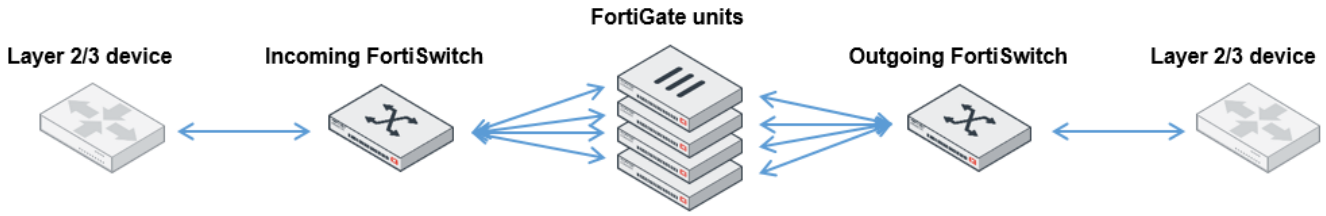
For IGMP snooping to work correctly in an MCLAG, you need to use the `set mclag-igmpsnooping-aware enable` command on all FortiSwitch units in the network topology and use the `set igmp-snooping-flood-reports enable` command on each MCLAG core FortiSwitch unit. For example:

```
config switch global
   set mac-aging-interval 600
   set mclag-igmpsnooping-aware enable
   config port-security
      set max-reauth-attempt 3
   end
end
config switch interface
   edit "D483Z15000094-0"
```

```
        set native-vlan 4094
        set allowed-vlans 1-4094
        set dhcp-snooping trusted
        set stp-state disabled
        set edge-port disabled
        set igmp-snooping-flood-reports enable
        set snmp-index 58
    next
end
```

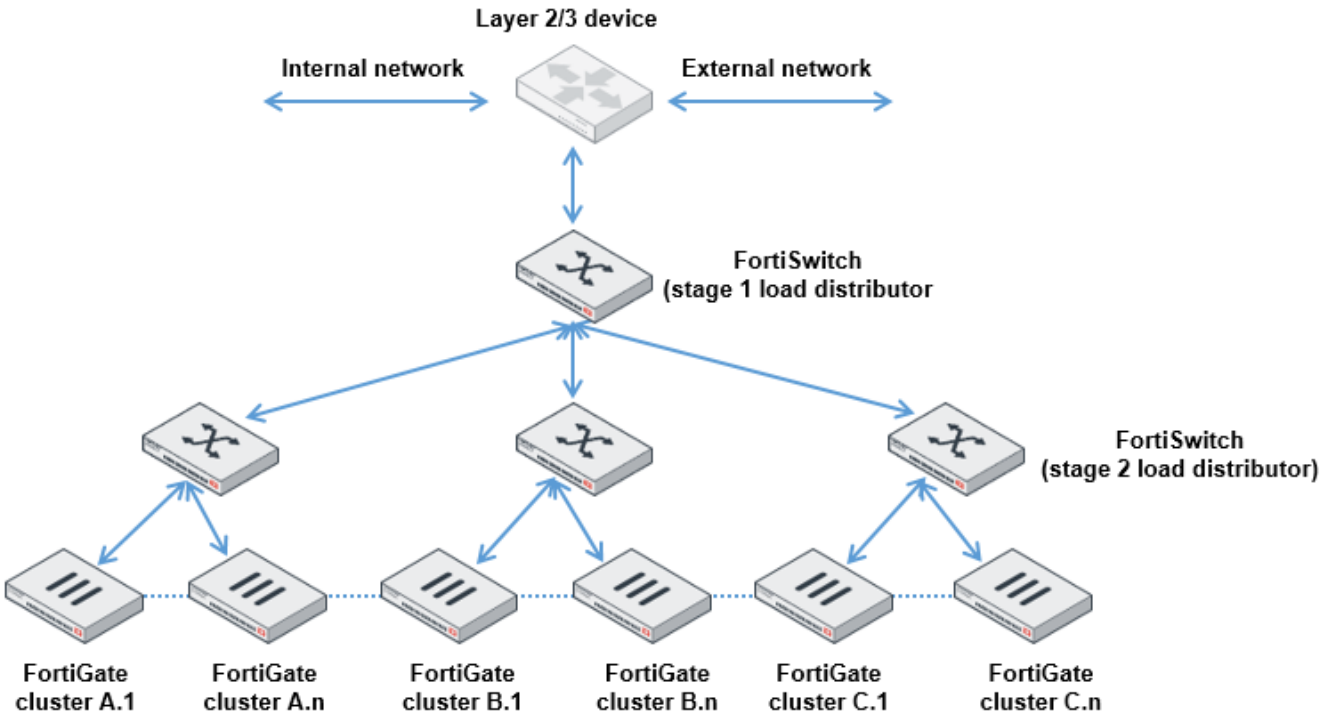
Multi-stage load balance

You can use a FortiSwitch unit to configure multi-stage load balancing on a set of FortiGate units. This capability allows you to scale security processing while maintaining a simple basic architecture. This configuration is commonly referred to a “firewall sandwich.”



Because the FortiGate unit provides session-aware analysis, the load distribution algorithm must be symmetric (traffic for a given session, in both directions, must all traverse the same FortiGate unit).

For larger scale deployment, the topology uses multiple layers of load distribution to allow for far larger numbers of FortiGate devices.



The hash at the first and second stages must be symmetric. The two stages must provide different hashing results.

This chapter covers the following topics:

Configuring the trunk ports

Use the following commands to configure the trunk members and set the port-selection criteria:

```
config switch trunk
   edit <trunk name>
      set description <description_string>
      set members <ports>
      set mode {fortinet-trunk | lacp-active | lacp-passive | static}
      set port-selection-criteria src-dst-ip-xor16
   end
end
```

Heartbeats

When in Fortinet-trunk mode, Heartbeat capability is enabled. Heartbeat messages monitor the status of FortiGate units. If one is unavailable, the FortiSwitch unit stops sending traffic to that FortiGate unit until the FortiGate unit becomes available.

If you enable `hb-verify`, each received heartbeat frame will be validated to match the signature (transmit-port plus switch serial number) and the following configured heartbeat parameters:

- hb-in-vlan
- hb-src-ip
- hb-dst-ip
- hb-src-upd-port
- hb-dst-udp-port

The destination MAC address of the heartbeat frame is set by default to 02:80:c2:00:00:02. You can change the value to any MAC address that is not a broadcast or multicast MAC address.

Configuring heartbeats

Configure the heartbeat fields using trunk configuration commands, as shown in this section. By default, all of the configurable values are set to zero, and hb-verify is disabled.

Set the mode to `forti-hb` and set the heartbeat loss limit to a value between 3 and 32.

The heartbeat will transmit at 1-second intervals on any link in the trunk that is up. This value is not configurable.

The heartbeat frame has configurable parameters for the layer-3 source and destination addresses and the layer-4 UDP ports. You must also specify the transmit and receive VLANs.

```
config switch trunk
   edit hb-trunk
      set mode fortinet-trunk
      set members <port> [<port>] ... [<port>]
      set hb-loss-limit <3-32>
      set hb-out-vlan <int>
      set hb-in-vlan <int>
      set hb-src-ip <x.x.x.x>
      set hb-dst-ip <x.x.x.x>
```

```
      set hb-src-udp-port <int>
      set hb-dst-udp-port <int>
      set hb-verify [ enable | disable ]
end
```

Use the following command to configure the destination MAC address:

```
config switch global
   set forti-trunk-dmac <mac address>
end
```

Example

The following example creates trunk tr1 with heartbeat capability:

```
config switch trunk
   edit "tr1"
      set mode fortinet-trunk
      set members "port1" "port2"
      set hb-out-vlan 300
      set hb-in-vlan 500
      set hb-src-ip 10.105.7.200
      set hb-dst-ip 10.105.7.199
      set hb-src-udp-port 12345
      set hb-dst-udp-port 54321
      set hb-verify enable
   next
end
```

LLDP-MED

The Fortinet data center switches support the Link Layer Discovery Protocol (LLDP) for transmission and reception wherein the switch will multicast LLDP packets to advertise its identity and capabilities. A switch receives the equivalent information from adjacent layer-2 peers.

Fortinet data center switches support LLDP-MED (Media Endpoint Discovery), which is an enhancement of LLDP that provides the following facilities:

- Auto-discovery of LAN policies (such as VLAN, layer-2 priority, and differentiated services settings), to enable plug-and-play networking.
- Device location discovery to allow the creation of location databases and Enhanced 911 services for Voice over Internet Protocol (VoIP).
- Extended and automated power management for power over Ethernet (PoE) endpoints.
- Inventory management, allowing network administrators to track their network devices, and determine their characteristics (manufacturer, software and hardware versions, serial or asset number).

The switch will multicast LLDP packets to advertise its identity and capabilities. The switch receives the equivalent information from adjacent layer-2 peers.

Starting in FortiSwitch 6.2.0, you can use the CLI to configure the location table used by LLDP-MED for enhanced 911 emergency calls.

This chapter covers the following topics:

Configuration notes

Review the following notes before configuring LLDP-MED:

- When 802.1x and LLDP turn on at the same port, switching between LLDP profiles requires a manual reset of all authentication sessions.
- Fortinet recommends LLDP-MED-capable phones.
- The FortiSwitch unit functions as a Network Connectivity device (that is, NIC, switch, router, and gateway), and will only support sending TLVs intended for Network Connectivity devices.
- LLDP supports up to 16 neighbors per physical port.

- The FortiSwitch unit accepts and parses packets using the CDP (Cisco Discovery Protocol) and count CDP neighbors towards the neighbor limit on a physical port. If neighbors exist, the FortiSwitch unit transmits CDP packets in addition to LLDP.
- With release 3.5.1, CDP is independently controllable through the `set cdp-status` command on the physical port. The FortiSwitch unit no longer requires a neighbor to trigger it to transmit CDP; it will transmit provided cdp-status is configured as tx-only or tx-rx. The default configuration for CDP-status is disabled. It still uses values pulled from the lldp-profile to configure its contents.
- LLDP must be globally enabled under the `config switch lldp settings` command for CDP to be transmitted or received:
- If a port is added into a *virtual-wire* (connects two ends of a controlled system using a radio frequency [RF] medium), the FortiSwitch unit will disable the transmission and receipt of LLDP and CDP packets and remove all neighbors from the port. This virtual-wire state is noted in the `get switch lldp neighbor-summary` command output.
- If the combination of configured TLVs exceeds the maximum frame size on a port, that frame cannot be sent.
- If a port is configured with an LLDP profile that has `auto-isl` enabled, the LLDP transmit frequency (normally set under `config switch lldp settings` with the `set tx-interval` command) for that port is overridden by the profile's `auto-isl-hello-timer` setting (the default is 3 seconds).
- When the switch is in FortLink mode, all ports are changed to have profiles with `auto-isl` enabled by default, and the ports' normal transmit interval is overridden by the `auto-isl-hello-timer` setting in that profile (the default is 3 seconds).
- The default-auto-isl LLDP profile, which is one of the two default LLDP profiles, has `auto-isl` enabled. Any port configured with the default-auto-isl profile will transmit LLDP PDUs every 3 seconds when the `auto-isl-hello-timer` option in that profile is set at the default of 3 seconds.
- The Time to Live (TTL) value sent in the LLDP PDUs is still based on the `tx-interval` and `tx-hold` values under `config switch lldp settings`, even if the transmit interval has been overridden by the `auto-isl-hello-timer` setting.

LLDP global settings

Using the GUI:

1. Go to *Switch* > *LLDP MED* > *Settings*.
2. Select or clear *Enable LLDP Transmit/Receive*.
3. Select the management interface.
4. Enter a value in the *Transmit Hold* field.
5. Enter the number of seconds for the transmit interval.
6. Select or clear *Fast Start*. If you select *Fast Start*, enter the number of seconds.
7. Select *Update*.

Using the CLI:

```
config switch lldp settings
   set status {enable | disable}
   set tx-hold <int>
   set tx-interval <int>
   set fast-start-interval <int>
   set management-interface <layer-3 interface>
end
```

Variable	Description
status	Enable or disable
tx-hold	Number of tx-intervals before the local LLDP data expires (that is, the packet TTL (in seconds) is `tx-hold` times `tx-interval`). The range for tx-hold is 1 to 16, and the default value is 4.
tx-interval	Frequency of LLDP PDU transmission ranging from 5 to 4095 seconds (default is 30).
fast-start-interval	How often the FortiSwitch unit transmits the first four LLDP packets when a link comes up. The range is 2 to 5 seconds, and the default is 2 seconds. Set this variable to zero to disable fast start.
management-interface	Primary management interface advertised in LLDP and CDP PDUs.

Setting the asset tag

To help identify the unit, LLDP uses the asset tag, which can be at most 32 characters. It will be added to the LLDP-MED inventory TLV (when that TLV is enabled):

```
config system global
   set asset-tag <string>
end
```

Configuring the location table

Because mobile phones have no fixed addresses associated with them, calls to 911 need the location information provided in emergency location identifier numbers (ELINs). You need to first configure the location table used by LLDP-MED for enhanced 911 emergency calls and then configure the LLDP profile to use the location table.

Using the GUI:

1. Go to *System* > *Locations*.
2. Select *Add Location*.
3. Required. In the Name field, enter a unique name for the location entry.
4. In the ELIN Number field, enter the ELIN, which is a unique phone number. The value must be no more than 31-characters long.
5. Enter the civic address.
   a. In the Additional field, enter additional location information, for example, `west wing`.
   b. In the Additional Code field, enter the additional country-specific code for the location. In Japan, use the Japan Industry Standard (JIS) address code.
   c. In the Block field, enter the neighborhood (Korea) or block
   d. In the Branch Road field, enter the branch road name. This value is used when side streets do not have unique names so that both the primary road and side street are used to identify the correct road
   e. In the Building field, enter the name of the building (structure) if the address includes more than one building, for example, `Law Library`.
   f. In the City field, enter the city (Germany), township, or shi (Japan).

g. In the City Division field, enter the city division, borough, city district (Germany), ward, or chou (Japan).
h. Required. In the Country field, enter the two-letter ISO 3166 country code in capital ASCII letters, for example, `US`, `CA`, `DK`, and `DE`.
i. In the Country Subdivision field, enter the national subdivision (such as state, canton, region, province, or prefecture). In Canada, the subdivision is province. In Germany, the subdivision is state. In Japan, the subdivision is metropolis. In Korea, the subdivision is province. In the United States, the subdivision is state.
j. In the County field, enter the county (Canada, Germany, Korea, and United States), parish, gun (Japan), or district (India).
k. In the Direction field, enter `N`, `E`, `S`, `W`, `NE`, `NW`, `SE`, or `SW` for the leading street direction.
l. In the Floor field, enter the floor number, for example, `4`.
m. In the Landmark field, enter the nickname, landmark, or vanity address, for example, `UC Berkeley`.
n. In the Language field, enter the ISO 639 language code used for the address information.
o. In the Name field, enter the person or organization associated with the address, for example, `Fortinet` or `Textures Beauty Salon`.
p. In the Number field, enter the street address, for example, `1560`.
q. In the Number Suffix field, enter any modifier to the street address. For example, if the full street address is 1560A, enter `1560` for the number and `A` for the number suffix.
r. In the Place Type field, enter the type of place, for example, `home`, `office`, or `street`.
s. In the Post Office Box field, enter the post office box, for example, `P.O. Box 1543`. When the post-office-box value is set, the street address components are replaced with this value.
t. In the Postal Community field, enter the postal community name, for example, `Alviso`. When the postal community name is set, the civic community name is replaced by this value.
u. In the Primary Road field, enter the primary road or street name for the address.
v. In the Road Section field, enter the specific section or stretch of a primary road. This field is used when the same street number appears more than once on the primary road.
w. In the Room field, enter the room number, for example, `7A`.
x. In the Script field, enter the script used to present the address information, for example, `Latn`.
y. In the Seat field, enter the seat number in a stadium or theater or a cubicle number in an office or a booth in a trade show.
z. In the Street field, enter the street (Canada, Germany, Korea, and United States).
aa. In the Street Name Post Mod field, enter an optional part of the street name that appears after the actual street name. If the full street name is East End Avenue Extended, enter `Extended`.
ab. In the Street Name Pre Mod field, enter an optional part of the street name that appears before the actual street name. If the full street name is Old North First Street, enter `Old`.
ac. In the Street Suffix field, enter the type of street, for example, `Ave` or `Place`. Valid values are listed in the United States Postal Service Publication 28 [18], Appendix C.
ad. In the Sub Branch Road field, enter the name of a street that branches off of a branch road. This value is used when the primary road, branch road, and subbranch road names are needed to identify the correct street.
ae. In the Trailing Str Suffix field, enter `N`, `E`, `S`, `W`, `NE`, `NW`, `SE`, or `SW` for the trailing street direction.
af. In the Unit field, enter the unit (apartment or suite), for example, `Apt 27`.
ag. In the ZIP field, enter the postal or zip code for the address, for example, `94089-1345`.

6. Enter the GPS coordinates.
   a. Required. In the Altitude field, enter the vertical height of a location in feet or meters. The format is +/- floating-point number, for example, `117.47`.
   b. Select *Feet* or *Meters* for the unit of measurement for the altitude.
   c. For the Datum drop-down list, select which map is used for the location: *WGS84*, *NAD83*, or *NAD83/MLLW*.

d. Required. In the Latitude field, enter the latitude. The format is floating point starting with +/- or ending with N/S, for example, `+/-16.67` or `16.67N`.

e. Required. In the Longitude field, enter the longitude. The format is floating point starting with +/- or ending with E/W, for example, `+/-26.789` or `26.789E`.

7. Select *Add*.

Using the CLI:

```
config system location
   edit <name>
      config address-civic
         set additional <string>
         set additional-code <string>
         set block <string>
         set branch-road <string>
         set building <string>
         set city <string>
         set city-division <string>
         set country <string>
         set country-subdivision <string>
         set county <string>
         set direction <string>
         set floor <string>
         set landmark <string>
         set language <string>
         set name <string>
         set number <string>
         set number-suffix <string>
         set place-type <string>
         set post-office-box <string>
         set postal-community <string>
         set primary-road <string>
         set road-section <string>
         set room <string>
         set script <string>
         set seat <string>
         set street <string>
         set street-name-post-mod <string>
         set street-name-pre-mod <string>
         set street-suffix <string>
         set sub-branch-road <string>
         set trailing-str-suffix <string>
         set unit <string>
         set zip <string>
      end
      config coordinates
         set altitude <string>
         set altitude-unit {f | m}
         set datum {NAD83 | NAD83/MLLW | WGS84}
         set latitude <string>
         set longitude <string>
      end
      config elin-number
         set elin-number <number>
      end
```

For example:

```
config system location
   edit Fortinet
      config address-civic
         set country "US"
         set language "English"
         set county "Santa Clara"
         set city "Sunnyvale"
         set street "Kifer"
         set street-suffix "Road"
         set number "899"
         set zip "94086"
         set building "1"
         set floor "1"
         set seat "1293"
      end
   next
   edit "Fortinet"
      config elin-number
         set elin-number "14082357700"
      end
   end
```

Configuring LLDP profiles

LLDP profile contains most of the port-specific configuration. Profiles are designed to provide a central point of configuration for LLDP settings that are likely to be the same for multiple ports.

Two static LLDP profiles, default and default-auto-isl, are created automatically. They can be modified but not deleted. The default-auto-isl profile always has auto-isl enabled and rejects any configurations that attempt to disable it.

LLDP-MED network policies

LLDP-MED network policies cannot be deleted or added. To use a policy, set the med-tlvs field to include `network-policy` and the desired network policy to `enabled`. The VLAN values on the policy are cross-checked against the VLAN native and untagged attributes for any interfaces that contain physical-ports using this profile. The cross-check determines if the policy Type Length Value (TLV) should be sent (VLAN must be native or allowed) and if the TLV should mark the VLAN as tagged or untagged (VLAN is native, or is in untagged). The network policy TLV is automatically updated when either a switch interface changes VLAN configuration or a physical port is added to, or removed from, a trunk.

The FortiSwitch unit supports the following LLDP-MED TLVs:

- Inventory Management TLVs
- Location Identification TLVs
- Network Policy TLV
- Power Management TLVs

Refer to the Configuration deployment example on page 136.

Custom TLVs (organizationally specific TLVs)

Custom TLVs are configured in their own subtable, available in each profile. They allow you to emulate the TLVs defined in various specifications by using their OUI and subtype and ensuring that the data is formatted correctly. You could also define a purely arbitrary custom TLV for some other vendor or for their company.

The “name” value for each custom TLV is neither used by nor has an effect on LLDP; it simply differentiates between custom TLV entries:

```
config custom-tlvs
   edit <TLVname_str>
      set information-string <hex-bytes>
      set oui <hex-bytes>
      set subtype <integer>
   next
```

The OUI value for each TLV must be set to three bytes. If just one of those bytes is nonzero it is accepted; any value other than "000" is valid. The subtype is optional and ranges from 0 (default) to 255. The information string can be 0 to 507 bytes, in hexadecimal notation.

The FortiSwitch unit does not check for conflicts either between custom TLV values or with standardized TLVs. That is, other than ensuring that the OUI is nonzero, the FortiSwitch unit does not check the OUI, subtype (or data) values entered in the CLI for conflicts with other Custom TLVs or with the OUI and subtypes of TLVs defined by the 802.1, 802.3, LLDP-MED, or other standards. While this behavior could cause LLDP protocol issues, it also allows a large degree of flexibility were you to substitute a standard TLV that is not supported yet.

802.1 TLVs

The only 802.1 TLV that can be enabled or disabled is Port VLAN ID. This TLV sends the native VLAN of the port. This value is updated when the native VLAN of the interface representing the physical port changes or if the physical port is added to, or removed from, a trunk.

By default, no 802.1 TLVs are enabled.

802.3 TLVs

There are three 802.3 TLVs that can be enabled or disabled:

- *Efficient Energy Ethernet Config*—This TLV sends whether energy-efficient Ethernet is enabled on the port. If this variable is changed, the sent value will reflect the updated value.
- *PoE+ Classification*—This TLV sends whether PoE power is enabled on the port. If this variable is changed, the sent value will reflect the updated value.
- *Maximum Frame Size*—This TLV sends the max-frame-size value of the port. If this variable is changed, the sent value will reflect the updated value.

By default, no 802.3 TLVs are enabled.

Auto-ISL

The auto-ISL configuration that was formerly in the `switch physical-port` command has been moved to the `switch lldp-profile` command. All behavior and default values are unchanged.

Assigning a VLAN to a port in the LLDP profile

You can configure the network policy of an LLDP profile to assign the specified VLAN to ports that use the LLDP profile. The VLAN is added as though it were configured in the `set allowed-vlans` setting in the `config switch interface` configuration.

This feature has the following requirements:

- The port cannot belong to a trunk or virtual wire.
- The port must have `lldp-status` set to `rx-only`, `tx-only`, or `tx-rx`.
- The port must have `private-vlan` set to `disabled`.
- LLDP must be enabled under the `config switch lldp settings` command.
- The `set med-tlvs network-policy` option must be set under the `config switch lldp profile` configuration.
- The `assign-vlan` option must be enabled in the `med-network-policy` configuration under the `config switch lldp profile` configuration.
- The VLAN assigned in the LLDP profile must be a valid VLAN.

Note:

- If the VLAN added to the interface by the LLDP profile is also listed under the `set untagged-vlans` configuration in the `config switch interface` command, the VLAN is added as untagged.
- If the VLAN added to the interface by the LLDP profile is also the native VLAN of the port, no changes occur.
- The LLDP service determines the contents of the network-policy TLV being sent based on the current state of the switch interface. If the LLDP VLAN assignment does not happen or the assigned VLAN is changed by another configuration (such as the `set untagged-vlans` configuration in `config switch interface`), the LLDP network policy TLVs being sent will reflect the actual state of the interface, not the configured value.

To specify a VLAN in the network policy of an LLDP profile:

```
config med-network-policy
   edit <policy_type_name>
      set status enable
      set assign-vlan enable
      set dscp <0-63>
      set priority <0-7>
      set vlan <0-4094>
   next
```

For example:

```
config med-network-policy
   edit default
      set status enable
      set assign-vlan enable
      set vlan 15
      set dscp 30
      set priority 3
```

```
        next
```

Configuring an LLDP profile for the port

Configure an LLDP profile for the port. By default, the port uses the default LLDP profile.

Using the GUI:

1. Go to *Switch* > *LLDP-MED* > *Profiles*.
2. Select *Add Profile*.
3. Enter a name for your LLDP profile.
4. If needed, select *Port VLAN ID*.
5. If needed, select one or more of the 802.3 TLVs: *Efficient Energy Ethernet Config*, *PoE+ Classification*, and *Maximum Frame Size*.
6. If needed, select *Enable* for Auto-ISL.
7. Enter the number of seconds for the Auto-ISL Hello Timer.
8. Enter the port group number for the Auto-ISL Port Group.
9. Enter the number of seconds for the Auto-ISL Receive Timeout.
10. If needed, select one or more of the MED TLVs: *Inventory Management*, *Location Identification*, *Network Policy*, and *Power Management*.
11. Select *Add*.

Using the CLI:

```
config switch lldp profile
   edit <profile>
      set 802.1-tlvs port-vlan-id
      set 802.3-tlvs max-frame-size
      set auto-isl {active | inactive}
      set auto-isl-hello-timer <1-30>
      set auto-isl-port-group <0-9>
      set auto-isl-receive-timeout <3-90>
      set auto-mclag-icl {enable | disable}
      set med-tlvs (inventory-management | location-identification | network-policy | power-
           management)
      config custom-tlvs
         edit <TLVname_str>
            set information-string <hex-bytes>
            set oui <hex-bytes>
            set subtype <integer>
         next
      config med-location-service
         edit address-civic
            set status {enable | disable}
            set sys-location-id <string>
         next
         edit coordinates
            set status {enable | disable}
            set sys-location-id <string>
         next
```

```
      edit elin-number
         set status {enable | disable}
         set sys-location-id <string>
      next
   config med-network-policy
      edit <policy_type_name>
         set status {enable | disable}
         set assign-vlan {enable | disable}
         set dscp <0-63>
         set priority <0-7>
         set vlan <0-4094>
      next
   end
```

Enabling LLDP on a port

To enable LLDP MED on a port, set the LLDP status to receive-only, transmit-only, or receive and transmit. The default value is TX/RX.

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select a port and select *Edit*.
3. Select *TX/RX*, *RX Only*, *TX Only*, or *Disable* for the LLDP-MED status.
4. Select an LLDP profile.
5. Select *Update*.

Using the CLI:

```
config switch physical-port
   edit <port>
      set lldp-status (rx-only | tx-only | tx-rx | disable)
      set lldp-profile <profile name>
   next
end
```

Checking the LLDP configuration

View the LLDP configuration settings using the GUI:

1. Go to *Switch* > *LLDP-MED* > *Settings*.
2. Make any changes that are needed.
3. Select *Update*.

View the LLDP configuration settings using the CLI:

```
get switch lldp settings
status : enable
```

```
tx-hold : 4
tx-interval : 30
fast-start-interval : 2
management-interface: internal
```

View the LLDP profiles using the GUI:

1. Go to *Switch* > *LLDP-MED* > *Profiles*.
2. Select a profile and then select *Edit*.
3. Make any changes that are needed.
4. Select *Update*.

View the LLDP profiles using the CLI:

```
get switch lldp profile
== [ default ]
name: default 802.1-tlvs: 802.3-tlvs: med-tlvs: inventory-management network-policy
== [ default-auto-isl ]
name: default-auto-isl 802.1-tlvs: 802.3-tlvs: med-tlvs:
```

Use the following commands to display the LLDP information about LLDP status or the layer-2 peers for this FortiSwitch unit:

```
get switch lldp (auto-isl-status | neighbors-detail | neighbors-summary | profile | settings
     | stats)
```

Configuration deployment example

To configure LLDP:

1. Configure LLDP global configuration settings using the `config switch lldp settings` command.
2. Create LLDP profiles using the `config switch lldp profile` command to configure Type Length Values (TLVs) and other per-port settings.
3. Assign LLDP profiles to physical ports.
4. Apply VLAN to interface. (**NOTE:** LLDP profile values that are tied to VLANs will only be sent if the VLAN is assigned on the switch interface.)
   a. Configure the profile.

```
show switch lldp profile Forti670i
config switch lldp profile
   edit "Forti670i"
      config med-network-policy
         edit "voice"
            set dscp 46
            set priority 5
            set status enable
            set vlan 400
         next
         edit "guest-voice"
         next
         edit "guest-voice-signaling"
```

```
        next
        edit "softphone-voice"
        next
        edit "video-conferencing"
        next
        edit "streaming-video"
           set dscp 40
           set priority 3
           set status enable
           set vlan 400
        next
        edit "video-signalling"
        next
     end
   set med-tlvs inventory-management network-policy
next
end
```

b. Configure the interface.

```
show switch interface port4
config switch interface
   edit "port4"
      set allowed-vlans 400
      set snmp auto
   next
end
```

c. Connect a phone with LLDP-MED capability to the interface. **NOTE:** Make certain the LLDP, Learning, and DHCP features are enabled.

```
show switch physical-port port4
config switch physical-port
   edit "port4"
      set lldp-profile "Forti670i"
      set speed auto
   next
end
```

d. Verify.

```
show switch lldp neighbor-det port4

Neighbor learned on port port4 by LLDP protocol
Last change 12 seconds ago
Last packet received 12 seconds ago
Chassis ID: 10.105.251.40 (ip)
System Name: FON-670i
System Description:
V12.740.335.12.B
Time To Live: 60 seconds
System Capabilities: BT
Enabled Capabilities: BT
MED type: Communication Device Endpoint (Class III)
MED Capabilities: CP
Management IP Address: 10.105.251.40
```

```
Port ID: 00:a8:59:d8:f1:f6 (mac)
Port description: WAN Port 10M/100M/1000M
IEEE802.3, Power via MDI:
Power devicetype: PD
PSE MDI Power: Not Supported
PSE MDI Power Enabled: No
PSE Pair Selection: Can not be controlled
PSE power pairs: Signal
Power class: 1
Power type: 802.3at off
Power source: Unknown
Power priority: Unknown
Power requested: 0
Power allocated: 0
LLDP-MED, Network Policies:
voice: VLAN: 400 (tagged), Priority: 5 DSCP: 46
voice-signaling: VLAN: 400 (tagged), Priority: 4 DSCP: 35
streaming-video: VLAN: 400 (tagged), Priority: 3 DSCP: 40
```

Checking LLDP details

Using the GUI:

Go to *Switch* > *Monitor* > *LLDP*.

LLDP OIDs

Starting in FortiSwitchOS 6.2.2, the following object identifiers (OIDs) are supported by the LLDP management information base (MIB) file:

- .1.0.8802.1.1.2.1.1 (lldpConfiguration)
  - lldpMessageTxInterval
  - lldpMessageTxHoldMultiplier
  - lldpReinitDelay
  - lldpTxDelay
  - lldpNotificationInterval
- .1.0.8802.1.1.2.1.4.1 (lldpRemoteSystemsData.lldpRemTable)
  - lldpRemChassisIdSubtype
  - lldpRemChassisId
  - lldpRemPortSubtype
  - lldpRemPortId
  - lldpRemPortDesc
  - lldpRemSysName
  - lldpRemSysDesc
  - lldpRemSysCapSupported
  - lldpRemSysCapEnabled

- .1.0.8802.1.1.2.1.4.2 (lldpRemoteSystemsData.lldpRemManAddrTable)
  - lldpRemManAddrIfSubtype
  - lldpRemManAddrIfId
  - lldpRemManAddrOID

MAC/IP/protocol-based VLANs

The FortiSwitch unit assigns VLANs to packets based on the incoming port or the VLAN tag in the packet. The MAC/IP/protocol-based VLAN feature enables the assignment of VLANs based on specific fields in an ingress packet (MAC address, IP address, or layer-2 protocol).

This chapter covers the following topics:

Overview

When a MAC/IP/protocol-based VLAN is assigned to a port, the default behavior is for egress packets with that VLAN value to include the VLAN tag. Use the `set untagged-vlans <vlan>` configuration command to remove the VLAN tag from egress packets. For an example of the command, see the Example configuration on page 142.

The MAC/IP/protocol-based VLAN feature assigns the VLAN based on MAC address, IP address, or layer-2 protocol.

MAC based

In MAC-based VLAN assignment, the FortiSwitch unit associates a VLAN with each packet based on the originating MAC address.

IP based

In IP-based VLAN assignment, the FortiSwitch unit associates a VLAN with each packet based on the originating IP address or IP subnet. IPv4 is supported with prefix masks from 1 to 32. IPv6 is also supported, depending on hardware availability, with prefix lengths from 1 to 64.

Protocol based

In protocol-based VLAN assignment, the FortiSwitch unit associates a VLAN with each packet based on the Ethernet protocol value and the frame type (ethernet2, 802.3d/SNAP, LLC).

Configuring MAC/IP/protocol-based VLANs

Note the following prerequisites:

- The VLAN must be created in the FortiSwitch unit
- The VLAN needs to be allowed on the ingress port

Using the GUI:

1. Go to *Switch* > *VLAN*.
2. Select *Add VLAN* for a new VLAN or select *Edit* for an existing VLAN.
3. To configure a MAC-based VLAN:
   a. Select *Add* under Members by MAC Address.
   b. Enter a description and the MAC address.
4. To configure an IP-based VLAN:
   a. Select *Add* under Members by IP Address.
   b. Enter a description and the IP address.
5. Select *Add* or *Update* to save the settings.

Using the CLI:

```
config switch vlan
   edit <vlan-id>
      config member-by-mac
         edit <id>
            set mac xx:xx:xx:xx:xx:xx
            set description <128 byte string>
         next
      end
      config member-by-ipv4
         edit <id>
            set address a.b.c.d/e #subnet mask must 1-32
            set description <128 byte string>
         next
      end
      config member-by-ipv6
         edit <id>
            set prefix xx:xx:xx:xx::/prefix #prefix must 1-64
            set description <128 byte string>
         next
      end
      config member-by-proto
         edit <id>
            set frametypes ethernet2 802.3d llc #default is all
            set protocol 0xXXXX
         next
      end
   next
end
```

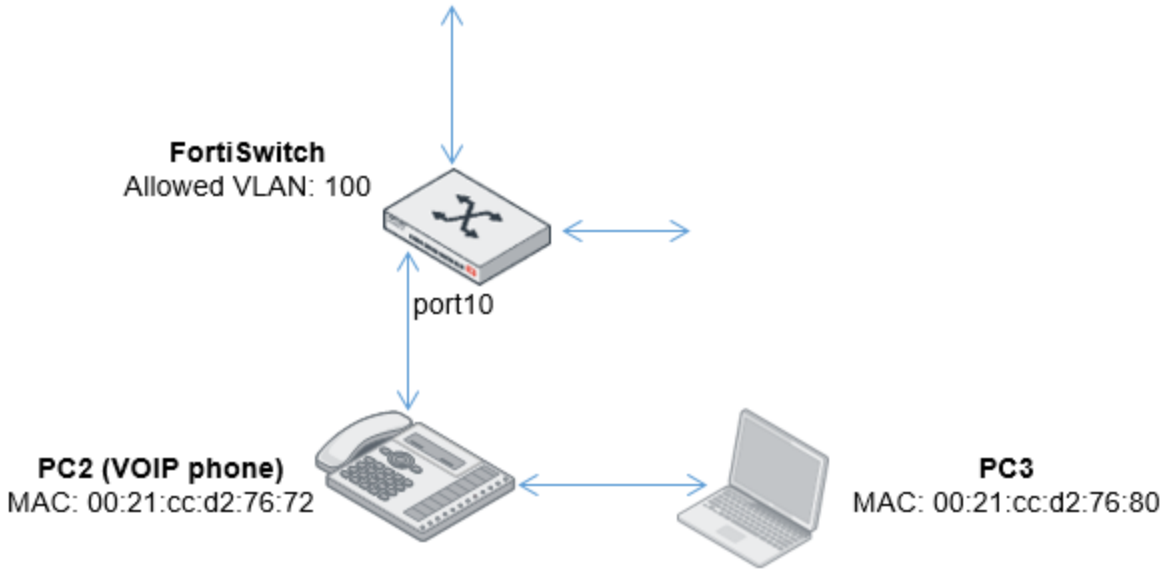
NOTE: There are hardware limits regarding how many MAC/IP/protocol-based VLANs that you can configure. If you try to add entries beyond the limit, the CLI will reject the configuration:

- Editing an existing VLAN—when you enter `next` or `end` on the `config member-by` command
- Adding a new VLAN— when you enter `next` or `end` on the `edit vlan` command
- When VLANS are defined by `config member-by-ipv4` or `config member-by-ipv6` on some FortiSwitch platforms (2xx and higher), matching ARP traffic is included in the assigned VLANs. For example, if the ARP target IP address or the ARP sender IP address match the member-by-ipv4 or member-by-ipv6 IP address, those ARP packets are included in the assigned VLANs.

Example configuration

The following example shows a CLI configuration for MAC-based VLAN where a VOIP phone and a PC share the same switch port.

In this example, a unique VLAN is assigned to the voice traffic, and the PC traffic is on the default VLAN for the port.



1. The FortiSwitch Port 10 is connected to PC2 (a VOIP phone), with MAC address 00:21:cc:d2:76:72.
2. The phone also sends traffic from PC3 (MAC= 00:21:cc:d2:76:80).
3. Assign the PC3 traffic to the default VLAN (1) on port 10.
4. Assign the voice traffic to VLAN 100.

Configure the voice VLAN

```
config switch vlan
   edit 100
      config member-by-mac
         edit 1
            set description "pc2"
            set mac 00:21:cc:d2:76:72
```

```
        next
      end
   end
end
```

Configure switch port 10

```
config switch interface
   edit "port10"
      # allow vlan=100 on this port
      # treat this as untagged on egress
      set allowed-vlans 100
      set untagged-vlans 100
      set snmp-index 10
   end
end
```

Checking the configuration

To view the MAC-based VLAN assignments, use the following command:

```
diagnose switch vlan assignment mac list sorted-by-mac

     00:21:cc:d2:76:72   VLAN: 100 Installed: yes
     Source: Configuration (entry 1)
     Description: pc2
```

Mirroring

Packet mirroring allows you to collect packets on specified ports and then send them to another port to be collected and analyzed. All FortiSwitch models support switched port analyzer (SPAN) mode, which mirrors traffic to the specified destination interface without encapsulation.

Using remote SPAN (RSPAN) or encapsulated RSPAN (ERSPAN) allows you to send the collected packets across layer-2 domains. You can have multiple RSPAN sessions but only one ERSPAN session. In RSPAN mode, traffic is encapsulated in a VLAN. In ERSPAN mode, traffic is encapsulated in Ethernet, IPv4, and generic routing encapsulation (GRE) headers.

NOTE:

- Mirror sources cannot also be mirror destinations or members of mirror destinations if the destination is a trunk. When using RSPAN or ERSPAN in FortiLink mode, the destination ports or trunks are determined automatically (the automatically determined port can be viewed with the `diagnose switch-controller switch-info mirror status` command on the FortiGate device). The destination is often an ISL interface towards the FortiGate device. This destination can cause conflicts if the user tries to configure ports in the ISL as source ports. In the case of conflict, Fortinet recommends disabling the FortiLink traffic sniffer or omitting ports that are part of the ISL.
- Some models support setting the mirror destination to “internal.” This is intended only for debugging purposes and might prevent critical protocols from operating on ports being used as mirror sources.
- When there are multiple mirror sessions in the FS-108D-POE, FS-224D-POE, and FSR-112D-POE models, some traffic might not be mirrored to the destination ports.
- Some destination ports are not listed because those models (FSR-112D-POE, FS-108E, FS-124E, FS-108E-POE, FS-108E-FPOE, FS-124E-POE, FS-124E-FPOE, FS-148E, and FS-148E-POE) do not support mirroring to the software interface.
- You cannot select a destination interface for the ERSPAN auto mirror.
- In cases where the mirrored traffic is not unicast, or is flooded unicast, and the mirrored and non-mirrored packets both leave the mirror “dst” port, the `mirror-qos` value is overridden by the QoS value of the non-mirrored packet.
- You can use the following commands to specify the quality of service (QoS) priority for mirrored packets on the FortiSwitch unit doing the mirroring:

```
config switch global
   set mirror-qos <0-7>
end
```

Some of the platform differences are listed in the following table:

	112D-POE	108E, 108E-FPOE, 108E-POE, 124E, 124E-FPOE, 124E-POE, 124F, 148F	124D, 224D-FPOE, 224E, 224E-POE	248D, 248E-FPOE, 248E-POE	424D, 424D-FPOE, 424D-POE	448D, 448D-FPOE, 448D-POE	424E, 424E-POE, 424E-FPOE, M426-FPOE	424E-Fiber, 448E, 448E-POE, 448E-FPOE	524D, 524D-FPOE, 548D, 548D-FPOE, 1048E	1024D, 1048D, 3032D, 3032E
“dst” values	Ports only (can be in trunk)	Ports only (can be in trunk)	Port or trunk (no trunk members)	Port or trunk (no trunk members)	Port or trunk (no trunk members)	Port or trunk (no trunk members)	Port or trunk (no trunk members)	Port or trunk (no trunk members)	Port or trunk (no trunk members)	Port or trunk (no trunk members)
Max. sessions (active or inactive)	—	—	32	32	32	32	32	32	32	32
Max. active sessions	7	4	6	6	6	6	8	8	8	4
Max. sessions with src-egress	6	4	1	1	1	1	1	1	4	4
Max. sessions with src-ingress	6	4	1	1	1	1	1	4	4	4

	112D-POE	108E, 108E-FPOE, 108E-POE, 124E, 124E-FPOE, 124E-POE, 124F, 148F	124D, 224D-FPOE, 224E, 224E-POE	248D, 248E-FPOE, 248E-POE	424D, 424D-FPOE, 424D-POE	448D, 448D-FPOE, 448D-POE	424E, 424E-POE, 424E-FPOE, M426-FPOE	424E-Fiber, 448E, 448E-POE, 448E-FPOE	524D, 524D-FPOE, 548D, 548D-FPOE, 1048E	1024D, 1048D, 3032D, 3032E
Max. sessions when one has src-ingress + src-egress and the rest are src-ingress	N/A	N/A	3	3	3	3	3	3	3	3
VLAN CFI and priority can be configured in RSPAN	N/A	N/A	Yes	No	Yes	No	Yes	Yes	Yes	Yes
SPAN support	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RSPAN and ERSPAN support	RSPAN	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
QoS support	No	No	No	No	No	No	Yes	Yes	Yes	3032D

The following topics are covered in this chapter:

- Configuring an ERSPAN auto mirror on page 150
- Configuring an ERSPAN manual mirror on page 151

Configuring a SPAN mirror

NOTE: You can use virtual wire ports as ingress and egress mirror sources. Egress mirroring of virtual wire ports will have an additional VLAN header on all mirrored traffic.

Using the GUI:

1. Go to *Switch* > *Mirror*.
2. Select *Add Port Mirror*.
3. Enter a name for the mirror.
4. Select *Enabled* to make the mirror active.
5. Select a destination interface.
   On FortiSwitch models that support RSPAN and ERSPAN, set the trunk or physical port that will act as a mirror. The physical port cannot be part of a trunk.
   On FortiSwitch models that do *not* support RSPAN and ERSPAN, set the physical port that will act as a mirror. The physical port can be part of a trunk.
6. Select from the excluded ports which ports to include for ingress mirroring and egress mirroring.
   NOTE: Only one active egress mirror session is allowed.
7. Select *Packet Switching When Mirroring* if the destination port is not a dedicated port. For example, enable this option if you connect a laptop to the switch and you are running a packet sniffer along with the management GUI on the laptop.
8. Select *SPAN* for the mode.
9. Select *Create* to create the mirror.

Using the CLI:

```
config switch mirror
   edit <mirror session name>
      set mode SPAN
      set dst <interface>
      set src-egress <interface_name>
      set src-ingress <interface_name>
      set switching-packet {enable | disable}
      set status active
   end
```

For example:

```
config switch mirror
   edit "m1"
      set mode SPAN
      set dst "port5"
      set src-egress "port2"
      set src-ingress "port3" "port4"
      set switching-packet enable
      set status active
end
```

Multiple mirror destination ports (MTPs)

With some FortiSwitch models, you can configure multiple mirror destination ports with the following guidelines and restrictions:

- Always set the destination port before setting the src-ingress or src-egress ports.
- Any port configured as a src-ingress or src-egress port in one mirror cannot be configured as a destination port in another mirror.
- The total number of active sessions depends on your configuration.
- For switch models 124D, 124D-POE, 224D-FPOE, 248D, 248D-POE, 248D-FPOE, 224E, 224E-POE, 248E-POE, 248E-FPOE, 424D, 424D-POE, 424D-FPOE, 448D, 448D-POE, and 448D-FPOE:
  - For access control lists, you can use a mirror destination that does not have src-ingress or src-egress configured or a mirror destination that has src-ingress or src-egress configured.
- For switch models 524D, 524D-FPOE, 548D, 548D-FPOE, 1024D, 1048D, 1048E, 3032D, and 3032E:
  - For access control lists, you can use a mirror destination that does not have src-ingress or src-egress configured or a mirror destination that has src-ingress or src-egress configured.
- For switch model FSR-112D-POE:
  - You can configure up to seven mirrors, each with a different destination port.
  - Multiple ingress or egress ports can be mirrored to the same destination port.
  - An ingress or egress port cannot be mirrored to more than one destination port.

These restrictions apply to active mirrors. If you try to activate an invalid mirror configuration, the system will display the `Hardware active mirror session limit reached. Please deactivate or delete another active session to make room.` error message.

The following example configuration is valid for FortiSwitch-3032D. This configuration includes three ingress ports, one egress port, and four destination ports. The port3 ingress and egress ports are mirrored to multiple destinations.

```
config switch mirror
   edit "m1"
      set mode SPAN
      set dst "port16"
      set status active
         set src-ingress "port3" "port5" "port7"
   next
   edit "m2"
      set mode SPAN
      set dst "port22"
      set status active
         set src-ingress "port3" "port5"
   next
   edit "m3"
      set mode SPAN
      set dst "port1"
      set status active
         set src-ingress "port3"
   next
   edit "m4"
      set mode SPAN
      set dst "port2"
      set status active
         set src-egress "port3"
end
```

The following example configuration includes three ingress ports, three egress ports and four destination ports. Each ingress and egress port is mirrored to only one destination port.

```
config switch mirror
   edit "m1"
      set mode SPAN
      set dst "port1"
      set status active
         set src-ingress "port2" "port7"
   next
   edit "m2"
      set mode SPAN
      set dst "port5"
      set status active
         set src-ingress "port2"
   next
   edit "m3"
      set mode SPAN
      set dst "port3"
      set status active
         set src-ingress "port6"
   next
   edit "m4"
      set mode SPAN
      set dst "port4"
      set status active
         set src-egress "port6" "port8"
end
```

Configuring an RSPAN mirror

NOTE: RSPAN traffic crossing a switch on a VLAN configured with “RSPAN-VLAN” enabled will appear as unknown unicast, multicast, or broadcast traffic. This traffic is not exempt from storm control and might be rate limited as a result. To avoid this issue, you can dedicate a port or ports to RSPAN and then disable storm control on those ports. Non-RSPAN VLANs can be used on those ports as well, but they will not be protected by storm control.

Using the GUI:

1. Go to *Switch* > *Mirror*.
2. Select *Add Port Mirror*.
3. Enter a name for the mirror.
4. Select *Enabled* to make the mirror active.
5. Select a destination interface.
   NOTE: The destination interface cannot be part of a trunk.
6. Select from the excluded ports which ports to include for ingress mirroring and egress mirroring.
   NOTE: Only one active egress mirror session is allowed.
7. Select *Packet Switching When Mirroring* if the destination port is not a dedicated port. For example, enable this option if you connect a laptop to the switch and you are running a packet sniffer along with the management GUI on the laptop.
8. Select *RSPAN* for the mode.
9. In the VLAN ID field, enter the VLAN identifier for the RSPAN VLAN header.

10. In the TPID field, enter the tag protocol identifier (TPID) for the encapsulating VLAN header. The default value, 0x8100, is for an IEEE 802.1Q-tagged frame.
11. In the Priority field, enter the class of service (CoS) bits in the RSPAN VLAN header.
NOTE: This option is not available on the 248D, 248D-POE, 248D-FPOE, 248E, 248E-POE, 248E-FPOE, 448D, 448D-POE, and 448D-FPOE models.
12. In the CFI/DEI field, enter the canonical format identifier (CFI) or drop eligible indicator (DEI) bit in the RSPAN VLAN header.
NOTE: This option is not available on the 248D, 248D-POE, 248D-FPOE, 248E, 248E-POE, 248E-FPOE, 448D, 448D-POE, and 448D-FPOE models.
13. Select *Create* to create the mirror.

Using the CLI:

```
config switch mirror
   edit <mirror session name>
      set mode RSPAN
      set dst <interface>
      set switching-packet {enable | disable}
      set src-ingress <interface_name>
      set src-egress <interface_name>
      set encap-vlan-tpid <0x0001-0xfffe>
      set encap-vlan-priority <0-7>
      set encap-vlan-cfi <0-1>
      set encap-vlan-id <1-4094>
      set status active
   end
```

Configuring an ERSPAN auto mirror

For an ERSPAN auto mirror, traffic on specified ports is mirrored to the specified destination interface using ERSPAN encapsulation. The header contents are automatically configured; you only need to specify the ERSPAN collector address.

Using the GUI:

1. Go to *Switch* > *Mirror*.
2. Select *Add Port Mirror*.
3. Enter a name for the mirror.
4. Select *Enabled* to make the mirror active.
5. Select from the excluded ports which ports to include for ingress mirroring and egress mirroring.
NOTE: Only one active egress mirror session is allowed.
6. Select *ERSPAN Auto* for the mode.
7. Enable *Strip VLAN Tags from Mirrored Traffic* if you want to remove VLAN tags from mirrored traffic.
8. In the Collector IP field, enter the IP address for the ERSPAN collector.
9. In the IPv4 TTL field, enter the IPv4 time-to-live (TTL) value in the ERSPAN IP header.
10. In the IPv4 TOS field, enter the type of service (ToS) value or enter the DSCP and ECN values in the ERSPAN IP header.
11. In the GRE Protocol field, enter the protocol value in the ERSPAN GRE header.

12. In the TPID field, enter the TPID for the encapsulating VLAN header.
    The default value, 0x8100, is for an IEEE 802.1Q-tagged frame.
13. In the Priority field, enter the CoS bits in the ERSPAN VLAN header.
14. In the CFI/DEI field, enter the CFI or DEI bit in the ERSPAN VLAN header.
15. Select *Create* to create the mirror.

Using the CLI:

```
config switch mirror
   edit <mirror session name>
      set mode ERSPAN-auto
      set encap-gre-protocol <hexadecimal_integer>
      set encap-ipv4-tos <hexadecimal_integer>
      set encap-ipv4-ttl <0-255>
      set encap-vlan-cfi <0-1>
      set encap-vlan-priority <0-7>
      set encap-vlan-tpid <0x0001-0xfffe>
      set erspan-collector-ip <0.0.0.1-255.255.255.255>
      set src-egress <interface_name>
      set src-ingress <interface_name>
      set strip-mirrored-traffic-tags {disable | enable}
      set status active
   end
```

Configuring an ERSPAN manual mirror

For an ERSPAN manual mirror, traffic on specified ports is mirrored to the specified destination interface using ERSPAN encapsulation. You need to manually configure the header contents with layer-2 and layer-3 addresses.

Using the GUI:

1. Go to *Switch* > *Mirror*.
2. Select *Add Port Mirror*.
3. Enter a name for the mirror.
4. Select *Enabled* to make the mirror active.
5. Select a destination interface.
   NOTE: The destination interface cannot be part of a trunk.
6. Select from the excluded ports which ports to include for ingress mirroring and egress mirroring.
   NOTE: Only one active egress mirror session is allowed.
7. Select *Packet Switching When Mirroring* if the destination port is not a dedicated port. For example, enable this option if you connect a laptop to the switch and you are running a packet sniffer along with the management GUI on the laptop.
8. Select *ERSPAN Manual* for the mode.
9. Enable *Strip VLAN Tags from Mirrored Traffic* if you want to remove VLAN tags from mirrored traffic.
10. Select *Add ERSPAN Headers* if you want to add the VLAN header to the encapsulated traffic.
11. In the Collector IP field, enter the IP address for the ERSPAN collector.
12. In the IPv4 Source Address field, enter the IPv4 source address in the ERSPAN IP header.
13. In the IPv4 TTL field, enter the IPv4 TTL value in the ERSPAN IP header.

14. In the IPv4 TOS field, enter the ToS value or enter the DSCP and ECN values in the ERSPAN IP header.
15. In the GRE Protocol field, enter the protocol value in the ERSPAN GRE header.
16. In the VLAN ID field, enter the VLAN identifier in the ERSPAN VLAN header.
    This field is available only if *Add ERSPAN Headers* is selected.
17. In the TPID field, enter the TPID for the encapsulating VLAN header.
    This field is available only if *Add ERSPAN Headers* is selected.
18. In the Priority field, enter the CoS bits in the ERSPAN VLAN header.
    This field is available only if *Add ERSPAN Headers* is selected.
19. In the CFI/DEI field, enter the CFI or DEI bit in the ERSPAN VLAN header.
    This field is available only if *Add ERSPAN Headers* is selected.
20. In the Source MAC Address field, enter the source MAC address in the ERSPAN Ethernet header.
    This field is available only if *Add ERSPAN Headers* is selected.
21. In the Destination MAC Address field, enter the MAC address of the next-hop or gateway on the path to the ERSPAN collector IP address.
    This field is available only if *Add ERSPAN Headers* is selected.
22. Select *Create* to create the mirror.

Using the CLI:

```
config switch mirror
   edit <mirror session name>
      set mode ERSPAN-manual
      set dst <interface>
      set encap-gre-protocol <hexadecimal_integer>
      set encap-ipv4-src IPv4_address>
      set encap-ipv4-tos <hexadecimal_integer>
      set encap-ipv4-ttl <0-255>
      set encap-mac-dst <MAC_address>
      set encap-mac-src <MAC_address>
      set encap-vlan {tagged | untagged}
         set encap-vlan-cfi <0-1>
         set encap-vlan-id <1-4094>
         set encap-vlan-priority <0-7>
         set encap-vlan-tpid <0x0001-0xfffe>
      set erspan-collector-ip <IPv4_address>
      set src-egress <interface_name>
      set src-ingress <interface_name>
      set strip-mirrored-traffic-tags {disable | enable}
      set switching-packet {enable | disable}
      set status active
   end
```

Access control lists

You can use access control lists (ACLs) to configure policies for three different stages in the pipeline:

- Ingress stage for incoming traffic
- Prelookup stage for processing traffic
- Egress stage for outgoing traffic

This chapter covers the following topics:

NOTES

- Before FortiSwitchOS 6.0.0, you used the `config switch acl policy` command to configure ACL policies only for the ingress stage. In FortiSwitchOS 6.0.0 and later, the `config switch acl` command has changed to specify which stage is being configured. Starting in FortiSwitchOS 6.2.0, you can create groups for multiple ingress ACLs.
- The FS-1024D and FS-524D-FPOE models do not support all action options on the ingress policy.
- There are some limitations for ACL configuration on the FS-108E, FS-108E-POE, FS-108E-FPOE, FS-124E, FS-124E-POE, FS-124E-FPOE, FS-148E, and FS-148E-POE models:
  - The layer-4 port range is limited and might not be available in FortiSwitchOS 6.4.0.
  - For the FS-108E, FS-108E-FPOE, FS-108E-POE, FS-124E, FS-124E-FPOE, and FS-124E-POE models, 256 counters are supported for the ingress stage.
  - For the FS-448E, FS-448E-FPOE, and FS-448E-POE models, 504 counters are supported only for the prelookup stage.
  - If a classifier was created with only layer-2 fields, layer-3 fields cannot be added later. If a classifier was created with only layer-3 fields, layer-2 fields cannot be added later.
  - You cannot use both drop and redirect actions in the same ACL policy.
  - ACL configuration is not supported in FortiLink mode.
  - Only the ingress policy can be configured.
- The `set redirect` command works differently for the following switch models:
  - For the FS-108E, FS-108E-POE, FS-108E-FPOE, FS-124E, FS-124E-POE, FS-124E-FPOE, FS-148E, and FS-148E-POE models, the egress VLAN membership is *not* necessary.
  - For the FS-148F, FS-148F-POE, FS-148F-FPOE, FS-124F, FS-124F-POE, and FS-124F-FPOE models, the egress VLAN membership is necessary.

ACL policy attributes

Key attributes of a policy include:

- *Interface*. The interface(s) on which traffic arrives at the switch. The interface can be a port, a trunk, or all interfaces. The policy applies to ingress traffic only (not egress traffic).

- *Classifier*. The classifier identifies the packets that the policy will act on. Each packet can be classified based on one or more criteria. Criteria include source and destination MAC address, VLAN id, source and destination IP address, or service (layer 4 protocol id and port number).
- *Marking* involves setting bits in the packet header to indicate the priority of this packet.
- *Actions*. If a packet matches the classifier criteria for a given ACL, the following types of action may be applied to the packet:
  - allow or block the packet, redirect the packet, mirror the packet
  - police the traffic
  - mirror the packet to another port, interface, or trunk
  - mirror the traffic
  - CoS queue assignment
  - outer VLAN tag assignment
  - egress mask to filter packets
  - specify a schedule when the ACL policy will be applied
  - make the ACL policy active or inactive

The switch uses specialized TCAM memory to perform ACL matching.

NOTE: Each model of the FortiSwitch unit provides different ACL-related capabilities. When you configure the ACL policy, the system will reject the request if the hardware cannot support it.

Configuring an ACL policy

You can configure ACL policies for each stage: ingress, egress, and prelookup.

NOTE: The order of the classifiers provided during group creation (or during an ACL update in a group when new classifiers are added) matter. Hardware resources are allocated as best fit at the time of creation, which can cause some fragmentation and segmentation of hardware resources because not all classifiers are available at all times. Because the availability of classifiers is order dependent, some allocations succeed or fail at different times. Rebooting the switch or running the `execute acl key-compaction <acl-stage><group-id>` command can help reduce the classifier resource fragmentation.

Creating an ACL ingress policy

Using the GUI:

1. Go to *Switch* > *ACL* > *Ingress*.
2. Select *Add Ingress Policy*.
3. Required. In the ID field, enter a unique number to identify this policy.
4. By default, *Active* is selected. If you do not want this policy to be active, clear the *Active* checkbox.
5. Required. Select which interfaces the policy applies to or select the *All Interface* checkbox.
6. Select a schedule for when the ACL policy is enforced. To create a schedule, see Example 4 on page 163.
7. In the Description field, enter a description or other information about the policy. The description is limited to 63 characters.

8. Configure the classifier.
   a. Enter the VLAN identifier to be matched.
   b. Enter the 802.1Q cost of service (CoS) value to match.
   c. Enter the DSCP value to match.
   d. Enter the Ethernet type to be matched.
   e. Select the service type to be matched.
   f. Enter the source MAC address to be matched.
   g. Enter the destination MAC address to be matched.
   h. Enter the source IP address and subnet mask to be matched.
   i. Enter the destination IP address and subnet mask to be matched.
9. Configure the action.
   a. Select the *Count* checkbox if you want to track the number of matching packets.
   b. Select the *Drop* checkbox if you want to drop matching packets.
   c. Select the *Redirect Broadcast CPU* checkbox if you want to redirect broadcast traffic to all ports including the CPU.
   d. Select the *Redirect Broadcast No CPU* checkbox if you want to redirect broadcast traffic to all ports excluding the CPU.
   e. In the CPU COS Queue field, enter the CPU CoS queue number. This CoS queue is only used if the packets reach the CPU.
   f. In the COS Queue field, enter the CoS queue number.
   g. In the Remark COS field, enter the CoS marking value.
   h. In the Outer VLAN Tag field, enter the outer VLAN tag.
   i. In the Remark DSCP field, enter the DSCP marking value.
   j. Select *Egress Mask* to configure which physical ports are included in the egress mask or select *Redirect Physical Port* to redirect packets to the selected physical ports.
   k. Select the physical ports to include in the egress mask or to redirect packets to.
   l. Select which policer to use from the Policer drop-down list. To create a policer, see Creating a policer on page 159.
   m. Select which redirect interface to use from the Redirect Interface drop-down list.
   n. Select the name of the mirror to use collect packets to analyze.
10. Select *OK* to save the ingress policy.

Using the CLI:

```
config switch acl ingress
edit <policy_ID>
   set description <string>
   set group <group_ID>
   set ingress-interface <port_name>
   set ingress-interface-all {enable | disable}
   set schedule <schedule_name>
   set status {active | inactive}
   config classifier
      set src-mac <MAC_address>
      set dst-mac <MAC_address>
      set ether-type <integer>
      set src-ip-prefix <IP_address> <mask>
      set dst-ip-prefix <IP_address> <mask>
      set service <service_ID>
      set vlan-id <VLAN_ID>
```

```
      set cos <802.1Q CoS value to match>
      set dscp <DSCP value to match>
   end
   config action
      set cos-queue <0 - 7>
      set count {enable | disable}
      set cpu-cos-queue <integer>
      set drop {enable | disable}
      set egress-mask {<physical_port_name> | internal}
      set mirror <mirror_session>
      set outer-vlan-tag <integer>
      set policer <policer>
      set redirect <interface_name>
      set redirect-bcast-cpu {enable | disable}
      set redirect-bcast-no-cpu {enable | disable}
      set redirect-physical-port <list of physical ports to redirect>
      set remark-cos <0-7>
      set remark-dscp <0-63>
   end
end
```

Creating an ACL egress policy

Using the GUI:

1. Go to *Switch* > *ACL* > *Egress*.
2. Select *Add Egress Policy*.
3. Required. In the ID field, enter a unique number to identify this policy.
4. By default, *Active* is selected. If you do not want this policy to be active, clear the *Active* checkbox.
5. Select which interface the policy applies to.
6. Select a schedule for when the ACL policy is enforced. To create a schedule, see Example 4 on page 163.
7. In the Description field, enter a description or other information about the policy. The description is limited to 63 characters.
8. Configure the classifier.
   a. Enter the VLAN identifier to be matched.
   b. Enter the 802.1Q cost of service (CoS) value to match.
   c. Enter the DSCP value to match.
   d. Enter the Ethernet type to be matched.
   e. Select the service type to be matched.
   f. Enter the source MAC address to be matched.
   g. Enter the destination MAC address to be matched.
   h. Enter the source IP address and subnet mask to be matched.
   i. Enter the destination IP address and subnet mask to be matched.
9. Configure the action.
   a. Select the *Count* checkbox if you want to track the number of matching packets.
   b. Select the *Drop* checkbox if you want to drop matching packets.
   c. In the Outer VLAN Tag field, enter the outer VLAN tag.
   d. In the Remark DSCP field, enter the DSCP marking value.

e. Select which policer to use from the Policer drop-down list. To create a policer, see Creating a policer on page 159.
f. Select which redirect interface to use from the Redirect Interface drop-down list.
g. Select the name of the mirror to use collect packets to analyze.

10. Select *OK* to save the egress policy.

Using the CLI:

```
config switch acl egress
edit <policy_ID>
   set description <string>
   set interface <port_name>
   set schedule <schedule_name>
   set status {active | inactive}
   config classifier
      set src-mac <MAC_address>
      set dst-mac <MAC_address>
      set ether-type <integer>
      set src-ip-prefix <IP_address> <mask>
      set dst-ip-prefix <IP_address> <mask>
      set service <service_ID>
      set vlan-id <VLAN_ID>
      set cos <802.1Q CoS value to match>
      set dscp <DSCP value to match>
   end
   config action
      set count {enable | disable}
      set drop {enable | disable}
      set mirror <mirror_session>
      set outer-vlan-tag <integer>
      set policer <policer>
      set redirect <interface_name>
      set remark-dscp <0-63>
   end
end
```

Creating an ACL prelookup policy

Using the GUI:

1. Go to *Switch* > *ACL* > *Prelookup*.
2. Select *Add Prelookup Policy*.
3. Required. In the ID field, enter a unique number to identify this policy.
4. By default, *Active* is selected. If you do not want this policy to be active, clear the *Active* checkbox.
5. Select which interface the policy applies to.
6. Select a schedule for when the ACL policy is enforced. To create a schedule, see Example 4 on page 163.
7. In the Description field, enter a description or other information about the policy. The description is limited to 63 characters.
8. Configure the classifier.
   a. Enter the VLAN identifier to be matched.
   b. Enter the 802.1Q cost of service (CoS) value to match.

c. Enter the DSCP value to match.
d. Enter the Ethernet type to be matched.
e. Select the service type to be matched.
f. Enter the source MAC address to be matched.
g. Enter the destination MAC address to be matched.
h. Enter the source IP address and subnet mask to be matched.
i. Enter the destination IP address and subnet mask to be matched.

9. Configure the action.
   a. Select the *Count* checkbox if you want to track the number of matching packets.
   b. Select the *Drop*checkbox if you want to drop matching packets.
   c. In the Outer VLAN Tag field, enter the outer VLAN tag.
   d. In the COS Queue field, enter the CoS queue number.
   e. In the Remark COS field, enter the CoS marking value.
10. Select *OK* to save the prelookup policy.

Using the CLI:

```
config switch acl prelookup
edit <policy_ID>
   set description <string>
   set interface <port_name>
   set schedule <schedule_name>
   set status {active | inactive}
   config classifier
      set src-mac <MAC_address>
      set dst-mac <MAC_address>
      set ether-type <integer>
      set src-ip-prefix <IP_address> <mask>
      set dst-ip-prefix <IP_address> <mask>
      set service <service_ID>
      set vlan-id <VLAN_ID>
      set cos <802.1Q CoS value to match>
      set dscp <DSCP value to match>
   end
   config action
      set cos-queue <0-7>
      set count {enable | disable}
      set drop {enable | disable}
      set outer-vlan-tag <integer>
      set remark-cos <0-7>
   end
end
```

Creating or customizing a service

Optionally, you can create or customize a service. When you create an ACL policy (ingress, egress, or prelookup), you select the service to use with the `set service <service_ID>` command under `config classifier`.

The FortiSwitch unit provides a set of pre-configured services that you can use. Use the following command to list the services:

```
show switch acl service custom
```

To create or customize a service:

```
config switch acl service custom
   edit <service name>
      set comment <string>
      set color <0-32>
      set protocol {ICMP | IP | TCP/UDP/SCTP}
      set sctp-portrange <dstportlow_int>[-<dstporthigh_int>: <srcportlow_int>-<srcporthigh_
           int>]
      set tcp-portrange <dstportlow_int>[-<dstporthigh_int>:
      <srcportlow_int>-<srcporthigh_int>]
      set udp-portrange <dstportlow_int>[-<dstporthigh_int>:<srcportlow_int>-<srcporthigh_
           int>]
   end
```

Creating a policer

Optionally, you can create a policer if you are defining ACLs to police different types of traffic. When you create an ACL policy (ingress or egress), you select the policer to use with the `set policer <policer>` command under `config action`.

Using the GUI:

1. Go to *Switch* > *ACL* > *Policer*.
2. Select *Add Policer*.
3. Required. In the ID field, enter a unique number to identify this policer.
4. In the Type drop-down list, select whether the policer is for egress or ingress policies.
5. In the Guaranteed Bandwidth field, enter the amount of bandwidth guaranteed (in Kbits/second) to be available for traffic controlled by the policy.
6. In the Guaranteed Burst field, enter the guaranteed burst size in bytes.
7. In the Maximum Burst field, enter the maximum burst size in bytes
8. In the Description field, enter a description of the policer.
9. Select *OK* to save the policer.

Using the CLI:

```
config switch acl policer
   edit <1-2048>
      set description <string>
      set guaranteed-bandwidth <bandwidth_value>
      set guaranteed-burst <in_bytes>
      set maximum-burst <in_bytes>
      set type {egress | ingress}
   end
```

Each policy is assigned a unique policy ID that is automatically assigned. To view it, use the `get switch acl {egress | ingress | prelookup}` command.

Viewing counters

NOTE: On the 4xxE platforms, the ACL byte counters for the prelookup stage are not available (they will always show as 0 on the CLI). The packet counters are available.

You can use the GUI and CLI to view the counters associated with the ingress, egress, and prelookup policies.

Using the GUI:

Go to *Switch* > *Monitor* > *ACL Counters*.

Using the CLI:

```
get switch acl counters {all | egress | ingress | prelookup}
```

For example:

```
S524DF4K15000024 # get switch acl counters ingress
ingress:
ID Packets Bytes description
_____________________________________________________
0001 0 0 cnt_n_mirror13
0002 0 0 cnt_n_mirror31
0003 0 0 cnt_n_mirror41
```

Clearing counters

You can use the GUI or CLI to clear the counters associated with all policies or the counters associated with just ingress, egress, or prelookup policies.

Using the GUI:

1. Go to *Switch* > *Monitor* > *ACL Counters*.
2. Select *Ingress*, *Egress*, *Prelookup*, or *All* to clear those counters.

Using the CLI:

```
execute acl clear-counter {all | egress | ingress | prelookup}
```

Clearing unused classifiers

Use the following command to clear the unused classifiers on ASIC hardware associated with ingress, egress, prelookup, or all policies for a particular group:

```
execute acl key-compaction {all | ingress | egress | prelookup} <group_ID>
```

NOTE: This command currently only works on the ingress policy.

Configuration examples

Example 1

In the following example, traffic from VLAN 3 is blocked to a specified destination IP subnet (10.10.0.0/16) but allowed to all other destinations:

```
config switch acl ingress
   edit 1
      config action
         set count enable
         set drop enable
      end
      config classifier
         set dst-ip-prefix 10.10.0.0 255.255.0.0
         set vlan-id 3
      end
      set ingress-interface-all enable
      set status active
   end
```

Example 2

In the following example, Server Message Block (SMB) traffic received on port 1 is mirrored to port 3. SMB protocol uses port 445:

```
config switch acl service custom
   edit "SMB"
      set tcp-portrange 445
   next
end
config switch acl ingress # apply policy to port 1 ingress and send to port 3
   edit 1
      set description "cnt_n_mirror_smb"
      set ingress-interface-all disable
      set ingress-interface "port1"
      set status active
      config action
         set count enable
         set mirror mirror-1
      end
      config classifier
         set service "SMB"
         set src-ip-prefix 20.20.20.100 255.255.255.255
         set dst-ip-prefix 100.100.100.0 255.255.255.0
      end
   next
end
```

Example 3

The FortiSwitch unit can map different flows (for example, based on source and destination IP addresses) to specific outgoing ports.

In the following example, flows are redirected (based on destination IP) to different outgoing ports, connected to separate FortiDDOS appliances. This allows you to apply different FortiDDOS service profiles to different types of traffic:

```
config switch acl ingress # apply policy to port 1 ingress and send to port 3
   edit 1
      config action
         set count enable
         set redirect "port3" # use redirect to shift selected traffic to new destination
      end
      config classifier
         set dst-ip-prefix 100.100.100.0 255.255.255.0
      end
      set description "cnt_n_mirror13"
      set ingress-interface "port1"
      set status active
   next
   edit 2
      config action # apply policy to port 3 ingress and send to port 1
         set count enable
         set redirect "port1"
      end
      config classifier
         set src-ip-prefix 100.100.100.0 255.255.255.0
      end
      set description "cnt_n_mirror31"
      set ingress-interface-all disable
      set ingress-interface "port3"
      set status inactive
   next
end

config switch acl ingress # apply policy to port 1 ingress and send to port 4
   edit 3
      config action
         set count enable
         set redirect "port4" # use redirect to shift selected traffic to new destination
      end
      config classifier
         set dst-ip-prefix 20.20.20.0 255.255.255.0
      end
      set description "cnt_n_mirror14"
      set ingress-interface "port1"
      set status active
   next
   edit 4
      config action # apply policy to port 4 ingress and send to port 1
         set count enable
         set redirect "port1"
      end
      config classifier
         set src-ip-prefix 20.20.20.0 255.255.255.0
      end
```

```
      set description "cnt_n_mirror41"
      set ingress-interface "port4"
      set status inactive
   next
end
```

Example 4

In the following example, a recurring schedule is created and then used to control when the ACL policy is active:

```
config system schedule recurring
   edit schedule2
      set day monday tuesday wednesday thursday friday saturday sunday
      set start 07:00
      set end 17:00
   end
config switch acl ingress
   edit 1
      config action
         set remark-cos 1
         set remark-dscp 23
      end
      config classifier
         set src-mac 00:21:cc:d2:76:72
         set dst-mac d6:dd:25:be:2c:43
      end
      set ingress-interface-all enable
      set schedule schedule2
      set status active
   next
end
```

Storm control

Storm control protects a LAN from disruption by traffic storms, which stem from mistakes in network configuration or denial-of-service attacks. A traffic storm, which can consist of broadcast, multicast, or unicast traffic, creates excessive traffic on the LAN and degrades network performance.

By default, storm control is disabled on a FortiSwitch unit. When enabled, it measures the data rate (in packets-per-second) for unknown unicast, unknown multicast, and broadcast traffic. You can enable and disable storm control for each of these traffic types individually. If the traffic rate for any of the types exceeds the configured threshold, the FortiSwitch unit drops the excess traffic.

By default, storm control configuration is global. Starting in FortiSwitchOS 6.2.0, you can configure storm control on a port level.

Starting in FortSwitchOS 6.4.3, you can configure the maximum burst size allowed by storm control. Using the CLI, you can select the burst-size level from 0 to 4 with the highest number for the highest maximum burst size allowed. The maximum number of packets or bytes allowed for each burst-size level depends on the switch model.

NOTE: The burst-size level cannot be controlled on a port level for the FS-108E, FS-108E-POE, FS-108-FPOE, FS-124E, FS-124E-POE, and FS-124E-FPOE models.

This chapter covers the following topics:

Configuring system-wide storm control

If you set the rate to zero, the system drops all packets (for the enabled traffic types).

Using the GUI:

1. Go to *Switch* > *Storm Control*.
2. Select *Restrict Traffic*.
3. Select *Broadcast*, *Unknown Unicast*, and *Unknown Multicast* as required.
4. Select the action to take, either *Drop Packets* or *Rate Limit*.
5. If you selected *Rate Limit*, enter the number of packets per second.
6. Select *Update* to save the changes.

Using the CLI:

```
config switch storm-control
   set broadcast {enable | disable}
   set burst-size-level <0-4>
   set rate [0 | 2-10000000]
   set unknown-unicast {enable | disable}
   set unknown-mcast {enable | disable}
```

```
end
```

Configuring port-level storm control

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select a port and then select *Edit*.
3. In the Storm Control area, select *Configure Manually*.
4. Select one or more of the packet types: *Broadcast*, *Unknown Multicast*, and *Unknown Unicast*.
5. Select the action to take, either *Drop Packets* or *Rate Limit*.
6. If you selected *Rate Limit*, enter the number of packets per second.
7. Select *Update* to save the changes.

Using the CLI:

```
config switch physical-port
   edit <port_name>
      set storm-control-mode override
         config storm-control
            set broadcast {enable | disable}
            set burst-size-level <0-4>
            set rate [0 | 2-10000000]
            set unknown-multicast {enable | disable}
            set unknown-unicast {enable | disable}
         end
      end
```

Displaying the storm-control configuration

Use the following command to display the system-wide storm-control configuration:

```
get switch storm-control
```

DHCP snooping

The DHCP-snooping feature monitors the DHCP traffic from untrusted sources (for example, typically host ports and unknown DHCP servers) that might initiate traffic attacks or other hostile actions. To prevent this, DHCP snooping filters messages on untrusted ports by performing the following activities:

- Validating DHCP messages received from untrusted sources and filtering out invalid messages. For example, a request to decline an DHCP offer or release a lease is ignored if the request is from a different interface than the one that created the entry.
- Building and maintaining a DHCP snooping binding database, which contains information about untrusted hosts with leased IP addresses.

Other security features like dynamic ARP inspection (DAI), a security feature that rejects invalid and malicious ARP packets, also use information stored in the DHCP-snooping binding database.

In the FortiSwitch unit, all ports are untrusted by default, and DHCP snooping is disabled on all untrusted ports. You indicate that a source is trusted by configuring the trust state of its connecting interface.

For additional security, you can specify in the CLI which DHCP servers that DHCP snooping will include in the allowed server list.

This chapter covers the following topics:

Configuring DHCP snooping

DHCP snooping is enabled per VLAN and, by default, DHCP snooping is disabled.

Configuring DHCP snooping consists of the following steps:

1. Set the system-wide DHCP-snooping options.
2. Configure the VLAN settings.
3. Configure the interface settings.

Set the system-wide DHCP-snooping options

Before you use DHCP snooping, you need to enable the trusted DHCP server list.

To set the system-wide DHCP-snooping options:

```
config system global
   set dhcp-server-access-list {enable | disable}
end
```

For example:

```
config system global
   set dhcp-server-access-list enable
end
```

Including option-82 data

You can include option-82 data in the DHCP request. (DHCP option 82 provides additional security by enabling a controller to act as a DHCP relay agent to prevent DHCP client requests from untrusted sources.) You can select a fixed format for the Circuit ID and Remote ID fields or select which values appear in the Circuit ID and Remote ID fields.

The following is the fixed format for the option-82 Circuit ID field

Circuit-ID: vlan-mod-port

vlan - [2 bytes]

mod - [(1 Byte) -> Snoop - 1 , Relay - 0]

port - [1 byte]

The following is the fixed format for the option-82 Remote ID field:

Remote-ID: mac [6 byte]

If you want to select which values appear in the Circuit ID and Remote ID fields:

- For the Circuit ID field, you can include the interface description, host name, interface name, mode, and VLAN.
- For the Remote ID field, you can include the host name, IP address, and MAC address.

To configure the option-82 data:

```
config system global
   set dhcp-option-format {ascii | legacy}
   set dhcp-client-location {description | hostname | intfname | mode | vlan}
   set dhcp-remote-id {hostname | ip | mac}
end
```

Configure the VLAN settings

Using the GUI:

1. Go to *Switch* > *VLAN*.
2. Select *Add VLAN*.
3. Enter the VLAN identifier.
4. Enter a description for the new VLAN.
5. Under DHCP Snooping, select *Enable*.
6. If needed, select *Verify Source MAC*, *Insert Option 82*, and *Dynamic ARP Inspection*.
7. Under the DHCP Server Whitelist, select + to add the name and IP address of an approved DHCP server.
8. In the Members by MAC Address section, select *Add* to add a MAC address.
9. In the Members by IP Address section, select *Add* to add an IPv4 address and netmask.
10. To save your changes, select *Add* at the bottom of the page.

Using the CLI:

```
config switch vlan
   edit <vlan-id>
      set dhcp-snooping enable
      set dhcp-snooping-verify-mac {enable | disable>}
      set dhcp-snooping-option82 {enable | disable}
      set dhcp6-snooping enable
      config member-by-mac
         edit <id>
            set mac XX:XX:XX:XX:XX:XX
            set description <128 byte string>
         next
      end
      config member-by-ipv4
         edit <id>
            set address a.b.c.d/e
            set description <128-byte string>
         next
      end
      config dhcp-server-access-list
         edit <string>
            set server-ip <xxx.xxx.xxx.xxx>
            set server-ip6 <xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx>
         next
      end
   next
end
```

NOTE: If you enable `dhcp-snooping-verify-mac`, the system will verify that the source MAC address in the DHCP request from an untrusted port matches the client hardware address.

NOTE: If you enable `dhcp-snooping-option82`, the system inserts option-82 data into the DHCP messages for this VLAN.

For example, to configure IPv4 DHCP snooping:

```
config switch vlan
   edit 10
      set dhcp-snooping enable
         config dhcp-server-access-list
            edit "list1"
               set server-ip 100.1.0.2
            next
         end
      next
   end
```

For example, to configure IPv6 DHCP snooping:

```
config switch vlan
   edit 10
      set dhcp6-snooping enable
         config dhcp-server-access-list
            edit "list1"
               set server-ip6 3f2e:6a8b:78a3:0d82:1725:6a2f:0370:6234
            next
```

```
        end
      next
   end
```

Configure the interface settings

After you enable DHCP snooping on a VLAN, all interfaces are in an untrusted state by default, and DHCP snooping is disabled on all untrusted interfaces. You must explicitly configure the trusted interfaces and enable DHCP snooping for each interface.

In addition, you can set a limit for how many IP addresses are in the DHCP snooping binding database for each interface by enabling the `dhcp-snoop-learning-limit-check` and setting the `learning-limit`. By default, `dhcp-snoop-learning-limit-check` is disabled, and the number of entries for an untrusted ports is 5. You can set the number of entries to 0. The maximum number of entries depends on which FortiSwitch unit you are using. For example:

```
S548DN4K16000313 # show switch vlan 1
config switch vlan
   edit 1
      set learning-limit 100
      set dhcp-snooping enable
   next
end
```

NOTE: If the FortiSwitch unit has already learned more IP addresses than the `dhcp-snoop-learning-limit` before the limit is set, the configuration is rejected because the FortiSwitch unit cannot select which IP addresses should be kept. If the FortiSwitch unit has learned fewer IP address or the same number of IP addresses as the `dhcp-snoop-learning-limit` before the limit is set, the configuration is accepted.

NOTE: The per-VLAN learning limit is not supported on dual-chip platforms (448 series).

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical* or *Switch* > *Interface* > *Trunk*.
2. Select an interface.
3. Select *Edit*.
4. Select a *Trusted* or *Untrusted* interface for DHCP snooping.
5. If you want to accept DHCP messages with option-82 data from an untrusted interface, select the *Option-82 Trust* check box.
6. Select *OK*.

Using the CLI:

```
config switch {interface | trunk}
   edit <interface-name>
      set native-vlan <VLAN-ID>
      set dhcp-snooping {trusted | untrusted}
      set dhcp-snoop-learning-limit-check {enable | disable}
      set learning-limit <integer>
      set dhcp-snoop-option82-trust {enable | disable}
   next
end
```

For example:

```
config switch interface
   edit "port5"
      set native-vlan 10
      set dhcp-snooping untrusted
      set dhcp-snoop-learning-limit-check enable
      set learning-limit 7
      set dhcp-snoop-option82-trust enable
      set snmp-index 5
   next
end
```

Set `dhcp-snooping` to reflect the trust state of the interface. Where DHCP servers are located, you must configure interfaces as trusted.

If you enable `dhcp-snoop-option82-trust`, the system accepts DHCP messages with option-82 data from an untrusted interface.

Checking the DHCP-snooping configuration

Use the following command to view the detailed status of IPv4 and IPv6 DHCP-snooping VLANs and ports:

```
get switch dhcp-snooping database-summary
```

An entry in the DHCP snooping binding database that contains an * after the IP address indicates a temporary or incomplete entry. For example:

```
08:00:27:13:16:51 2000 100.0.0.159* 10 4 port4
```

The DHCP server has not acknowledged this entry yet. If the DHCP server does not acknowledge the entry within 10 seconds, the entry is removed from the database. If the DHCP server does acknowledge the entry within 10 seconds, the entry will be considered “complete” (that is, no * after the IP address), and a proper expiration time is assigned to it.

To view the details of the IPv4 and IPv6 DHCP-snooping client and server databases:

```
get switch dhcp-snooping status
```

To view the details of the IPv4 DHCP-snooping client database:

- Enter the following CLI command: `get switch dhcp-snooping client-db-details`
- Go to *Switch* > *Monitor* > *DHCP Snooping* > *Clients*.

To view the details of the IPv6 DHCP-snooping client database:

- Enter the following CLI command: `get switch dhcp-snooping client6-db-details`
- Go to *Switch* > *Monitor* > *DHCP Snooping* > *Clients*.

To view the details of the IPv4 DHCP-snooping server database:

- Enter the following CLI command: `get switch dhcp-snooping server-db-details`
- Go to *Switch* > *Monitor* > *DHCP Snooping* > *Servers*.

To view the details of the IPv6 DHCP-snooping server database:

- Enter the following CLI command: `get switch dhcp-snooping server6-db-details`
- Go to *Switch* > *Monitor* > *DHCP Snooping* > *Servers*.

If the dhcp-server-access-list is enabled globally and the server is configured for the dhcp-server-access-list, the svr-list column displays `allowed` for that server. If the dhcp-server-access-list is enabled globally and the server is not configured in the dhcp-server-access-list, the svr-list column displays `blocked` for that server.

Removing an entry from the DHCP-snooping binding database

You can remove an IP address from the DHCP-snooping binding database by specifying the associated VLAN ID and MAC address:

```
execute dhcp-snooping expire-client <1-4095> <xx:xx:xx:xx:xx:xx>
```

For example:

```
execute dhcp-snooping expire-client 100 01:23:45:67:89:01
```

IP source guard

IP source guard protects a network from IPv4 spoofing by only allowing traffic on a port from specific IPv4 addresses. Traffic from other IPv4 addresses is discarded. The discarded addresses are not logged.

IP source guard allows traffic from the following sources:

- Static entries—IP addresses that have been manually associated with MAC addresses.
- Dynamic entries—IP addresses that have been learned through DHCP snooping.

By default, IP source guard is disabled. You must enable it on each port that you want protected. If you enable IP source guard and then disable it, all static and dynamic entries are removed for that interface.

There is a maximum of 2,048 IP source guard entries. When there is a conflict between static entries and dynamic entries, static entries take precedence over dynamic entries.

The following FortiSwitch models support IP source guard:

FSR-124D, FS-224D-FPOE, FS-248D, FS-2xxE, FS-424D, FS-424D-POE, FS-424D-FPOE, FS-448D, FS-448D-POE, and FS-448D-FPOE

NOTE: IP source guard does not work with VLAN translation.

Configuring IP source guard

Configuring IP source guard consists of the following steps:

1. Enable IP source guard.
2. Configure IP source guard by binding IPv4 addresses with MAC addresses
3. Check the IP source-guard entries.
4. Optional. Check the IP source-guard violation log.

1. Enable IP source guard

You must enable IP source guard before you can configure it.

To enable IP source guard:

```
config switch interface
   edit <port_name>
      set ip-source-guard enable
   end
```

For example:

```
config switch interface
   edit port6
      set ip-source-guard enable
```

```
   end
```

2. Configure IP source-guard static entries

After you enable IP source guard, you can configure static entries by binding IPv4 addresses with MAC addresses. For IP source-guard dynamic entries, you need to configure DHCP snooping. See DHCP snooping on page 166.

Using the GUI:

1. Go to *Switch* > *IP Source Guard*.
2. Select *Configure* for the interface that you want to add IP source guard to.
3. In the Description field, add a description of the configuration.
4. Select +.
5. Required. In the Name field, enter a name for the binding entry.
6. Required. In the IP address field, enter the IPv4 address to bind to the MAC address. Masks are not supported.
7. Required. In the MAC address field, enter the MAC address to bind to the IPv4 address.
8. Select *Configure* to save your configuration.

Using the CLI:

```
config switch ip-source-guard
   edit <port_name>
      config binding-entry
         edit <id>
            set ip <xxx.xxx.xxx.xxx>
            set mac <XX:XX:XX:XX:XX:XX>
         next
      end
   next
end
```

For example:

```
config switch ip-source-guard
   edit port4
      config binding-entry
         edit 1
            set ip 172.168.20
            set mac 00:21:cc:d2:76:72
         next
      end
   next
end
```

3. Check the IP source-guard entries

After you configure IP source guard, you can check the database entries. Static entries are manually added by the `config switch ip-source-guard` command. Dynamic entries are added by DHCP snooping.

Using the GUI:

Go to *Switch* > *Monitor* > *IP Source Guard*.

Using the CLI:

```
diagnose switch ip-source-guard hardware entry list
```

4. Check the IP source-guard violation log

If you want to see events that violate the IP source-guard settings, enable the IP source-guard violation log.

The IP source-guard violation log contains a maximum of 128 entries with a maximum of 5 entries per port, even if more violations have occurred. The maximum values cannot be changed.

To enable the IP source-guard violation log:

```
config switch global
   set log-source-guard-violations enable
   set source-guard-violation-timer <1-1500 minutes>
end
```

To display all IP source-guard violations:

```
get switch ip-source-guard-violations all
```

To display IP source-guard violations for a specific switch interface:

```
get switch ip-source-guard-violations interface <interface_name>
```

To reset all IP source-guard violations:

```
execute source-guard-violation reset all
```

To reset IP source-guard violations for a specific switch interface:

```
execute source-guard-violation reset interface <interface_name>
```

Dynamic ARP inspection

Dynamic ARP Inspection (DAI) prevents man-in-the-middle attacks and IP address spoofing by checking that packets from untrusted ports have valid IP-MAC-address binding. To use DAI, you must first enable the DHCP snooping feature and then enable DAI for each VLAN. See DHCP snooping on page 166.

This chapter covers the following topics:

Configuring DAI

Configuring DAI consists of the following steps:

1. Enable DAI for each VLAN. By default, it is disabled.
2. Enable DAI for the switch interface. By default, all interfaces are in an untrusted state. You must explicitly configure the trusted interfaces.

Enable DAI for each VLAN

Using the GUI:

1. Go to *Switch* > *VLAN*.
2. Select *Add VLAN*.
3. Enter the VLAN identifier.
4. Enter a description for the new VLAN.
5. Under DHCP Snooping, select *Enable*.
6. Select *Dynamic ARP Inspection*.
7. To save your changes, select *Add* at the bottom of the page.

Using the CLI:

```
config switch vlan
   edit <vlan-id>
      set arp-inspection {enable | disable}
   next
end
```

Enable DAI for the switch interface

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select an interface and select *Edit*.

3. Enter the VLAN identifier.
4. Enter a description for the new VLAN.
5. Select *Untrusted* or *Trusted* for *DHCP Snooping*.
6. Select *OK*.

Using the CLI:

```
config switch interface
   edit <interface-name>
      set arp-inspection-trust <untrusted | trusted>
   next
end
```

Checking ARP packets

Use the following command to see how many ARP packets have been dropped or forwarded:

```
#diagnose switch arp-inspection stats

vlan 100           arp-request               arp-reply
-------------------------------------------------------------------------
received                 0                         0
forwarded                0                         0
dropped                  0                         0
```

IGMP snooping

The FortiSwitch unit uses the information passed in IGMP messages to optimize the forwarding of IPv4 multicast traffic.

IGMP snooping allows the FortiSwitch unit to passively listen to the Internet Group Management Protocol (IGMP) network traffic between hosts and routers. The switch uses this information to determine which ports are interested in receiving each multicast feed. The FortiSwitch unit can reduce unnecessary multicast traffic on the LAN by pruning multicast traffic from links that do not contain a multicast listener.

Essentially, IGMP snooping is a layer-2 optimization for the layer-3 IGMP.

The current version of IGMP is version 3, and the FortiSwitch unit is also compatible with IGMPv1 and IGMPv2.

Starting in FortiSwitchOS 6.4.3, you can configure the IGMP-snooping querier version 2 or 3. When the IGMP querier version 2 is configured, the FortiSwitch unit will send IGMP queries version 2 when no external querier is present. When the IGMP querier version 3 is configured, the FortiSwitch unit will send IGMP queries version 3 when no external querier is present. The default IGMP querier version is 2.

Here is the basic IGMP snooping operation:

1. A host expresses interest in joining a multicast group. (Sends or responds to a join message).
2. The FortiSwitch unit creates an entry in the layer-2 forwarding table (or adds the host's port to an existing entry). The switch creates one table entry per VLAN per multicast group.
3. The FortiSwitch unit removes the entry when the last host leaves the group (or when the entry ages out).

In addition, you can configure the FortiSwitch unit to send periodic queries from all ports in a specific VLAN to request IGMP reports. The FortiSwitch unit uses the IGMP reports to update the layer-2 forwarding table.

NOTE: If you want to use IGMP snooping with an MCLAG, see Configuring an MCLAG with IGMP snooping on page 121.

This chapter covers the following topics:

Notes

- To make well-known multicast packets, such as mDNS, flood to all ports when IGMP snooping is enabled on FSR-112D-POE, you need to make the following configuration change.

  In 6.2.x through 6.4.2 GA:

```
config switch igmp-snooping globals
   set flood-unknown-multicast
end
```

In 6.4.3 GA and later:

```
config switch global
   set flood-unknown-multicast enable
end
```

- On the FS-100E series, IGMP snooping can be enabled on a maximum of 6 VLANs.
- Enabling the `set flood-unknown-multicast` command and then disabling it disrupts the forwarding of unknown multicast traffic to mRouter ports for a short period, depending on the query interval, because the mRouter ports need to be relearned.
- The IGMP group's source address(es) in the IGMPv3 report are not considered.
- The IGMP snooping entries are added based on multicast group MAC addresses.
- When IGMP snooping is enabled on a VLAN on the FSR-112D-POE model:
  - All IPv6 multicast and any non-IP multicast are forwarded to querier ports only instead of getting flooded on the VLAN. The forwarding of IPv6 to the CPU is unchanged.
  - IPv4 reserved multicast is flooded to the VLAN and not forwarded to the CPU, even if the CPU is part of the VLAN.
  - Unregistered IPv4 multicast is forwarded to querier ports only.
    If IPv6 multicast and/or non-IP multicast is expected to be forwarded to any ports other than querier ports, the `mcast-snooping-flood-traffic` setting can be enabled on the required ports.
- Starting with FortiSwitchOS 6.4.0, when an inter-switch link (ISL) is formed automatically, the `igmp-snooping-flood-reports` and `mcast-snooping-flood-traffic` options are disabled by default.
- Proxy reporting is not supported for IGMPv3.
- Explicit host tracking is not supported.
- Immediate leave for IGMPv3 is not supported.
- IGMP snooping and MLD snooping share the same lookup table. Starting with FortiSwitchOS 6.4.5, the following snooping table limits apply:

FortiSwitch Models	Snooping Table Limit
FSR-112D-POE	4,096
FSR-124D, FS-2xxD, FS-2xxE, FS-4xxD, FS-4xxE, FS-M426E-FPOE	1,024
FS-124E, FS-124F, and FS-108E	1,024
FS-148E and FS-148F	4,096
FS-5xx	8,192 (IGMP snooping) and 6,144 (MLD snooping)
FS-1048E	8,192
FS-1048D and FS-1024D	4,096
FS-3032D and FS-3032E	8,192

  Until FortiSwitchOS 3.5.1, the table limits were hardware only. The software limit for all platforms was 8192.
- When the IGMP proxy is enabled, the proxy report and proxy leave use the IP address 0.0.0.0. IGMP group-specific queries sent by the proxy use the internal querier's IP address if it is configured.

Configuring IGMP snooping

Configuring IGMP snooping consists of the following major steps:

1. Configure IGMP snooping on a global level.
2. Optional. Enable IGMP-snooping options on the interfaces.
3. Configure IGMP snooping on the VLANs.

1. Configure IGMP snooping on a global level

By default, the maximum time (`aging-time`) that multicast snooping entries without any packets are kept is for 300 seconds. This value can be in the range of 15-3,600 seconds. By default, `flood-unknown-multicast` is disabled, and unregistered multicast packets are forwarded only to mRouter ports. If you enable `flood-unknown-multicast`, unregistered multicast packets are forwarded to all ports in the VLAN.

Using the CLI:

```
config switch igmp-snooping globals
   set aging-time <15-3600>
end

config switch global
   set flood-unknown-multicast {enable | disable}
end
```

For example:

```
config switch igmp-snooping globals
   set aging-time 500
end

config switch global
   set flood-unknown-multicast enable
end
```

2. Enable IGMP-snooping options on the interfaces

Optional. You can flood IGMP reports and flood multicast traffic on a specified switch interface. By default, these options are disabled.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical* or *Switch* > *Interface* > *Trunk*.
2. Select an interface.
3. Select *Edit*.
4. In the IGMP Snooping area, select *Flood Reports*, *Flood Traffic*, or both if needed.
5. Select *OK*.

Using the CLI:

```
config switch interface
   edit <port>
      set native-vlan <vlan-id>
      set igmp-snooping-flood-reports {enable | disable}
      set mcast-snooping-flood-traffic {enable | disable}
   next
end
```

For example:

```
config switch interface
   edit port10
      set native-vlan 30
      set igmp-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port2
      set native-vlan 30
      set igmp-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port4
      set native-vlan 30
      set igmp-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port6
      set native-vlan 30
      set igmp-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port8
      set native-vlan 30
      set igmp-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
end
```

Use the following command to clear the learned/configured multicast group from an interface:

```
execute clear switch igmp-snooping
```

3. Configure IGMP snooping on the VLANs

Enable IGMP snooping on a specified VLAN and configure IGMP static groups. By default, IGMP snooping is disabled.

You can define static groups for particular multicast addresses in a VLAN that has IGMP snooping enabled. You can specify multiple ports in the static group, separated by a space. The trunk interface can also be included in a static group. There are two restrictions for IGMP static groups:

- The range of multicast addresses (mcast-addr) from 224.0.0.1 to 224.0.0.255 cannot be used.

- The VLAN must already be assigned as the native VLAN for a switch interface and be included in the range of allowed VLANs for a switch interface. You can check the Physical Port Interfaces page to see which VLANs can be used for IGMP static groups.

Starting in FortiSwitchOS 6.2.0, you can also use the CLI to enable IGMP proxy, which allows the VLAN to send IGMP reports. After you enable `igmp-snooping-proxy` on a VLAN, it will start suppressing reports and leave messages. For each multicast group, only one report is sent to the upstream interface. When a leave message is received, the FortiSwitch unit will only send the leave message to the upstream interface when there are no more members left in the multicast group. The FortiSwitch unit will also reply to generic queries and will send IGMP reports to the upstream interface.

Using the GUI:

1. Go to *Switch* > *VLAN*.
2. Select *Add VLAN*.
3. In the ID field, enter the VLAN identifier.
4. In the Description field, enter a description for the new VLAN.
5. In the IGMP Snooping area, select *Enable*.
6. Optionally, select *IGMP Proxy*.
7. In the IGMP Static Groups area, select + to add an IGMP static group.
   NOTE: If the VLAN identifier that you entered in step 3 is not already assigned as the native VLAN for an interface and is not included in the range of allowed VLANs for an interface, the + button does not work.
8. In the Name field, enter a name for the IGMP static group.
9. In the Multicast Address field, enter the multicast address.
10. Select the interfaces to include.
11. Select *Add* to create the new VLAN.

Using the CLI:

```
config switch vlan
   edit <vlan-id>
      set igmp-snooping {enable |disable}
      set igmp-snooping-proxy {enable | disable}
      set igmp-snooping-fast-leave {enable | disable}
      config igmp-snooping-static-group
         edit <group-name>
            set mcast-addr <IPv4_multicast_address>
            set members <interface_name1> <interface_name2>...
         next
      end
   next
end
```

For example, to configure two static groups for the same VLAN:

```
config switch vlan
   edit 30
      set igmp-snooping enable
      config igmp-snooping-static-group
         edit g239-1-1-1
            set mcast-addr 239.1.1.1
            set members port2 port5 port28
         next
```

```
        edit g239-2-2-2
           set mcast-addr 239.2.2.2
           set members port5 port10 trunk-1
        next
      end
   next
end
```

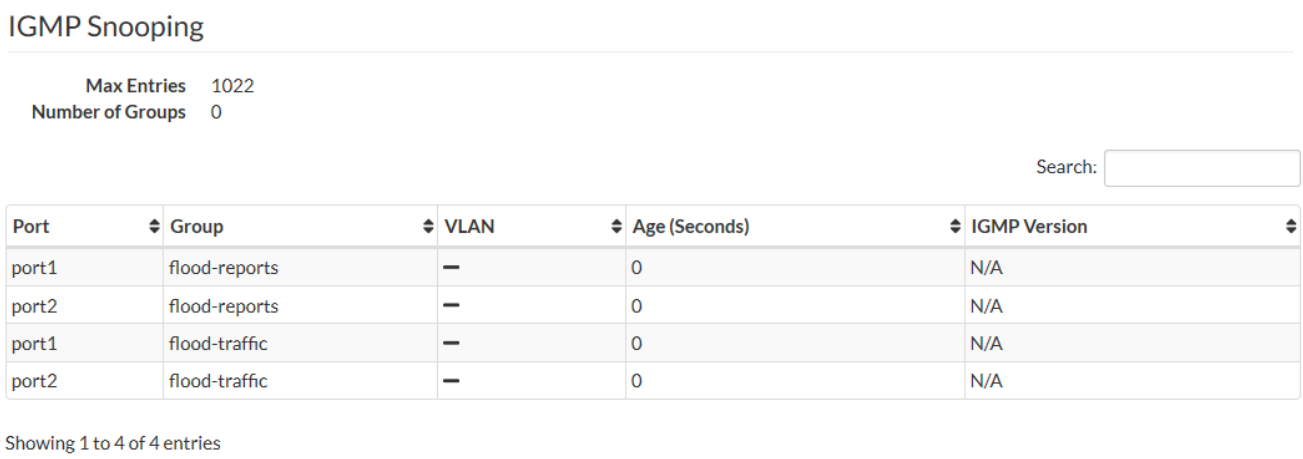
Check the IGMP-snooping configuration

Use the following commands to display information about IGMP snooping:

```
# get switch igmp-snooping {globals | group | static-group | status}
```

- `globals`: display the IGMP-snooping global configuration on the FortiSwitch unit
- `group`: display a list of learned multicast groups
- `static-group`: display the list of configured static groups
- `status`: display the status of IGMP-snooping VLANs and group

Go to *Switch* > *Monitor* > *IGMP Snooping* to see the learned multicast groups:



Use the following CLI command to see the learned multicast groups:

```
FS1D243Z13000023 # get switch igmp-snooping group
Number of Groups: 7
port of-port VLAN GROUP Age
(__port__9) 1 23 231.8.5.4 16
(__port__9) 1 23 231.8.5.5 16
(__port__9) 1 23 231.8.5.6 16
(__port__9) 1 23 231.8.5.7 16
(__port__9) 1 23 231.8.5.8 16
(__port__9) 1 23 231.8.5.9 16
(__port__9) 1 23 231.8.5.10 16
(__port__43) 3 23 querier 17
(__port__14) 8 --- flood-reports ---
(__port__10) 2 --- flood-traffic ---
```

Display the list of configured static groups:

```
FS1D243Z13000023 # get switch igmp-snooping static-group
```

```
VLAN ID Group-Name     Multicast-addr  Member-interface
_______ _____________ _____________ ____________________________
11      g239-1         239:1:1:1       port6 trunk-2
11      g239-11        239:2:2:11      port26 port48 trunk-2
40      g239-1         239:1:1:1       port5 port25 trunk-2
40      g239-2         239:2:2:2       port25 port26
```

Configuring the IGMP querier

To use the IGMP querier, you need to configure how often IGMP queries are sent and enable the IGMP querier for a specific VLAN. Optionally, you can specify the address for the IGMP querier.

Use the following commands to specify how many seconds are between IGMP queries. The default is 120 seconds.

```
config switch igmp-snooping globals
   set query-interval <10-1200>
end
```

For example:

```
config switch igmp-snooping globals
   set aging-time 150
   set query-interval 200
end
```

Use the following commands to enable the IGMP querier for a specific VLAN and specify the address that IGMP reports are sent to:

```
config switch vlan
   edit 100
      set igmp-snooping {enable | disable}
      set igmp-snooping-querier {enable | disable}
      set igmp-snooping-querier-addr <IPv4_address>
      set igmp-snooping-querier-version {2 | 3}
   next
end
```

For example:

```
config switch vlan
   edit 100
      set igmp-snooping enable
      set igmp-snooping-querier enable
      set igmp-snooping-querier-addr 1.2.3.4
      set igmp-snooping-querier-version 3
   next
end
```

Configuring mRouter ports

Use the following commands to configure a FortiSwitch port as an mRouter port:

NOTE: These settings are not per-VLAN, so the port will act as a querier/mRouter port for all of its associated VLANs.

```
config switch interface
   edit <port>
      set igmp-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
end
```

MLD snooping

The FortiSwitch unit uses the information passed in Multicast Listener Discovery (MLD) messages to optimize the forwarding of IPv6 multicast traffic.

MLD snooping allows the FortiSwitch unit to passively listen to the MLD network traffic between hosts and multicast routers. The switch uses this information to determine which hosts are interested in receiving each multicast feed. The FortiSwitch unit can reduce unnecessary multicast traffic on the VLAN by pruning multicast traffic from links that do not contain a multicast listener.

FortiSwitch MLD snooping supports MLD version 1. RFC 2710 describes MLD snooping; RFC 4605 describes MLD proxy and MLD querier.

Here is the basic MLD-snooping operation:

1. A host expresses interest in joining a multicast group. (Sends or responds to a join message).
2. The FortiSwitch unit creates one table entry per VLAN per multicast group per port.
3. The FortiSwitch unit removes the entry when the last host leaves the group (or when the entry ages out).

In addition, you can configure the FortiSwitch unit to send periodic queries from all ports in a specific VLAN to request MLD reports. The FortiSwitch unit uses the MLD reports to update the layer-2 forwarding table.

This chapter covers the following topics:

Notes

- Enabling the `set flood-unknown-multicast` command and then disabling it disrupts the forwarding of unknown multicast traffic to mRouter ports for a short period, depending on the query interval, because the mRouter ports need to be relearned.
- The MLD-snooping entries are added based on multicast group IP addresses.
- IGMP snooping and MLD snooping share the same lookup table. Starting with FortiSwitchOS 6.4.5, the following snooping table limits apply:

FortiSwitch Models	Snooping Table Limit
FSR-112D-POE	4,096
FSR-124D, FS-2xxD, FS-2xxE, FS-4xxD, FS-4xxE, FS-M426E-FPOE	1,024
FS-124E, FS-124F, and FS-108E	1,024
FS-148E and FS-148F	4,096
FS-5xx	8,192 (IGMP snooping) and 6,144 (MLD

FortiSwitch Models	Snooping Table Limit
	snooping)
FS-1048E	8,192

Configuring MLD snooping

Configuring MLD snooping consists of the following major steps:

1. Configure MLD snooping on a global level.
2. Optional. Enable MLD-snooping options on the interfaces.
3. Configure MLD snooping on the VLANs.

1. Configure MLD snooping on a global level

By default, the maximum time (`aging-time`) that multicast snooping entries without any packets are kept is for 300 seconds. This value can be in the range of 15-3,600 seconds. By default, `flood-unknown-multicast` is disabled, and unregistered multicast packets are forwarded only to mRouter ports. If you enable `flood-unknown-multicast`, unregistered multicast packets are forwarded to all ports in the VLAN.

Using the CLI:

```
config switch mld-snooping globals
   set aging-time <15-3600>
end

config switch global
   set flood-unknown-multicast {enable | disable}
end
```

For example:

```
config switch mld-snooping globals
   set aging-time 500
end

config switch global
   set flood-unknown-multicast enable
end
```

2. Enable MLD-snooping options on the interfaces

Optional. You can flood MLD reports and flood multicast traffic on a specified switch interface. By default, these options are disabled.

Using the CLI:

```
config switch interface
```

```
   edit <port>
      set native-vlan <vlan-id>
      set mld-snooping-flood-reports {enable | disable}
      set mcast-snooping-flood-traffic {enable | disable}
   next
end
```

For example:

```
config switch interface
   edit port10
      set native-vlan 30
      set mld-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port2
      set native-vlan 30
      set mld-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port4
      set native-vlan 30
      set mld-snooping-flood-reportsenable
      set mcast-snooping-flood-traffic enable
   next
   edit port6
      set native-vlan 30
      set mld-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
   edit port8
      set native-vlan 30
      set mld-snooping-flood-reports enable
      set mcast-snooping-flood-traffic enable
   next
end
```

Use the following command to clear the learned/configured multicast group from an interface:

```
execute clear switch mld-snooping
```

3. Configure MLD snooping on the VLANs

Enable MLD snooping on a specified VLAN and configure MLD static groups. By default, MLD snooping is disabled.

You can define static groups for particular multicast addresses in a VLAN that has MLD snooping enabled. You can specify multiple ports in the static group, separated by a space. The trunk interface can also be included in a static group. There are two restrictions for MLD static groups:

- The range of well-known IPv6 multicast addresses that cannot be used for static groups is FF00::/12.
- The VLAN must already be assigned as the native VLAN for a switch interface *or* be included in the range of allowed VLANs for a switch interface. You can check the Physical Port Interfaces page to see which VLANs can be used for MLD static groups.

You can also enable the MLD proxy, which allows the VLAN to send MLD reports. After you enable `mld-snooping-proxy` on a VLAN, it will start suppressing reports and leave messages. For each multicast group, only one report is sent to the upstream interface. When a leave message is received, the FortiSwitch unit will only send the leave message to the upstream interface when there are no more members left in the multicast group. The FortiSwitch unit will also reply to generic queries and will send MLD reports to the upstream interface. If `mld-snooping-fast-leave` is disabled, the FortiSwitch unit sends a group-specific query (GSQ) when a leave message is received.

Using the CLI:

```
config switch vlan
   edit <vlan-id>
      set mld-snooping {enable |disable}
      set mld-snooping-proxy {enable | disable}
      config mld-snooping-static-group
         edit <group-name>
            set mcast-addr <IPv6_multicast_address>
            set members <interface_name1> <interface_name2>...
         next
      end
   next
end
```

For example:

```
config switch vlan
   edit 30
      set mld-snooping enable
      config mld-snooping-static-group
         edit g239-1-1-1
            set mcast-addr FF3E::1
            set members port2 port5 port28
         next
      end
   next
end
```

Check the MLD-snooping configuration

Use the following commands to display information about MLD snooping:

```
# get switch mld-snooping {globals | group | static-group | status}
```

- `globals`: display the MLD-snooping global configuration on the FortiSwitch unit
- `group`: display a list of learned multicast groups
- `static-group`: display the list of configured static groups
- `status`: display the status of MLD-snooping VLANs and group

Configuring the MLD querier

To use the MLD querier, you need to configure how often MLD queries are sent and enable the MLD querier for a specific VLAN. Optionally, you can specify the address for the MLD querier.

Use the following commands to specify how many seconds are between MLD queries. The default is 125 seconds.

```
config switch mld-snooping globals
   set query-interval <10-1200>
end
```

For example:

```
config switch mld-snooping globals
   set aging-time 150
   set query-interval 200
end
```

Use the following commands to enable the MLD querier for a specific VLAN and specify the address that MLD reports are sent to:

```
config switch vlan
   edit 100
      set mld-snooping {enable | disable}
      set mld-snooping-querier {enable | disable}
      set mld-snooping-querier-addr <IPv6_address>
   next
end
```

For example:

```
config switch vlan
   edit 100
      set mld-snooping enable
      set mld-snooping-querier enable
      set mld-snooping-querier-addr fe80::a5b:eff:fef1:95e5
   next
end
```

IPv6 router advertisement guard

IPv6-enabled routers send router advertisement (RA) messages to neighboring hosts in the local network. To prevent the spoofing of the RA messages, RA guard inspects RA messages to see if they meet the criteria contained in an RA-guard policy. If the RA messages match the criteria in the policy, they are forwarded. If the RA messages do not match the criteria in the policy, they are dropped.

The IPv6 RA-guard policy checks for the following criteria in each RA message:

- Whether it has been flagged with the M (managed address configuration) flag or O (other configuration) flag
- Whether the hop number is equal or more than the minimum hop limit
- Whether the hop number is equal or less than the maximum hop limit
- Whether the default router preference is set to high, medium, or low
- Whether the source IPv6 address matches an allowed address in an IPv6 access list (created with the `config router access-list6` command)
- Whether the IPv6 address prefix matches an allowed prefix in an IPv6 prefix list (created with the `config router prefix-list6` command)
- Whether the device is a host or a router. If the device is a host, all RA messages are dropped. If the device is a router, the other criteria in the policy are checked.

IPv6 RA guard is supported on 2xx models and higher.

Configuring IPv6 RA guard

Configuring IPv6 RA guard consists of the following steps:

1. (Optional) Create lists of source IPv6 addresses and IPv6 address prefixes that are allowed in RA messages.
2. Create one or more IPv6 RA-guard policies.
3. Apply the IPv6 RA-guard policies to switch interfaces and VLANs.

Create an IPv6 access list

Create an IPv6 access list if you want to specify which source IPv6 address are allowed in RA messages. When no rule in the IPv6 access list is matched, the RA messages are dropped.

To create an IPv6 access list:

```
config router access-list6
   edit <name_of_IPv6_access_list>
      set comments <string>
      config rule
         edit <rule_ID>
            set action {deny | permit}
            set prefix6 {<xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx> | any}
            set exact-match {enable | disable}
         next
```

```
      end
   end
```

For example:

```
config router access-list6
   edit accesslist1
      set comments "IPv6 access list"
      config rule
         edit 1
            set action permit
            set prefix6 fe80::a5b:eff:fef1:95e5
            set exact-match disable
         next
      end
   end
```

Create an IPv6 prefix list

Create an IPv6 prefix list if you want to specify which IPv6 prefixes in the RA option type 3 are allowed in RA messages. When no rule in the IPv6 prefix list is matched, the RA messages are dropped.

To create an IPv6 prefix list:

```
config router prefix-list6
   edit <name_of_IPv6_prefix_list>
      set comments <string>
      config rule
         edit <rule_ID>
            set action {deny | permit}
            set prefix6 {<IPv6_prefix> | any}
            set ge <0-128>
            set le <0-128>
         next
      end
   end
```

For example:

```
config router prefix-list6
   edit prefixlist1
      set comments "IPv6 prefix list"
      config rule
         edit 1
            set action permit
            set prefix6 any
            set ge 50
            set le 50
         next
      end
   end
```

Create an IPv6 RA-guard policy

In the IPv6 RA-guard policy, you specify the criteria that RA messages must match before the RA messages are forwarded.

To create an IPv6 RA-guard policy:

```
config switch raguard-policy
   edit <RA-guard policy name>
      set device-role {host | router}
      set managed-flag {Off | On}
      set other-flag {Off | On}
      set max-hop-limit <0-255>
      set min-hop-limit <0-255>
      set max-router-preference {high | medium | low}
      set match-src-addr <name_of_IPv6_access_list>
      set match-prefix <name_of_IPv6_prefix_list>
   next
end
```

For example:

```
config switch raguard-policy
   edit RApolicy1
      set device-role router
      set managed-flag On
      set other-flag On
      set max-hop-limit 100
      set min-hop-limit 5
      set max-router-preference medium
      set match-src-addr accesslist1
      set match-prefix prefixlist1
   next
end
```

Apply the IPv6 RA-guard policy

After you create an IPv6 RA-guard policy, you need to apply it to the appropriate switch ports or trunks and VLANs. You can create and apply different policies to different VLANs.

To apply the IPv6 RA-guard policy:

```
config switch interface
   edit <interface_name>
   config raguard
      edit <ID>
         set raguard-policy <name_of_RA_guard_policy>
         set vlan-list <list_of_VLANs>
      next
   end
end
```

For example:

```
config switch interface
   edit <interface_name>
   config raguard
      edit 1
         set raguard-policy RApolicy1
         set vlan-list 1
      next
      edit 2
         set raguard-policy RApolicy2
         set vlan-list 2-5
      next
   end
end
```

View available IPv6 RA-guard policies

Use the following command to list the available IPv6 RA-guard policies:

```
get switch raguard-policy
```

For example:

```
S524DF4K15000024 # get switch raguard-policy
== [ RApolicy1 ]
name: RApolicy1
```

Private VLANs

A private VLAN (PVLAN) divides the original VLAN (termed the primary VLAN) into sub-VLANs (secondary VLANs), while retaining the existing IP subnet and layer-3 configuration. Unlike a regular VLAN, which is a single broadcast domain, a PVLAN partitions one broadcast domain into multiple smaller broadcast subdomains.

After a PVLAN VLAN is configured, the primary VLAN forwards frames downstream to all secondary VLANs.

There are two main types of secondary VLANs:

- **Isolated**: Any switch ports associated with an isolated VLAN can reach the primary VLAN, but not any other secondary VLAN. In addition, hosts associated with the same isolated VLAN cannot reach each other. Only one isolated VLAN is allowed in one PVLAN domain.
- **Community**: Any switch ports associated with a common community VLAN can communicate with each other and with the primary VLAN but not with any other secondary VLAN. You might have multiple distinct community VLANs within one PVLAN domain.

There are mainly two types of ports in a PVLAN: promiscuous (P-Port) and host.

- **Promiscuous Port (P-Port)**: The switch port connects to a router, firewall, or other common gateway device. This port can communicate with anything else connected to the primary or any secondary VLAN. In other words, it is a type of a port that is allowed to send and receive frames from any other port on the VLAN.
- **Host Ports** further divides into two types – isolated port (I-Port) and community port (C-port).
- **Isolated Port (I-Port)**: Connects to the regular host that resides on isolated VLAN. This port communicates only with P-Ports.
- **Community Port (C-Port)**: Connects to the regular host that resides on community VLAN. This port communicates with P-Ports and ports on the same community VLAN.

This chapter covers the following topics:

Creating and enabling a PVLAN

Using the GUI:

1. Go to *Switch* > *VLAN*.
2. Select *Add VLAN* to create a new PVLAN.
3. Enter the VLAN identifier.
4. Enter a description for the new PVLAN.
5. Select *Enabled* to enable the new Private VLAN.
6. Enter a single VLAN identifier for the isolated subVLAN.
7. If needed, enter one VLAN identifier or multiple VLAN identifiers for a common community subVLAN.
8. To save your changes, select *Add* at the bottom of the page.

Configuring the PVLAN ports

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select the port to configure.
3. Select *Edit*.
4. Select if the Private VLAN port is a promiscuous port or part of a sub-VLAN.
5. For a promiscuous port, select the primary VLAN identifier.
6. For a port that is part of a sub-VLAN, select the primary VLAN identifier and the sub-VLAN identifier.
7. Select *OK*.

Private VLAN example

1. Enable a PVLAN:

```
config switch vlan
   edit 1000
      set private-vlan enable
      set isolated-vlan 101
      set community-vlans 200-210
   end
end
```

2. Configure the PVLAN ports:

```
config switch interface
   edit "port2"
      set private-vlan promiscuous
      set primary-vlan 1000
   next
   edit "port3"
      set private-vlan sub-vlan
      set primary-vlan 1000
      set sub-vlan 200
   next
   edit "port7"
      set private-vlan sub-vlan
      set primary-vlan 1000
      set sub-vlan 101
   next
   edit "port19"
      set private-vlan promiscuous
      set primary-vlan 1000
   next
   edit "port20"
      set private-vlan sub-vlan
      set primary-vlan 1000
      set sub-vlan 101
   next
```

```
    edit "port21"
       set private-vlan sub-vlan
       set primary-vlan 1000
       set sub-vlan 101
    end
end
```

Quality of service

Quality of service (QoS) provides the ability to set particular priorities for different applications, users, or data flows.

QoS involves the following elements:

- **Classification** is the process of determining the priority of a packet. This can be as simple as trusting the QoS markings in the packet header when it is received and so accept the packet. Alternatively, it can hinge on criteria (such as incoming port, VLAN, or service) that are defined by the network administrator.
- **Marking** involves setting bits in the packet header to indicate the priority of this packet.
- **Queuing** involves defining priority queues to ensure that packets marked as high priority take precedence over those marked as lower priority. If network congestion becomes so severe that packet drops are inevitable, the queuing process will also select the packets to drop.

The FortiSwitch unit supports the following QoS configuration capabilities:

- Mapping the IEEE 802.1p and layer-3 QoS values (Differentiated Services and IP Precedence) to an outbound QoS queue number.
- Providing eight egress queues on each port.
- Policing the maximum data rate of egress traffic on the interface.

NOTE: There are some differences in QoS configuration on the FS-108E, FS-108E-POE, FS-108E-FPOE, FS-124E, FS-124E-POE, FS-124E-FPOE, FS-148E, FS-148E-POE, FS-124F, FS-124F-POE, FS-124F-FPOE, FS-148F, FS-148F-POE, and FS-148F-FPOE models:

- You can configure only one dot1p-map per switch.
- You can configure only one ip-dscp-map per switch.
- You cannot set `min-rate`, `min-rate-percent`, `drop-policy`, or `wred-slope` under the `config switch qos qos-policy` command.
- Under the `config switch qos qos-policy` command, the switch rounds the `max-rate` value to the nearest multiple of 16 internally. If the rounding result is 0, `max-rate` is disabled internally.
- You cannot configure priority tagging on outgoing frames (`egress-pri-tagging`) under the `config switch qos dot1p-map` command.
- You can configure only one QoS drop policy per switch. You can configure the QoS drop policy under the `config switch global` command. You can specify random early detection (RED) with the `set qos-drop-policy random-early-detection` command.
- You can set the QoS RED/WRED drop probability (`qos-red-probability`) under the `config switch global` command. The FS-108E, FS-108E-POE, FS-108E-FPOE, FS-124E, FS-124E-POE, and FS-124E-FPOE models support 0-100 percent. The FS-148E, FS-148E-POE, FS-148E-FPOE, FS-124F, FS-124F-POE, FS-124F-FPOE, FS-148F, FS-148F-POE, and FS-148F-FPOE models support 0-25 percent.
- Adaptive or active RED (ARED) and robust RED (RRED) are not supported.

This chapter covers the following topics:

- Checking the QoS statistics on page 206
- Resetting and restoring QoS counters on page 207

Classification

The IEEE 802.1p standard defines a class of service (CoS) value (ranging from 0-7) that is included in the Ethernet frame. The Internet Protocol defines the layer-3 QoS values that are carried in the IP packet (Differentiated Services, IP Precedence). The FortiSwitch unit provides configurable mappings from CoS or IP-DSCP values to egress queue values.

Fortinet recommends that you do not enable trust for both Dot1p and DSCP at the same time on the same interface. If you do want to trust both Dot1p and IP-DSCP, the switch uses the latter value (DSCP) to determine the queue. The switch will use the Dot1p value and mapping only if the packet contains no DSCP value. For details, refer to Determining the egress queue on page 199.

Marking

FortiSwitchOS supports two ways to indicate the priority of outgoing packets:

- **CoS marking**: The priority is set with the CoS value of the 802.1Q tag. The range of CoS values is 0-7.
- **Differential service code point (DSCP) marking**: The priority is set with the DSCP value in the IP header. The range of DSCP values is 0-63.

You can use one of these methods or both methods.

Whether the CoS or DSCP values of inbound packets are remarked is subject to the classification by ACL rules for the ingress interfaces. When CoS or DSCP marking take place, the outbound queuing is not impacted, meaning it is still based on trust maps and the original CoS or DSCP values, as described in Determining the egress queue on page 199.

The following example shows how to use the CLI to configure an ACL policy to mark the CoS and DSCP values of inbound packets to 4 and 48 on port1 when their CoS values are 2:

```
config switch acl ingress
   edit 10
      config action
         set count enable
         set remark-cos 4
         set remark-dscp 48
      end
      config classifier
         set cos 2
      end
      set ingress-interface "port1"
      set status active
   next
end
```

Queuing

Queuing determines how queued packets on an egress port are served. Each egress port supports eight queues, and three scheduling modes are available:

- **Strict Scheduling**: The queues are served in descending order (of queue number), so higher number queues receive higher priority. Queue7 has the highest priority, and queue0 has the lowest priority. The purpose of the strict scheduling mode is to provide lower latency service to higher classes of traffic. However, if the interface experiences congestion, the lower priority traffic could be starved.
- **Simple Round Robin (RR)**: In round robin mode, the scheduler visits each backlogged queue, servicing a single packet from each queue before moving on to the next one. The purpose of round robin scheduling is to provide fair access to the egress port bandwidth.
- **Weighted Round Robin (WRR)**: Each of the eight egress queues is assigned a weight value ranging from 0 to 63. The purpose of weighted round robin scheduling is to provide prioritized access to the egress port bandwidth, such that queues with higher weight get more of the bandwidth, but lower priority traffic is not starved.

A drop policy determines what happens when a queue is full or exceeds a minimum threshold. Depending on your switch model, you can select from one of two drop policies:

- The **tail-drop** drop policy is the default and is available on all platforms. When a queue is full, additional incoming packets are dropped until there is space available in the queue.
- The **random early detection (RED)** drop policy is available on 124D, 2xx, and 4xxD models. When the queue size exceeds the minimum threshold, packets are dropped at a constant rate until the queue is full. Using the RED drop policy helps improve the throughput during network congestion.
- The **weighted random early detection (WRED)** drop policy is an advanced version of RED and is available on 4xxE, 5xx, 1xxx, and 3xxx models. When the queue size exceeds the threshold, the WRED slope controls the rate at which packets are dropped until the queue is full. The drop rate increases when the queue buffer usage increases. If you select `weighted-random-early-detection` in the CLI, you can enable explicit congestion notification (ECN) marking to indicate that congestion is occurring without just dropping packets.

Determining the egress queue

To determine the egress queue value for the packet, the FortiSwitch unit uses the configured trust values (and mappings) on the port and the QoS/CoS fields in the packet.

Packets with DSCP and CoS values

If the port is set to trust DSCP, the switch uses this value to find the queue assignment in the DSCP map for the port.

If the port is set to trust Dot1p and **not** to trust DSCP, the switch uses the packet's CoS value to look up the queue assignment in the Dot1p map for the port.

If the port is **not** set to trust Dot1p, the switch uses the default queue 0.

Packets with a CoS value but no DSCP value

The switch ignores the trust DSCP value.

- If the port is set to trust Dot1p, the switch uses the packet's CoS value to look up the queue assignment in the Dot1p map for the port.
- If the port is **not** set to trust Dot1p, the switch uses the default queue 0.

Packets with a DSCP value but no CoS value

If the port is set to trust DSCP, the switch uses the packet's DSCP value to look up the queue assignment in the DSCP map for the port.

If the port is set to trust Dot1p but **not** to trust DSCP, the switch uses the default CoS value of the port to look up the queue assignment in the Dot1p map for the port.

If the port is **not** set to trust Dot1p, the switch uses the default queue 0.

Configuring FortiSwitch QoS

FortiSwitch uses "queue-7" for network control and critical management traffic. To avoid affecting critical network control and management traffic, do not oversubscribe queue-7 or avoid using queue-7 for data traffic when configuring QoS.

This section provides procedures for the following configuration tasks:

- Configure an 802.1p map on page 200
- Configure a DSCP map on page 201
- Configure the QoS egress policy on page 202
- Configure the egress drop mode on page 203
- Configure the switch ports on page 204
- Configure QoS on trunks on page 205
- Configure QoS on VLANs on page 205
- Configure CoS and DSCP markings on page 206

Configure an 802.1p map

Using the GUI:

1. Go to *Switch* > *QoS* > *802.1p*.
2. Select *Add Map*.
3. Enter the name of your 802.1p map.
4. Enter a description of your 802.1p map.
5. Select the queue number for each priority.
6. Select *Add Map*.

Values that are not explicitly included in the map will follow the default mapping, which maps each priority (0-7) to queue 0. If an incoming packet contains no CoS value, the switch assigns a CoS value of zero.

Using the CLI:

You can configure an 802.1p map, which defines a mapping between IEEE 802.1p CoS values (from incoming packets on a trusted interface) and the egress queue values.

If you want to enable priority tagging on outgoing frames, enable the `egress-pri-tagging` option. This option is disabled by default.

NOTE: "Priority tagging" refers to adding a VLAN tag to untagged traffic with with VLAN 0 and a valid priority value. If the port is configured to transmit packets with a valid VLAN, priority tagging is not applicable.

```
config switch qos dot1p-map
   edit <dot1p map name>
      set description <text>
      set [priority-0|priority-1|priority-2|....priority-7] <queue number>
      set egress-pri-tagging {disable | enable}
   next
end
```

For example:

```
config switch qos dot1p-map
   edit "test1"
      set priority-0 queue-2
      set priority-1 queue-0
      set priority-2 queue-1
      set priority-3 queue-3
      set priority-4 queue-4
      set priority-5 queue-5
      set priority-6 queue-6
      set priority-7 queue-7
      set egress-pri-tagging enable
   next
end
```

Values that are not explicitly included in the map will follow the default mapping, which maps each priority (0-7) to queue 0. If an incoming packet contains no CoS value, the switch assigns a CoS value of zero.

Use the `set default-cos` command to set a different default CoS value, ranging from 0 to 7:

```
config switch interface
   edit port1
      set default-cos <0-7>
```

NOTE: The `set default-cos` command is not available on the following FortiSwitch models: 224D-FPOE, 248D, 424D, 424D-POE, 424D-FPOE, 448D, 448D-POE, 448D-FPOE, 224E, 224E-POE, 248E-POE, and 248E-FPOE.

Configure a DSCP map

A DSCP map defines a mapping between IP precedence or DSCP values and the egress queue values.

Using the GUI:

1. Go to *Switch* > *QoS* > *IP/DSCP*.
2. Select *Add Map*.
3. Enter the name of your DCSP map.
4. Enter a description of your DCSP map.
5. Select which queue to configure.
6. Select the differentiated services to use.
7. Select the IP precedence to use.
8. Enter the raw values to use.
9. Select *Add Map*.

Using the CLI:

```
config switch qos ip-dscp-map
   edit <ip-dscp map name>
      set description <text>
      config map
      edit <entry-name1>
         set diffserv [ [ AF11 | AF12 | AF13 | AF21 | AF22 | AF23 | AF31 | AF32 | AF33 | AF41
               | AF42 | AF43 | CS0 | CS1 | CS2 | CS3 | CS4 | CS5 | CS6 | CS7 | EF ]
         set ip-precedence [ Network Control | Internetwork Control | Critic/ECP | Flash
              Override | Flash, Immediate | Priority | Routine ]
         set value <dscp raw value>
         set cos-queue <queue number>
      next
   end
end
```

The following example defines a mapping for two of the DSCP values:

```
config switch qos ip-dscp-map
   edit "m1"
      config map
         edit "e1"
            set cos-queue 0
            set ip-precedence Immediate
         next
         edit "e2"
            set cos-queue 3
            set value 13
         next
      end
   next
end
```

Configure the QoS egress policy

In a QoS egress policy, you set the scheduling mode (Strict, Round Robin, or Weighted Round Robin) for the policy, and configure one or more CoS queues.

The QoS egress policy includes the following settings:

- min-rate (minimum rate in kbps) or min-rate-percent (minimum percentage)
- max-rate (maximum rate in kbps) or max-rate-percent (maximum percentage)
- drop policy: tail drop, RED, or WRED
- weight value (applicable if the policy schedule is weighted)

Using the GUI:

1. Go to *Switch* > *QoS* > *Egress Policy*.
2. Select *Add Policy*.
3. Enter the name of your QoS egress policy.
4. Select the scheduling mode to use.
5. For each queue, enter a description, select the drop policy to use, and enter the minimum rate in kbps, maximum rate in kbps, weight value, and WRED slope.
6. Select *Add*.

Using the CLI:

```
config switch qos qos-policy
   edit <policy_name>
      set rate-by {kbps | percent}
      set schedule {strict | round-robin | weighted}
      config cos-queue
         edit [queue-0 ... queue-7]
            set description <text>
            set drop-policy {taildrop | weighted-random-early-detection}
            set ecn {enable | disable}
            set max-rate <rate kbps>
            set min-rate <rate kbps>
            set max-rate-percent <percentage>
            set min-rate-percent <percentage>
            set weight <value>
            set wred-slope <value>
         next
      end
   next
end
```

Configure the egress drop mode

NOTE: The egress-drop-mode command is available only for the 1024/1048/3032/5xx series.

When there are too many packets going through the same egress port, you can choose whether packets are dropped on ingress or egress.

Use the following commands to set the drop mode:

```
config switch physical-port
   edit <port>
      set egress-drop-mode <disabled | enabled>
   end
```

Variable	Description
disabled	Drop packets on ingress.
enabled	Drop packets on egress.

NOTE: Because too many packets are going through the same egress port, you might want to use the pause frame for flow control on the ingress side. To see the pause frame on ingress, enable the flow control “tx” on the ingress interface and disable egress-drop-mode on the egress interface.

Configure the switch ports

You can configure the following QoS settings on a switch port or a trunk:

- trust dot1p values on ingress traffic and the dot1p map to use
- trust ip-dscp values on ingress traffic and the ip-dscp map to use. (**NOTE:** Trust the dot1p values **or** the ip-dscp values but not both.)
- an egress policy for the interface
- a default CoS value (for packets with no CoS value)

If neither of the trust policies is configured on a port, the ingress traffic is mapped to queue 0 on the egress port.

If no egress policy is configured on a port, the FortiSwitch unit applies the default scheduling mode (that is, round-robin).

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select the switch port to update and then select *Edit*.
3. Select the QoS egress policy in the *QoS Policy* drop-down list.
4. Select the 802.1p map in the *Trust 802.1p* drop-down list.
5. Select the DSCP map in the *Trust IP-DSCP* drop-down list.
6. Select *OK*.

Using the CLI:

```
config switch interface
   edit <port>
      set trust-dot1p-map <map-name>
      set trust-ip-dscp-map <map-name>
      set qos-policy < policy-name >
      set default-cos <default cos value 0-7>
   next
end
```

NOTE: The `set default-cos` command is not available on the following FortiSwitch models: 224D-FPOE, 248D, 424D, 424D-POE, 424D-FPOE, 448D, 448D-POE, 448D-FPOE, 224E, 224E-POE, 248E-POE, and 248E-FPOE.

Configure QoS on trunks

Configuring QoS on trunk interface follows the same configuration steps as for a switch port (configure a Dot1p/DSCP map and an egress policy).

When you add a port to a trunk, the port inherits the QoS configuration of the trunk interface. A port member reverts to the default QoS configuration when it is removed from the trunk interface.

Using the GUI:

1. Go to *Switch* > *Interface* > *Trunk*.
2. Select the trunk to update and then select *Edit*.
3. Select the QoS egress policy in the *QoS Policy* drop-down list.
4. Select the 802.1p map in the *Trust 802.1p* drop-down list.
5. Select the DSCP map in the *Trust IP-DSCP* drop-down list.
6. Select *OK*.

Using the CLI:

The following example shows QoS configuration on a trunk interface:

```
config switch interface
   edit "tr1"
      set snmp-index 56
      set trust-dot1p-map "dot1p_map1"
      set default-cos 1
      set qos-policy "p1"
   next
end
```

When you configure an egress QoS policy with rate control on a trunk interface, that rate control value is applied to each port in the trunk interface. The FortiSwitch unit does not support an aggregate value for the whole trunk interface.

NOTE: The `set default-cos` command is not available on the following FortiSwitch models: 224D-FPOE, 248D, 424D, 424D-POE, 424D-FPOE, 448D, 448D-POE, 448D-FPOE, 224E, 224E-POE, 248E-POE, and 248E-FPOE.

Configure QoS on VLANs

You can configure a CoS queue value for a VLAN by creating an ACL policy:

```
config switch acl ingress
   edit 1
      config action
         set cos-queue 7
         set count enable
      end
      config classifier
         set vlan-id 200
      end
      set ingress-interface "port25"
      set status active
end
```

Configure CoS and DSCP markings

You can classify a packet by matching the CoS value, DSCP value, or both CoS and DSCP values. You can also configure the action to set the CoS marking value, DSCP marking value, or both.

```
config switch acl ingress
   edit <policy-id>
      config classifier
         set cos <802.1Q CoS value to match>
         set dscp <DSCP value to match>
      end
      config action
         set remark-cos <0-7>
         set remark-dscp <0-63>
      end
```

For example:

```
config switch acl ingress
   edit 1
      config classifier
         set src-mac 11:22:33:44:55:66
         set cos 2
         set dscp 10
      end
      config action
         set count enable
         set remark-cos 4
         set remark-dscp 20
      end
   set ingress-interface port2
   set status active
end
```

Checking the QoS statistics

To check the statistics for the QoS queues for all ports:

```
diagnose switch physical-ports qos-stats list
```

To check the statistics for the QoS queues for specific ports:

```
diagnose switch physical-ports qos-stats list <list_of_ports>
```

NOTE: The output differs depending on the FortiSwitch model.

To view the real-time egress QoS queue rates for specific ports:

```
diagnose switch physical-ports qos-rates list <list_of_ports>
```

To view the real-time egress QoS queue rates for all ports:

```
diagnose switch physical-ports qos-rates list
```

NOTE: To stop the output: press `CTRL+C`.

Resetting and restoring QoS counters

To reset the QoS counters to zero (applies to all applications except SNMP) for the specified ports:

```
diagnose switch physical-ports qos-stats set-qos-counter-zero [<port_list>]
```

To restore the QoS counters to the hardware values for the specified ports:

```
diagnose switch physical-ports qos-stats set-qos-counter-revert [<port_list>]
```

For example:

```
diagnose switch physical-ports qos-stats set-qos-counter-zero 2,4,7-9
diagnose switch physical-ports qos-stats set-qos-counter-revert 1,3-5,7
```

sFlow

sFlow is a method of monitoring the traffic on your network to identify areas on the network that may impact performance and throughput. With sFlow you can export truncated packets and interface counters. The FortiSwitch unit implements sFlow version 5 and supports trunks and VLANs.

This chapter covers the following topics:

About sFlow

sFlow uses packet sampling to monitor network traffic. The sFlow agent captures packet information at defined intervals and sends them to an sFlow collector for analysis, providing real-time data analysis. To minimize the impact on network throughput, the information sent is only a sampling of the data.

The sFlow collector is a central server running software that analyzes and reports on network traffic. The sampled packets and counter information, referred to as flow samples and counter samples, respectively, are sent as sFlow datagrams to a collector. Upon receiving the datagrams, the sFlow collector provides real-time analysis and graphing to indicate the source of potential traffic issues. sFlow collector software is available from a number of third-party software vendors.

Configuring sFlow

Configuration consists of the following steps:

1. Enable the sFlow agent.
2. Configure sampling information on the interfaces.

Configure sFlow agents

To configure an sFlow agent:

1. Set the IP address of the collector.
2. Set the collector port number, which is the destination port number in sFlow UDP packets. The default value is 6343.

Using the GUI:

1. Go to *Switch* > *sFlow*.
2. Select *Enable.*

3. Set the collector IP address and port number.
4. Select *Apply* to save the changes.

Using the CLI:

```
config system sflow
   set collector-ip <ip/hostname>
   set collector-port <port>
end
```

Configure the interfaces

To configure sFlow on a port:

- Enable sFlow on the port (CLI only).
- Set the sample rate (CLI only). An average of one out of `count` packets is randomly sampled. The rate ranges from 0-99999; the default is 512.
- Set the direction for capturing the traffic (CLI only). sFlow can capture the ingress traffic (RX), the egress traffic (TX), or both (the default).
- Set the polling interval, which defines how often the switch sends interface counters to the collector. The range of values is 1-255 and default is 30.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical* or *Switch* > *Interface* > *Physical*.
2. Select one or more ports or a trunk to update and then select *Edit*.
3. In the sFlow area, select *Polling Interval*.
4. In the Interval (Seconds) field, enter the number of seconds to use for the polling interval.
5. Select *OK* to save the changes.

Using the CLI:

```
config switch interface
   edit <port>
      set packet-sampler {enabled | disabled}
      set packet-sample-rate <count>
      set sample-direction {rx | tx | both}
      set sflow-counter-interval <interval>
   next
end
```

For example:

```
config switch interface
   edit "port20"
      set packet-sampler enabled
      set packet-sample-rate 4
      set sflow-counter-interval 3
      set snmp-index 58
   next
end
```

NOTE: Ensure that you can use the exec command `ping collector_ip_address` to ping the collector from the FortiSwitch unit. Then, use the built-in sniffer to trace sFlow packets (`diag sniff packet <vlan_interface_name> "udp port 6343"`).

Checking the sFlow configuration

Use the following command to display the sFlow configuration:

```
get system sflow
```

Feature licensing

Advanced features (such as dynamic routing protocols) require a feature license.

This chapter covers the following topics:

About licenses

Each feature license is tied to the serial number of the FortiSwitch unit. Therefore, a feature license is valid on one system.

Configuring licenses

Configuration consists of the following steps:

1. Check license status.
2. Add a license.

Checking the license status

Using the GUI:

1. Go to *System* > *Dashboard*.
2. Check which licenses are currently active.
   They are listed in the Current License field of the System Information section.

Using the CLI:

```
execute license status
```

Adding a license

NOTE: Adding license keys causes the system to log you out.

Using the GUI:

1. Go to *System* > *Config* > *Licenses*.
2. Select Add License.

3. Enter your license key.
4. Select *Add*.

Using the CLI:

```
execute license add <key>
```

Removing a license

Using the GUI:

1. Go to *System* > *Config* > *Licenses*.
2. Select *Delete* for the license to remove
3. Select *Delete* to acknowledge the warning.

NOTE: Deleting license keys causes the system to log you out before rebooting. You will lose all configurations related to the license.

Using the CLI:

```
execute license type <type> clear
```

Layer-3 interfaces

Fortinet data center switches support loopback interfaces and switch virtual interfaces (SVIs), both of which are described in this chapter.

This chapter covers the following topics:

Loopback interfaces

A loopback interface is a special virtual interface created in software that is not associated with any hardware interface.

Dynamic routing protocols typically use a loopback interface as a reliable IP interface for routing updates. You can assign the loopback IP address to the router rather than the IP address of a specific hardware interface. Services (such as Telnet) can access the router using the loopback IP address, which remains available independent of hardware interfaces status.

No limit exists on the number of loopback interfaces you can create.

A loopback interface does not have an internal VLAN ID or a MAC addresses and always uses a /32 network mask.

Configuring loopback interfaces

Using the GUI:

1. Go to *System* > *Network* > *Interface* > *Loopback*.
2. Select *Add Interface*.
3. Enter a name for the loopback interface.
4. Select *Static* for the mode and then enter the IP address and netmask in the *IP/Netmask* field.
5. Select the protocols allowed to access the loopback interface.
6. Select the administration status.
7. Select *Add*.

Using the CLI:

```
config system interface
   edit "loopback"
```

```
      set ip 172.168.20.1 255.255.255.255
      set allowaccess ping https http ssh telnet
      set type loopback
      set snmp-index 28
   next
end
```

Switch virtual interfaces

A switch virtual interface (SVI) is a logical interface that is associated with a VLAN and supports routing and switching protocols.

You can assign an IP address to the SVI to enable routing between VLANs. For example, SVIs can route between two different VLANs connected to a switch (no need to connect through a layer-3 router).

Configuring a switch virtual interface

Using the GUI:

1. Go to *System* > *Network* > *Interface* > *VLAN*.
2. Select *Add VLAN*.
3. Enter a name for the interface.
4. Select *internal* from the *Interface* drop-down list.
5. Enter a VLAN identifier in the *VLAN ID* field.
6. Select *Static* for the mode and enter an IP address and netmask in the *IP/Netmask* field.
7. Select the administration status.
8. Select *PING*, *SSH*, and T*ELNET* for the *Access* options.
9. Select *Add*.

Using the CLI:

Create a system interface. Give it an IP subnet and an associated VLAN:

```
config system interface
   edit <system interface name>
      set ip <IP address and mask>
      set vlanid <vlan>
      set allowaccess ping ssh telnet
```

Example SVI configuration

The following is an example CLI configuration for SVI static routing.

In this configuration, Server-1 is connected to switch Port1, and Server-2 is connected to switch Port2. Port1 is a member of VLAN 4000, and Port2 is a member of VLAN 2. Port1 is the gateway for Server-1, and port2 is the gateway for Server-2.

NOTE: For simplicity, assume that both port1 and port are on same switch.

1. Configure the native VLANs for Port 1 and Port 2:

```
config switch interface
   edit port1
      set native-vlan 4000
   edit port2
      set native-vlan 2
   end
```

2. Create L3 system interfaces that correspond to Port 1 (VLAN 4000) and Port 2 (VLAN 2):

```
config system interface
   edit vlan4000
      set ip 192.168.11.1/24
      set vlanid 4000
      set allowaccess ping ssh telnet
   next
      edit vlan2
         set ip 192.168.10.1/24
         set vlanid 2
         set allowaccess ping ssh telnet
   end
```

Viewing the SVI configuration

Display the status of SVI configuration using following command:

```
show system interface [ <system interface name> ]
```

Layer-3 routing in hardware

In FortiSwitchOS 3.3.0 and later, some FortiSwitch models support hardware-based layer-3 forwarding.

For FortiSwitch models that support Equal Cost Multi-Path (ECMP) (see Feature matrix: FortiSwitchOS 6.4.6 on page 15), forwarding for all ECMP routes is performed in hardware.

For switch models that support hardware-based layer-3 forwarding but do not support ECMP, only one route to each destination will be hardware-forwarded. If you configure multiple routes to the same destination, you can configure a priority value for each route. Only the route with highest priority will be forwarded by the hardware. If no priority values are assigned to the routes, the most recently configured route is forwarded by the hardware.

Router activity

Logging allows you to review all router activity.

NOTE: Router logs are available only on supported platforms if you have the advanced features license.

To enable router logging:

1. Go to *Log* > *Config*.
2. Under *Event Logging*, select *Enable* and *Router*.
3. Select *Apply*.

To view router logs:

1. Go to *Log* > *Event Log* > *Router*.
2. Select *Download Router Log* to review the entries offline.

Equal cost multi-path (ECMP) routing

ECMP is a forwarding mechanism that enables load-sharing of traffic to multiple paths of equal cost. An ECMP set is formed when the routing table contains multiple next-hop address for the same destination with equal cost. Routes of equal cost have the same preference and metric value. If there is an ECMP set for an active route, the switch uses a hash algorithm to choose one of the next-hop addresses. As input to the hash, the switch uses one or more of the following fields in the packet to be routed:

- Source IP
- Destination IP
- Input port

Configuring ECMP

The switch automatically uses ECMP to choose between equal-cost routes.

This configuration value is system-wide. The source IP address is the default value.

Notes and Restrictions

When you configure a static route with a gateway, the gateway must be in the same IP subnet as the device. Also, the destination subnet cannot match any of device IP subnets in the switch.

When you configure a static route without a gateway, the destination subnet must be in the same IP subnet as the device.

Using the CLI:

```
config system settings
   set ip-ecmp-mode [ source-ip-based ] [ dst-ip-based ] [ port-based ]
end
```

Example ECMP configuration

The following is an example CLI configuration for ECMP forwarding.

In this configuration, ports 2 and 6 are routed ports. Interfaces I-RED and I-GREEN are routed VLAN interfaces. The remaining ports in the switch are normal layer-2 ports.

1. Configure native VLANs for ports 2, 6, and 9. Also configure the “internal” interface to allow native VLANs for ports 2, 6, and 9:

```
config switch interface
   edit port2
      set native-vlan 10
   edit port6
      set native-vlan 20
   edit port9
      set native-vlan 30
   edit internal
      set allowed-vlans 10,20,30
   end
```

2. Configure the system interfaces:

```
config system interface
   edit "internal"
      set type physical
   next
      edit "i-blue"
         set ip 1.1.1.1 255.255.255.0
         set allowaccess ping https http ssh snmp telnet
         set vlanid 10
         set interface internal
   next
      edit "i-red"
         set ip 172.16.11.1 255.255.255.0
         set allowaccess ping ssh telnet
         set vlanid 20
         set interface internal
   next
      edit "i-green"
         set ip 172.168.13.1 255.255.255.0
         set allowaccess ping https http ssh snmp telnet
         set vlanid 30
         set interface internal
   next
end
```

3. Configure static routes. This code configures multiple next-hop gateways for the same network:

```
config router static
   edit 1
      set device "mgmt"
      set gateway 10.105.0.1
      set status enable
   next
   edit 2
      set device "i-red"
      set dst 8.8.8.0/24
      set gateway 172.16.11.2
      set status enable
```

```
next
edit 3
   set device "i-green"
   set dst 8.8.8.0/24
   set gateway 172.168.13.2
   set status enable
next
```

Viewing ECMP configuration

Display the status of the ECMP configuration using following command:

```
show system interface [ <system interface name> ]
```

Bidirectional forwarding detection

FortiSwitchOS v3.4.2 and later supports static bidirectional forwarding detection (BFD), a point-to-point protocol to detect faults in the datapath between the endpoints of an IETF-defined tunnel (such as IP, IP-in-IP, GRE, and MPLS LSP/PW).

BFD defines demand mode and asynchronous mode operation. The FortiSwitch unit supports asynchronous mode. In this mode, the systems periodically send BFD control packets to one another, and if a number of those packets in a row are not received by the other system, the session is declared to be down.

BFD packets are transported using UDP/IP encapsulation and BFD control packets are identified using well-known UDP destination port 3784 (**NOTE:** BFD echo packets are identified using 3785).

BFD packets are not visible to the intermediate nodes and are generated and processed by the tunnel end systems only.

Configuring BFD

Use the following steps to configure BFD:

1. Configure the following values in the system interface:
   - *Enable BFD*: Set to *enable* or set to *global* to inherit the global configuration value.
   - *Desired min TX interval*: This is the minimum interval that the local system would like to use between transmission of BFD control packets. Value range is 200 ms – 30,000 ms. Default value is 250.
   - *Required min RX interval*: This is the minimum interval that the local system can support between receipt of BFD control packets. If you set this value to zero, the remote system will not transmit BFD control packets. The value range is 200 ms – 30000 ms. The default value is 250.
   - *Detect multi*: This is the detection time multiplier. The negotiated transmit interval multiplied by this value is the Detection Time for the receiving system. The value range is 1 – 20. The default is 3.
2. Enable BFD in the static router configuration.

Using the CLI:

```
config system interface
   edit <system interface name>
      set bfd {enable| disable | global}
      set bfd-desired-min-tx <number of ms>
```

```
      set bfd-required-min-rx <number of ms>
      set bfd-detect-multi [1…20]
next
config router static
   edit 1
      set bfd enable
      set status enable
```

Viewing BFD configuration

Using the GUI:

Go to *Router* > *Monitor* > *BFD Neighbor*.

Using the CLI:

To display the status of BFD sessions:

```
get router info bfd neighbor [ <IP address of neighbor>]
```

```
OurAddr          NeighAddr       LD/RD   State    Int
192.168.15.2     192.168.15.1    1/4     UP       vlan2000
192.168.16.2     192.168.16.1    2/2     UP       vlan2001
```

To filter the command output:

```
get router info bfd neighbor [<BFD_local_IPv4_address>] [<BFD_peer_interface>]
```

Unicast reverse-path forwarding (uRPF)

RPF, also called anti-spoofing, prevents an IP packet from being forwarded if its source IP address does not belong to a locally attached subnet (local interface) or is not part of the routing between the FortiSwitch unit and another source (such as a static route, RIP, OSPF, or BGP).

In unicast RPF, the router not only looks up the destination information but it also looks up the source information to ensure that it exists. If no source is found, that packet is dropped because the router assumes it is an error or an attack on the network.

There are two uRPF modes:

- Strict—The packet must be received on the same interface that the router uses to forward the return packet. In this mode, asymmetric routing paths in the network might cause legitimate traffic to be dropped.
- Loose—The routing table must include the source IP address of the packet. If you disable the `src-check-allow-default` option, the packet is dropped if the source IP address is not found in the routing table. If you enable the `src-check-allow-default` option, the packet is allowed even if the source IP address is not found in the routing table, but the default route is found in the routing table.

Configuring uRPF

By default, uRPF is disabled. You must enable it on each interface that you want protected.

```
config system interface
```

```
edit <interface_name>
   set src-check {disable | loose | strict}
   set src-check-allow-default {enable | disable} // This option is available only when
        src-check is set to loose.
end
```

IP-MAC binding

Use IP-MAC binding to prevent ARP spoofing.

The port accepts a packet only if the source IP address and source MAC address in the packet match an entry in the IP-MAC binding table.

You can enable/disable IP-MAC binding for the whole switch, and you can override this global setting for each port.

Configuring IP-MAC binding

Use the following steps to configure IP-MAC binding:

1. Enable the IP-MAC binding global setting.
2. Create the IP-MAC bindings. You can activate each binding individually.
3. Set each port to follow the global setting. You can also override the global setting for individual ports by enabling or disabling IP-MAC binding for the port.

Using the GUI:

Create the IP-MAC binding:

1. Go to *Switch* > *IP MAC Binding*.
2. Select *Add IP MAC Binding* to create a new binding.
3. Select *Status*.
4. Enter the IP address and netmask.
5. Enter the MAC address.
6. Select *Add*.

Using the CLI:

```
config switch global
   set ip-mac-binding [enable| disable]

config switch ip-mac-binding
   edit 1
      set ip <IP address and network mask>
      set mac <MAC address>
      set status (enable| disable)
   next
end
config switch interface
   edit <port>
      set ip-mac-binding (enable| disable | global)
   edit <trunk name>
```

```
set ip-mac-binding (enable| disable | global)
```

Notes

- For a switch port, the default IP-MAC binding value is disabled.
- When you configure a trunk, the trunk follows the global value by default. You can also explicitly enable or disable IP-MAC binding for a trunk, as shown in the CLI configuration.
- When you add member ports to the trunk, all ports take on the trunk setting. If you later remove a port from the trunk group, the port is reset to the default value (disabled).
- No duplicate entries are allowed in the mapping table.
- Rules are disabled by default. You need to explicitly enable each rule.
- The mapping table holds up to 1024 rules.

Viewing IP-MAC binding configuration

Display the status of IP-MAC binding using the following command:

```
show switch ip-mac-binding <entry number>
```

Virtual routing and forwarding

NOTE: This feature is supported only on the SVI.

You can use the virtual routing and forwarding (VRF) feature to create multiple routing tables within the same router.

Use the following steps to configure VRF:

1. Create a VRF instance.
2. Assign the VRF instance to a switch virtual interface (SVI).
3. Assign theVRF instance to an IPv4 or IPv6 static route.
4. Check the VRF configuration.

1. Create a VRF instance

You create a VRF instance by assigning a name and an identifier.

- The VRF name cannot match any SVI name.
- The VRF identifier is a number in the range of 1-1023, except for 252, 253, 254, and 255. You cannot assign the same VRF identifier to more than one VRF instance. After the VRF instance is created, the VRF identifier cannot be changed.

```
config router vrf
     edit <string>
        set vrfid <VRF_ID>
     end
```

For example:

```
config router vrf
   edit vrfv4
```

```
      set vrfid 1
   next
   edit vrfv6
      set vrfid 2
   next
end
```

2. Assign the VRF instance to a SVI

You assign the VRF instance to an SVI when you create the SVI. After the SVI is created, the VRF instance cannot be changed or unset.

You can assign the same VRF instance to more than one SVI. The VRF instance cannot be assigned to an internal SVI.

```
config system interface
   edit <interface_name>
      set vrf <string>
   end
```

For example:

```
config system interface
   edit v40
      set vlanid 40
      set vrf vrfv4
   next
   edit v50
      set vlanid 50
      set vrf vrfv4
   next
end
```

3. Assign the VRF instance to a static route

You assign the VRF instance to an IPv4 or IPv6 static route when you create the static route. After the static route is created, the VRF instance cannot be changed or unset.

You can assign the same VRF instance to more than one static route.

```
config router static
   edit <seq-num>
      set vrf <string>
   end

config router static6
   edit <seq-num>
      set vrf <string>
   end
```

For example:

```
config router static
   edit 1
      set device mgmt
      set gateway 192.168.0.10
      set status enable
      set vrf vrfv4
   end
```

```
config router static6
   edit 2
      set dst 5555::/64
      set gateway 4000::2
      set status enable
      set vrf vrfv6
   end
```

4. Check the VRF configuration

Use the following commands to check the VRF configuration:

- `get router info routing-table all`
- `get router info6 routing-table`

DHCP server and relay

A DHCP server provides an address, from a defined address range, to a client on the network that requests it.

You can configure one or more DHCP servers on any FortiSwitch interface. A DHCP server dynamically assigns IP addresses to hosts on the network connected to the interface. The host computers must be configured to obtain their IP addresses using DHCP.

You can configure a FortiSwitch interface as a DHCP relay. The interface forwards DHCP requests from DHCP clients to an external DHCP server and returns the responses to the DHCP clients. The DHCP server must have the appropriate routing so that its response packets to the DHCP clients arrive at the unit.

NOTE:

- DHCP snooping and the DHCP server can be enabled at the same time.
- The DHCP server and DHCP relay cannot be enabled at the same time.

This chapter covers the following topics:

Configuring a DHCP server

NOTE: The 4xx, 5xx, 1xxx, and 3xxx models support configuring DHCP servers. The following table lists the maximum number of clients for the supported FortiSwitch models:

FortiSwitch models	Maximum number of clients
4xx	15,000
5xx	20,000
1024D, 1048D, 3032D	30,000
1048E, 3032E	50,000

Using the GUI:

1. Go to *System* > *DHCP*.
2. Select *Add DHCP Server*.
3. Required. In the ID field, enter a number to identify the entry.
4. Select the Enable checkbox to make the DHCP server active.
5. Select the Auto-Configuration checkbox if you want the DHCP server to dynamically assign IP addresses to hosts on the network connected to the interface.
6. Required. In the Netmask field, enter the netmask of the addresses that the DHCP server assigns.

7. In the Interface drop-down list, select an interface. The DHCP server assigns IP configurations to clients connected to this interface.
8. Required. In the Lease Time field, enter the lease time in seconds. The lease time determines the length of time an IP address remains assigned to a client.
9. Required. In the Conflicted IP Timeout field, enter the number of seconds before a conflicted IP address is removed from the DHCP range and is available to be reused.
10. In the Default Gateway field, enter the IP address of the default gateway that the DHCP server assigns to DHCP clients.
11. In the Domain field, enter the domain name suffix for the IP addresses that the DHCP server assigns to the clients.
12. In the Next Server field, enter the IPv4 address of a server (for example, a TFTP sever) that DHCP clients can download a boot file from.
13. In the Filename field, enter the name of the boot file on the TFTP server.
14. In the DNS Service Type drop-down list, select how DNS servers are assigned to DHCP clients.
    - Select *Default* for clients to be assigned the FortiSwitch unit's configured DNS servers.
    - Select *Local* to use the IP address of the DHCP server interface for the client's DNS server IP address.
    - Select *Specify* to enter IPv4 addresses for up to three DNS servers.
15. In the Controller 1, Controller 2, and Controller 3 fields, enter the IPv4 addresses for the WiFi access controllers.
16. In the NTP Service Type drop-down list, select how Network Time Protocol (NTP) servers are assigned to DHCP clients.
    - Select *Default* for clients to be assigned the FortiSwitch unit's configured NTP servers.
    - Select *Local* to use the IP address of the DHCP server interface for the client's NTP server IP address.
    - Select *Specify* to enter the IPv4 address for up to three NTP servers.
17. In the WINS Server section, enter the IPv4 addresses for the Windows Internet Name Service (WINS) servers.
18. In the Timezone Mode drop-down list, select how the DHCP server sets the client's time zone.
    - Select *Default* for clients to be assigned the FortiSwitch unit's configured time zone.
    - Select *Disable* for the DHCP server to not set the client's time zone.
    - Select *Specify* to choose which time zone is assigned to DHCP clients.
19. In the VCI area, select the Enable checkbox to enter the vendor class identifier (VCI) to match. When enabled, only DHCP requests with a matching VCI are served.
20. In the IP Ranges section, you can configure the IP address range.
    a. In the ID field, enter a unique number to identify the entry or use the default value.
    b. Required. In the Start IP field, enter the start of the DHCP IP address range.
    c. Required. In the End IP field, enter the end of the DHCP IP address range.
    d. To add another IP address range, select *Add IP Range*.
21. In the Exclusion Ranges section, you can block a range of addresses that will not be included in the available addresses for the connecting users.
    a. Select *Add Exclusion Range*.
    b. In the ID field, enter a number to identify the entry or use the default value.
    c. In the Start IP field, enter the start of the IP address range that will not be assigned to clients.
    d. In the End IP field, enter the end of the IP address range that will not be assigned to clients.
    e. To add another exclusion range, select *Add Exclusion Range*.
22. In the Reserved Addresses section, you can reserve IP addresses for the DHCP server to use to assign IP addresses to specific MAC addresses.
    a. Select *Add IP*.
    b. In the ID field, enter a number to identify the entry or use the default value.
    c. In the Type drop-down list, select whether to match the IP address with the MAC address or DHCP option 82.

d. In the Action drop-down list, select how the DHCP server configures the client with the reserved MAC address. Select *Reserved* for the DHCP server to assign the reserved IP address to the client with this MAC address. Select *Assign* for the DHCP server to configure the client with this MAC address like any other client. Select *Block* to prevent the DHCP server from assigning IP settings to the client with this MAC address.
e. In the Description field, enter a description of this entry.
f. In the IP field, enter the IPv4 address to be reserved for the MAC address. This value is required when the action is *Reserved* and the type is *MAC*.
g. In the MAC field, enter the MAC address of the client that will get the reserved IP address. This value is required when the type is *MAC* and the action is *Assign* or *Block*.
h. In the Circuit Type drop-down list, select whether the format of the Circuit ID is hexadecimal or string. This option is only available when the type is *Option-82*.
i. In the Circuit ID field, enter the DHCP option-82 Circuit ID of the client that will get the reserved IP address. The Circuit ID format is controlled by the Circuit Type setting. This value is required when the type is *Option-82*.
j. In the Remote Type drop-down list, select whether the format of the Remote ID is hexadecimal or string. This option is only available when the type is *Option-82*.
k. In the Remote ID field, enter the DHCP option-82 Remote ID of the client that will get the reserved IP address. This value is required when the type is *Option-82*.
l. To add another reserved address, select *Add IP*.

23. In the Options section, you can add up to 30 DHCP custom options.
    a. Select *Add Option*.
    b. In the ID field, enter a number to identify the entry or use the default value.
    c. In the Type drop-down list, select the format of the DHCP option: fully qualified domain name (FQDN), hexadecimal, IP address, or string.
    d. In the Code field, select the DHCP option code. The range is 0-255.
    e. In the Value field, enter the DHCP option value. This value is required when the type is set to *FQDN*, *Hex*, or *String*.
    f. In the IP field, enter the IP address. This value is required when the type is set to *IP*.
    g. To add another DHCP custom option, select *Add Option*.
24. Select *Add* to save the new DHCP server.

Using the CLI:

```
config system dhcp server
   edit <id>
      set auto-configuration {enable | disable}
      set conflicted-ip-timeout <integer>
      set default-gateway <xxx.xxx.xxx.xxx>
      set dns-server1 <xxx.xxx.xxx.xxx>
      set dns-server2 <xxx.xxx.xxx.xxx>
      set dns-server3 <xxx.xxx.xxx.xxx>
      set dns-service {default | local | specify
      set domain <string>
      set filename <string>
      set interface <string>
      set lease-time <integer>
      set netmask <xxx.xxx.xxx.xxx>
      set next-server <xxx.xxx.xxx.xxx>
      set ntp-server1 <xxx.xxx.xxx.xxx>
      set ntp-server2 <xxx.xxx.xxx.xxx>
      set ntp-server3 <xxx.xxx.xxx.xxx>
      set ntp-service {default | local | specify}
      set status {enable | disable}
```

```
      set tftp-server <xxx.xxx.xxx.xxx>
      set timezone <00-75>
      set timezone-option {default | disable | specify}
      set vci-match {enable | disable}
      set vci-string <VCI_strings>
      set wifi-ac1 <xxx.xxx.xxx.xxx>
      set wifi-ac2 <xxx.xxx.xxx.xxx>
      set wifi-ac3 <xxx.xxx.xxx.xxx>
      set wins-server1 <xxx.xxx.xxx.xxx>
      set wins-server2 <xxx.xxx.xxx.xxx>
   next
end
```

For example:

```
config system dhcp server
   edit 1
      set default-gateway 50.50.50.2
      set domain "FortiswitchTest.com"
      set filename "text1.conf"
      set interface "svi10"
      config ip-range
         edit 1
            set end-ip 50.50.0.10
            set start-ip 50.50.0.5
         next
      end
      set lease-time 360
      set netmask 255.255.0.0
      set next-server 60.60.60.2
      config options
         edit 1
            set value "dddd"
         next
      end
      set tftp-server "1.2.3.4"
      set timezone-option specify
      set wifi-ac1 5.5.5.1
      set wifi-ac2 5.5.5.2
      set wifi-ac3 5.5.5.3
      set wins-server1 6.6.6.1
      set wins-server2 6.6.6.2
      set dns-server1 7.7.7.1
      set dns-server2 7.7.7.2
      set dns-server3 7.7.7.3
      set ntp-server1 8.8.8.1
      set ntp-server2 8.8.8.2
      set ntp-server3 8.8.8.3
   next
end
```

Configuring the IP address range

By default, the FortiSwitch unit assigns an address range based on the address of the interface for the complete scope of the address. For example, if the interface address is 172.20.120.230, the default range created is 172.20.120.231 to

172.20.120.254.

To configure the IP address range:

```
config system dhcp server
   edit <id>
      config ip-range
         edit <id>
            set end-ip <xxx.xxx.xxx.xxx>
            set start-ip <xxx.xxx.xxx.xxx>
         next
      end
   next
end
```

Excluding addresses in DHCP

If you have a large address range for the DHCP server, you can block a range of addresses that will not be included in the available addresses for the connecting users.

To exclude addresses in DHCP:

```
config system dhcp server
   edit <id>
      config exclude-range
         edit <id>
            set end-ip <xxx.xxx.xxx.xxx>
            set start-ip <xxx.xxx.xxx.xxx>
         next
      end
   next
end
```

Assigning IP settings to specific MAC addresses

If you want the DHCP server to assign IP addresses to specific MAC addresses, you need to reserve the IP addresses.

To reserve IP addresses:

```
config system dhcp server
   edit <id>
      config reserved-address
         edit <id>1
            set action {assign | block | reserved}
            set circuit-id {<string> | <hex>}
            set circuit-id-type {hex | string}
            set description <string>
            set ip <xxx.xxx.xxx.xxx>
            set mac <xx:xx:xx:xx:xx:xx>
            set remote-id {<string> | <hex>}
            set remote-id-type {hex | string}
            set type {mac | option82}
         next
```

```
      end
   next
end
```

Configuring DHCP custom options

The DHCP server maintains a table for the potential options. The FortiSwitch DHCP server supports up to a maximum of 30 custom options.

To configure the DHCP custom options:

```
config system dhcp server
   edit <id>
      config options
         edit <id>
            set code <integer>
            set ip <IP_addresses>
            set type {fqdn | hex | ip | string}
            set value <string>
         next
      end
   next
end
```

Listing DHCP leases

The lease time determines the length of time an IP address remains assigned to a client. After the lease expires, the address is released for allocation to the next client that requests an IP address. Use one of the following commands to check the DHCP leases:

```
execute dhcp lease-list
execute dhcp lease-list <interface>
```

Breaking DHCP leases

If you need to end an IP address lease, you can break the lease. This is useful if you have limited addresses and longer lease times when some leases are no longer necessary, for example, with corporate visitors. Use one of the following commands to break the DHCP leases:

```
execute dhcp lease-clear all
execute dhcp lease-clear <xxx.xxx.xxx.xxx,yyy.yyy.yyy.yyy,...>
```

Detailed operation of a DHCP relay

A DHCP relay operates as follows:

1. DHCP client C broadcasts a DHCP/BOOTP discover message on its subnet.
2. The relay agent examines the gateway IP address field in the DHCP/BOOTP message header. If the field has an IP address of 0.0.0.0, the agent fills it with the relay agent's or router's IP address and forwards the message to the remote subnet of the DHCP server.
3. When DHCP server receives the message, it examines the gateway IP address field for a DHCP scope that can be used by the DHCP server to supply an IP address lease.
4. If DHCP server has multiple DHCP scopes, the address in the gateway IP address field (GIADDR) identifies the DHCP scope from which to offer an IP address lease.
5. DHCP server sends an IP address lease offer (DHCPOFFER) directly to the relay agent identified in the gateway IP address (GIADDR) field.
6. The router then relays the address lease offer (DHCPOFFER) to the DHCP client.

NOTE:

- DHCP relay service supports up to 8 relay targets per interface.
- Each target is sent a copy of the DHCP message.

Configuring a DHCP relay

You can configure a DHCP relay on any layer-3 interface.

Using the GUI:

1. Go to *System* > *Network* > *Interface* > *Physical*.
2. Select *Edit* for an interface.
3. Select *Enabled* under *DHCP Relay*.
4. Enter the IP addresses for the relay servers, separated by a space.
5. If you want to include Option-82 data, select *Option-82*.
6. Select *Update*.

Using the CLI:

```
config system interface
   edit <interface-name>
      set dhcp-relay-service (enable | disable)
      set dhcp-relay-ip <ip-address1> [<ip-address2> ... <ip-address8>]
      set dhcp-relay-option82 (enable | disable)
   next
end
```

In the following example, the DHCP server has address 192.168.23.2:

```
config system interface
   edit "v15-p15"
      set dhcp-relay-service enable
```

```
      set dhcp-relay-ip "192.168.23.2" -> the DHCP server address
      set ip 192.168.15.1 255.255.255.0 -> the DHCP client subnet
      set allowaccess ping ssh snmp telnet set snmp-index 53
      set vlanid 15
      set interface "internal"
   next
end
```

OSPF routing

NOTE: You must have an advanced features license to use OSPF routing.

Open shortest path first (OSPF) is a link-state interior routing protocol that is widely used in large enterprise organizations. OSPF provides routing within a single autonomous system (AS). This differs from BGP, which provides routing between autonomous systems.

An OSPF AS can contain only one area, or it can consist of a group of areas connected to a backbone area. A router connected to more than one area is an area border router (ABR). An autonomous system boundary router (ASBR) is located between an OSPF autonomous system and a non-OSPF network. Routing information is contained in a link-state database. Routing information is communicated between routers using link-state advertisements (LSAs).

The main benefit of OSPF is that it detects link failures in the network quickly and converges network traffic successfully within seconds without any network loops. Also, OSPF has features to control which routes are propagated to contain the size of the routing tables.

You can enable bidirectional forwarding detection (BFD) with OSPF. BFD is used to quickly locate hardware failures in the network. Routers running BFD communicate with each other, and, if a timer runs out on a connection, that router is declared to be down. BFD then communicates this information to OSPF, and the routing information is updated.

NOTE: OSPF MIBs are not supported in this release.

For additional information about OSPF routing, see the OSPF section of the FortiOS Administration Guide.

This chapter covers the following topics:

How OSPF works

Areas

An OSPF implementation consists of one or more areas. An area consists of a group of contiguous networks. If you configure more than one area, Area Zero is always the backbone area. An ABR links one or more areas to the OSPF backbone area.

The FortiSwitch unit supports different types of areas—stub areas, Not So Stubby areas (NSSA), and regular areas. A stub area is an interface without a default route configured. NSSA is a type of stub area that can import AS external routes and send them to the backbone but cannot receive AS external routes from the backbone or other areas. All other areas are considered regular areas.

Adjacencies

When an OSPF router boots up, it sends OSPF Hello packets to find neighbors on the same network. Neighbors exchange information, and the link-state databases of both neighbors are synchronized. At this point, these neighbors are said to be adjacent.

For two OSPF routers to become neighbors, the following conditions must be met:

- The subnet number and subnet mask for the interface must match in both routers.
- The Hello interval and Dead interval values must match.
- The routers must have the same OSPF area ID.
- If authentication is used, they must pass authentication checks.

In OSPF, routing protocol packets are only passed between adjacent routers.

Route summarization

Using route summarization reduces the number of LSAs being sent between routers. OSPF offers two types of route summarization:

- Between areas through an ABR. This method summarizes routes in the area configuration.

```
config area
   edit <area_IPv4_address>
      config range
         edit <id>
            set prefix <xxx.xxx.xxx.xxx> <xxx.xxx.xxx.xxx>
         next
      end
   next
end
```

- Between an OSPF AS and a non-OSPF network through an ASBR. This method summarizes external routes when you redistribute them.

```
config summary-address
   edit <id>
      set prefix <xxx.xxx.xxx.xxx> <xxx.xxx.xxx.xxx>
   next
end
```

Graceful restart helper mode

Starting in FortiSwitchOS 6.4.3, the FortiSwitch unit enters the helper (neighbor) mode when a neighboring router sends a grace LSA before it restarts. The FortiSwitch unit keeps the restarting router in the forwarding path for OSPF routing, as long as there are no network topology changes. After the restarting router completes its graceful restart, the FortiSwitch unit exits the helper mode.

This feature is always enabled.

Database overflow protection

When the OSPF link-state database is large, some routers do not have enough resources to store the complete link-state database. To prevent database overflow, you can limit the number of AS-external-LSAs in the link-state database. When the maximum number of AS-external-LSAs is reached, the router deletes all AS-external-LSAs that it originated and stops originating AS-external-LSAs for the specified number of seconds.

By default, this feature is disabled.

Use the following commands to configure database overflow protection:

```
config router ospf
```

```
    set database-overflow enable
    set database-overflow-max-external-lsa <0-2147483647>
    set database-overflow-time-to-recover <0-65535>
end
```

Configuring OSPF

Using the GUI:

1. Create a switch virtual interface. See Configuring a switch virtual interface on page 214.
2. Go to *Router* > *Config* > *OSPF* > *Settings*.
   a. Enter a unique 32-bit number in dotted decimal format for the router identifier. **NOTE:** Without a router identifier, OSPF routing will not work.
   b. If you are going to advertise default routes within OSPF, configure the default route option and enter the routing metric (cost) for other routing protocols.
   c. If you want to redistribute non-OSPF routes, select *Enabled* under Connected, Static, RIP, BGP, or ISIS and then enter the routing metric in the Metric field.
   d. Select *Update*.
3. Got to *Router* > *Config* > *OSPF* > *Areas* and select *Add OSPF Area*.
   a. Enter the area IP address.
   b. Select if the area is a stub area, NSSA, or a regular area.
   c. Select *Add*.
4. Go to *Router* > *Config* > *OSPF* > *Networks* and select *Add Network*.
   a. Enter the network identifier.
   b. Enter the IP address and netmask, separated with a space. Use an IP address that includes the switch virtual interface.
   c. Select the area that you created.
   d. Select *Add*.
5. Go to *Router* > *Config* > *OSPF* > *Interfaces* and select *Configure OSPF Interface*.
   a. Select the same type of authentication that you selected for the area.
   b. If you want static bidirectional forwarding detection, select *Enable* or *Global*.
   c. Enter the maximum transmission unit.
   d. Enter the cost.
   e. Enter the number of seconds between Hello packets being sent.
   f. Enter the number of seconds that a Hello packet is not received before the OSPF router decides that a neighbor has failed.
   g. Select *Add*.

Using the CLI:

Configuring OSPF using IPv4 on the FortiSwitch unit includes the following major steps:

1. Enter the OSPF configuration mode.
2. Set the router identifier. Each router must have a unique 32-bit number. **NOTE:** Without a router identifier, OSPF routing will not work.
3. Create an area. You must create at least one area.

4. Configure the network. Attach one or more networks to each area.
5. Configure an interface to a peer OSPF router.
6. Redistribute non-OSPF routes with route summarization. Advertise these non-OSPF routes within OSPF.

NOTE: You can also configure OSPF using IPv6 with the `config router ospf6` command.

1. Enter the OSPF configuration mode

Enter the OSPF configuration mode to access all of the OSPF configuration commands:

```
# config router ospf
```

2. Set the router identifier

Each router within an area must have a unique 32-bit number. The router identifier is written in dotted decimal format, but it is not an IPv4 address. **NOTE:** Without a router identifier, OSPF routing will not work.

```
set router-id <router-id>
```

For example:

```
# config router ospf
(ospf) # set router-id 1.1.1.2
```

3. Create an area

You must create at least one area. The area number is written in dotted decimal format (for example, configure area 100 as 0.0.0.100).

```
config area
   edit <area number>
      set shortcut (default | disable | enable)
      set type {nssa | regular | stub}
end
```

For example:

```
   (ospf) # config area
   (area) # edit 0.0.0.4
   (0.0.0.4) # set type nssa
```

4. Configure the network

Use this subcommand to identify the OSPF-enabled interfaces. The prefix length in the interface must be equal or larger than the prefix length in the network statement.

```
   config network
      edit <network number>
         set area <area>
         set prefix <network prefix> <mask>
```

For example:

```
   (ospf) # config network
   (network) # edit 1
   (1) # set area 0.0.0.4
```

```
(1) # set prefix 10.1.1.0 255.255.255.0
```

5. Configure the OSPF interface

Configure interface-related OSPF settings. Enter a descriptive name for the OSPF interface name.

```
config interface
   edit <OSPF_interface_name>
      set priority <1-255>
```

For example:

```
(ospf) # config interface
(ospf-interface) # edit oi1
(oi1) # set priority 255
```

NOTE: The following values must match for an adjacency to form:

- area type and number
- interface subnet and mask
- hello interval
- dead interval

6. Redistribute non-OSPF routes

Redistribute non-OSPF routes (directly connected or static routes) within OSPF:

```
config redistribute {bgp | connected | isis | rip | static}
   set status enable
   set metric <integer>
   set metric-type {1 | 2}
end
```

Add route summarization:

```
config summary-address
   edit <id>
      set prefix <xxx.xxx.xxx.xxx> <xxx.xxx.xxx.xxx>
   next
end
```

For example:

```
(ospf) # config redistribute connected
(connected) # set status enable
(connected) # end

(ospf) # config summary-address
(summary-address) # edit 1
new entry '1' added
(1) # set prefix 10.1.0.0 255.255.0.0
(1) # next
(summary-address) # end
```

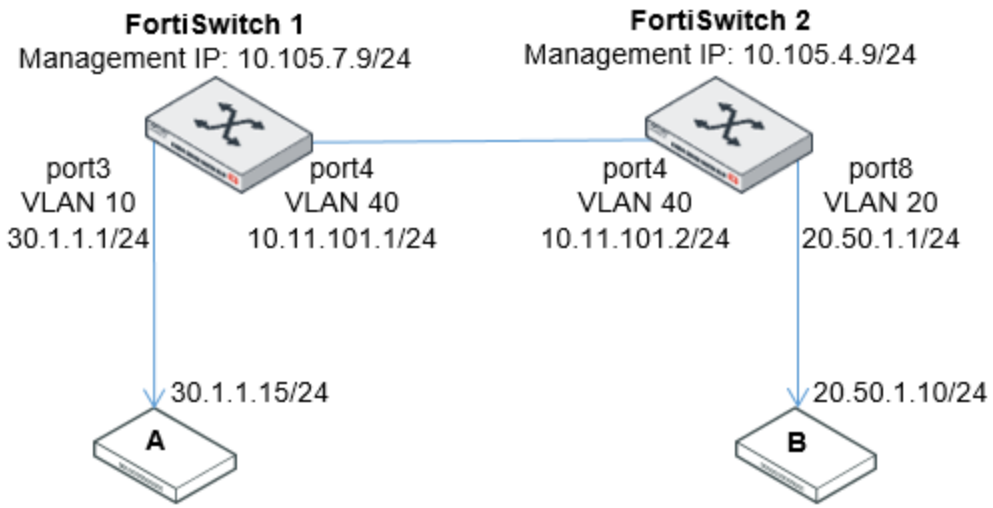
Check the OSPF configuration

The `get router info ospf` command has options to display different aspects of the OSPF configuration and status. For example:

```
get router info ospf neighbor {<neighbor_ID> | all | detail | detail all | <interface_IP_
     address>}
get router info ospf database {brief | self-originate | router | network | summary | asbr-
     summary| external | nssa-external | opaque-link | opaque-area | opaque-as | max-age}
```

Example configuration

The following example shows a very simple OSPF network with one area. FortiSwitch 1 has one OSPF interface to FortiSwitch 2:



Configure system interfaces

These are the same configuration steps as for static routing.

Switch 1

```
config system interface
   edit vlan10-p3
      set ip 30.1.1.1 255.255.255.0
      set allowaccess ping https http ssh telnet
      set vlanid 10
   next
   edit vlan40-p4
      set ip 10.11.101.1 255.255.255.0
      set allowaccess ping https http ssh telnet
      set vlanid 40
end
config switch interface
   edit "port3"
      set native-vlan 10
```

```
   next
   edit "port4"
      set native-vlan 40
   next
end
```

Switch 2

```
config system interface
   edit vlan20-p8
      set ip 20.50.1.1 255.255.255.0
      set allowaccess ping https http ssh telnet
      set vlanid 20
   next
   edit vlan40-p4
      set ip 10.11.101.2 255.255.255.0
      set allowaccess ping https http ssh telnet
      set vlanid 40
end
config switch interface
   edit "port8"
      set native-vlan 20
   next
   edit "port4"
      set native-vlan 40
   next
end
```

Configure the OSPF router

Configure OSPF with the following:

1. Set the router ID.
2. Create the area.
3. Create the network (set network prefix and associate with an area).
4. Configure the OSPF interface.

Switch 1

```
config router ospf

   set router-id 10.11.101.1

   config area
      edit 0.0.0.0
      next
   end

   config network
      edit 1
         set area 0.0.0.0
         set prefix 10.11.101.0 255.255.255.0
      next
   end
```

```
   config interface
      edit vlan40
         set cost 100
         set priority 100
      next
   end

   config redistribute connected
      set status enable
   end

end
```

Switch 2

```
config router ospf
   set router-id 10.11.101.2

   config area
      edit 0.0.0.0
      next
   end

   config network
      edit 1
         set area 0.0.0.0
         set prefix 10.11.101.0 255.255.255.0
      next
   end

   config interface
      edit vlan40
         set cost 100
         set priority 100
      next
   end

   config redistribute connected
      set status enable
   end

end
```

Verify OSPF neighbors

```
get router info ospf neighbor all
```

Verify OSPF routes

```
get router info ospf route
```

RIP routing

NOTE: You must have an advanced features license to use RIP routing.

The Routing Information Protocol (RIP) is a distance-vector routing protocol that works best in small networks that have no more than 15 hops. Each router maintains a routing table by sending out its routing updates and by asking neighbors for their routes. RIP is relatively simple to configure on FortiSwitch units but slow to respond to network outages. RIP routing is better than static routing but less scalable than open shortest path first (OSPF) routing.

The FortiSwitch unit supports RIP version 1 and RIP version 2:

- RIP version 1 uses classful addressing and broadcasting to send out updates to router neighbors. It does not support different sized subnets or classless inter-domain routing (CIDR) addressing.
- RIP version 2 supports classless routing and subnets of various sizes. Router authentication supports MD5 and authentication keys. Version 2 uses multicasting to reduce network traffic.

RIP uses three timers:

- The update timer determines the interval between routing updates. The default setting is 30 seconds.
- The timeout timer is the maximum time that a route is considered reachable while no updates are received for the route. The default setting is 180 seconds. The timeout timer setting should be at least three times longer than the update timer setting.
- The garbage timer is the is the how long that the FortiSwitch unit advertises a route as being unreachable before deleting the route from the routing table. The default setting is 120 seconds.

You can enable bidirectional forwarding detection (BFD) with RIP. BFD is used to quickly locate hardware failures in the network. Routers running BFD communicate with each other, and, if a timer runs out on a connection, that router is declared to be down. BFD then communicates this information to RIP, and the routing information is updated.

When you configure RIP routing, you can choose the strategy the access list uses to permit or deny IP addresses:

- *Prefix*—Specify the IP address and bit mask to allow or block.
- *Wildcard*—Specify the Cisco-style filter to allow or block.

For additional information about RIP routing, see the RIP section of the FortiOS Administration Guide.

This chapter covers the following topics:

Terminology

Access list: A list of IP addresses and the action to take for each one. Access lists provide basic route and network filtering.

Active RIP interface: Each RIP router sends and receives updates by actively communicating with its neighbors.

Keychain: A list of one or more authentication keys including its lifetime, which is how long each key is valid.

Metric: RIP uses hop count as the metric for choosing the best route. A hop count of 1 represents a network that is connected directly to the FortiSwitch unit. A hop count of 16 represents a network that cannot be reached.

Passive RIP interface: The RIP router listens to updates from other routers but does not send out updates. A passive RIP interface reduces network traffic.

Prefix list: A more powerful prefix-based filtering mechanism. A prefix is an IP address and netmask.

Split horizon: A way to avoid routing loops.

Configuring RIP routing

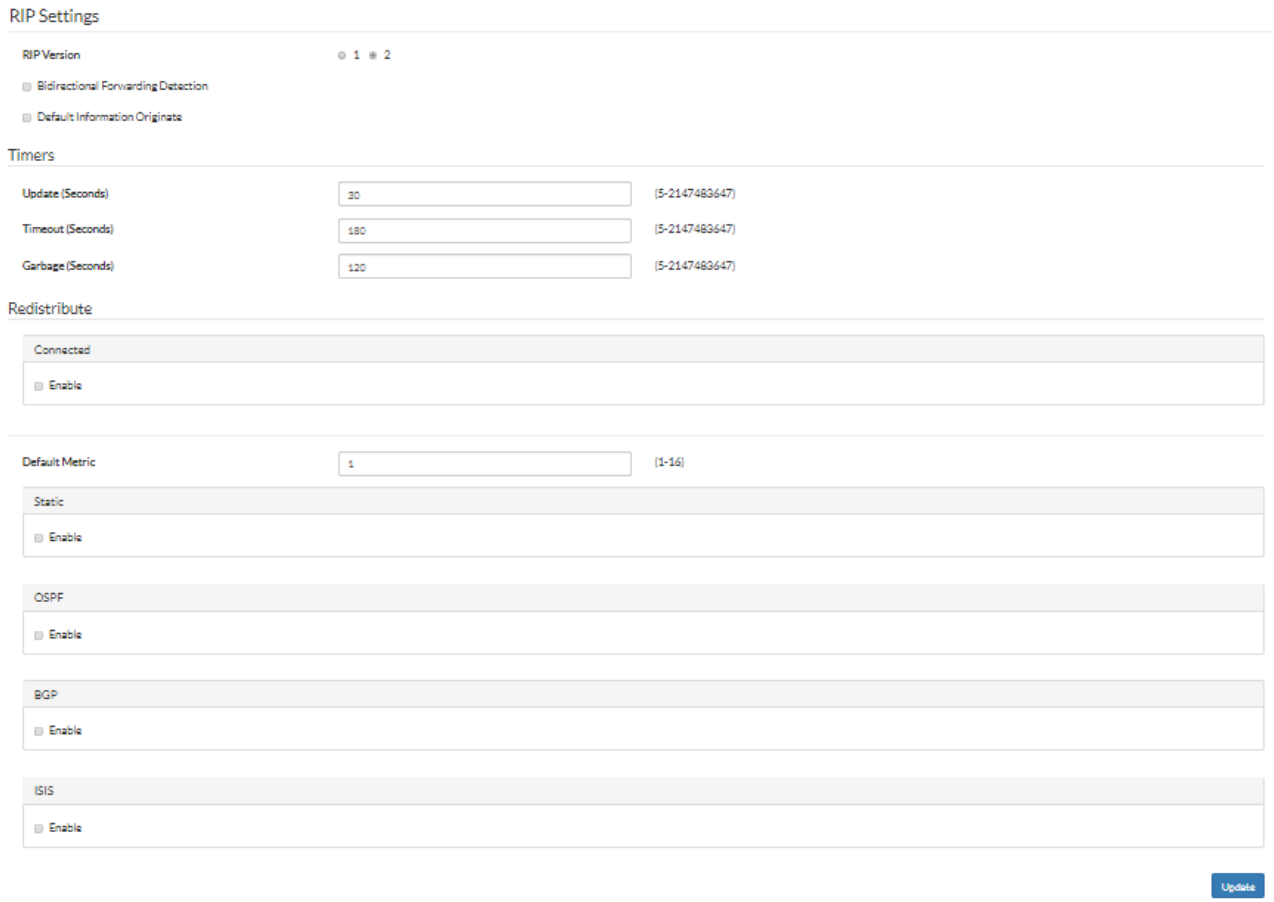
NOTE: You must create a keychain first before you can use the MD5 authentication mode with RIP version 2.

To add a new keychain using the CLI:

```
config router key-chain
   edit <keychain identifier>
   next
end
```

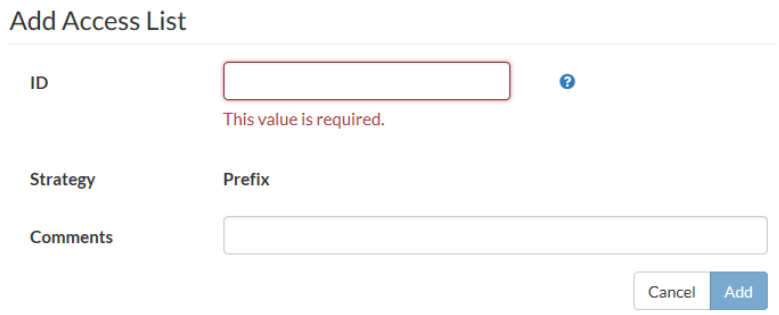
Using the GUI and the prefix strategy:

1. Create a switch virtual interface (SVI). See Configuring a switch virtual interface on page 214.
2. Go to *Router* > *Config* > *RIP* > *Settings*.

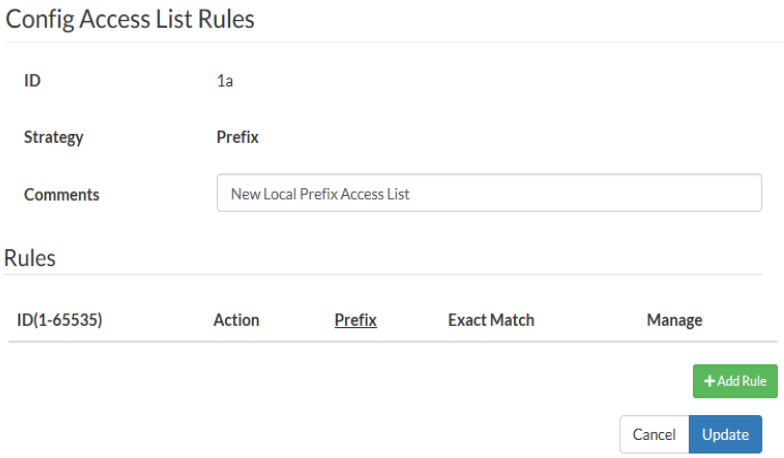


   a. Select whether you want to use RIP version 1 or RIP version 2. RIP version 2 is the default.
   b. If you want to use BFD, select *Bidirectional Forwarding Detection*.
   c. If you want to use a default route, select *Default Information Originate*.
   d. If you want to change the default timer values, enter the number of seconds in the *Update*, *Timeout*, and *Garbage* fields.
   e. If you want to redistribute non-RIP routes, select *Enable* under Connected, Static, OSPF, BGP, or ISIS.
      - If you select *Enable* under Connected, enter the routing metric to use.
      - If you select *Enable* under Static, OSPF, BGP, or ISIS, select *Override Metric* if you do not want to use the default routing metric and then enter the routing metric to use.
   f. Enter the default routing metric to use for static routing, OSPF, BGP, and ISIS.

3. Go to *Router* > *Config* > *Access Lists* and select *Add Access List*.

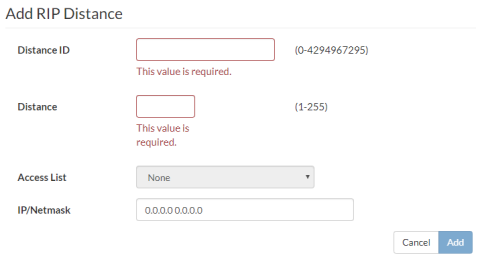


   a. Enter an identifier with one or more alphabetic characters.
   b. Enter an optional description of the access list.
   c. Select *Add*.
   d. Select *Config Rules* in the row for the access list that you just created.



   e. Select *Add Rule*.
   f. Enter an identifier (1-65535), select *Deny* or *Permit* to specify if the rule will block or allow the specified IP addresses, and enter the prefix.
   g. If you entered the complete IP address, select the *Exact Match* checkbox.
   h. Select *Add Rule* if you want to add more rules.
   i. After you have added all of the rules that you want in the access list, select *Update* to save the rules you added.

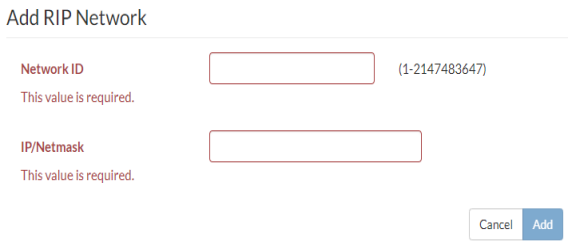
4. Go to *Router* > *Config* > *RIP* > *Distances* and select *Add RIP Distance*.



   a. Enter the distance identifier in the Distance ID field.
   b. Enter the distance.
   c. Select the access list that you added in the previous step.

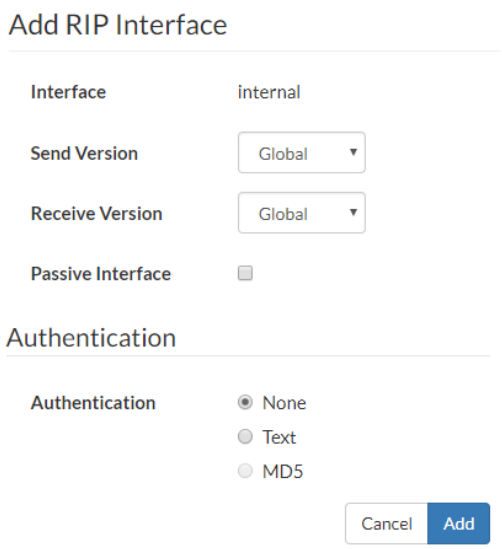
d. Enter the IP address and netmask, separated with a space or with a slash. For example, enter `1.2.3.4/5` or `1.2.3.4 248.0.0.0`.
e. Select *Add*.

5. Go to *Router* > *Config* > *RIP* > *Networks* and select *Add Network*.



a. Enter a unique value to identify this network configuration.
b. Enter an IP address and netmask for your RIP network, separated with a slash, and select *Add*. For example, enter 172.168.200.0/255.255.255.0. **NOTE:** Select an IP address for a network that includes all SVIs that you want to use. You can configure multiple network ranges to cover all SVIs that will be using RIP routing.

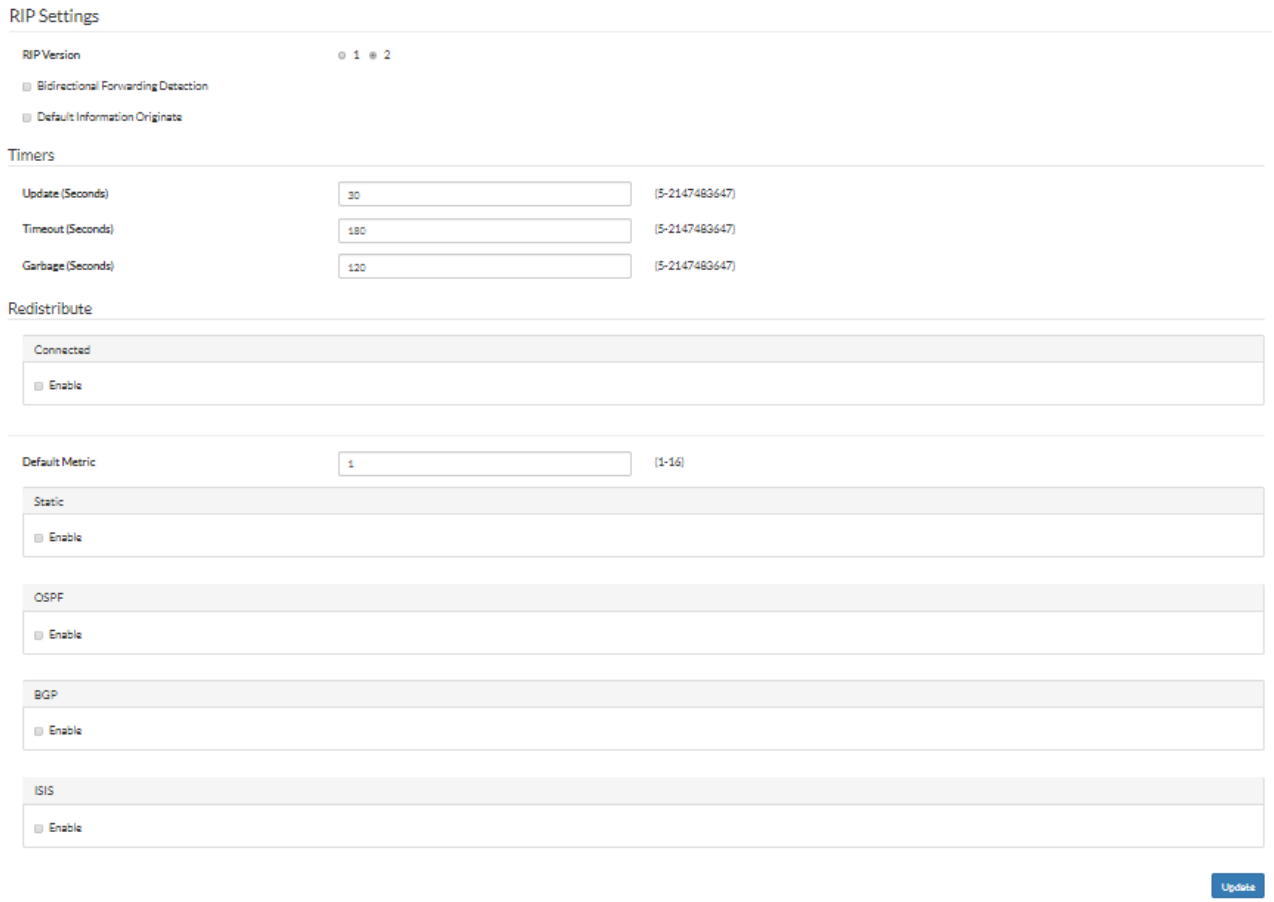
6. Go to *Router* > *Config* > *RIP* > *Interfaces* and select *Configure RIP* for the appropriate interface.



a. If you want to change the RIP version used to send and receive routing updates, select from the *Send Version* and *Receive Version* drop-down menus.
b. If you do not want to send RIP updates from this interface, select *Passive Interface*.
c. If you want to use authentication, select *Text* or *MD5*.
d. Select *Add*.

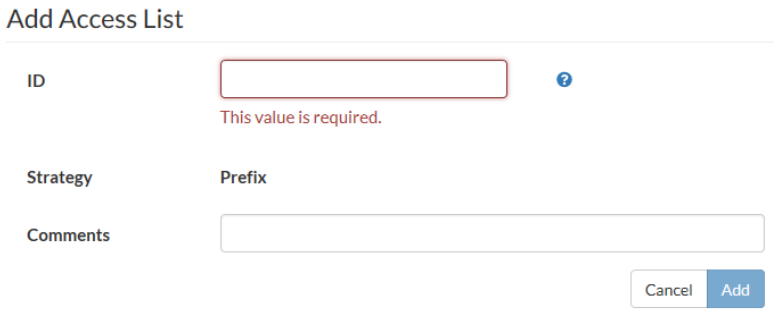
Using the GUI and the wildcard strategy:

1. Create a switch virtual interface (SVI). See Configuring a switch virtual interface on page 214.
2. Go to *Router* > *Config* > *RIP* > *Settings*.



   a. Select whether you want to use RIP version 1 or RIP version 2. RIP version 2 is the default.
   b. If you want to use BFD, select *Bidirectional Forwarding Detection*.
   c. If you want to use a default route, select *Default Information Originate*.
   d. If you want to change the default timer values, enter the number of seconds in the *Update*, *Timeout*, and *Garbage* fields.
   e. If you want to redistribute non-RIP routes, select *Enable* under Connected, Static, OSPF, BGP, or ISIS.
      - If you select *Enable* under Connected, enter the routing metric to use.
      - If you select *Enable* under Static, OSPF, BGP, or ISIS, select *Override Metric* if you do not want to use the default routing metric and then enter the routing metric to use.
   f. Enter the default routing metric to use for static routing, OSPF, BGP, and ISIS.

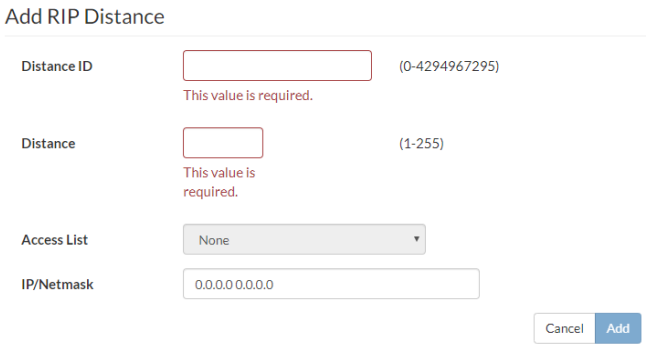
3. Go to *Router* > *Config* > *Access Lists* and select *Add Access List*.



   a. Enter an identifier with all digits (in the range of 1-99).
   b. Enter an optional description of the access list.
   c. Select *Add*.
   d. Select *Config Rules* in the row for the access list that you just created.

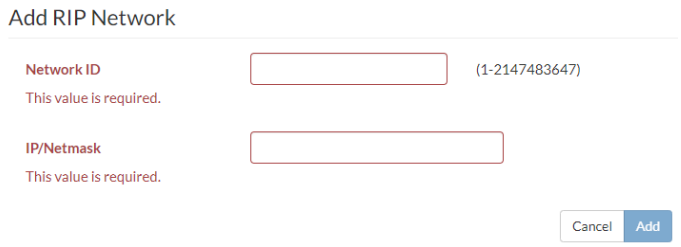
   e. Select *Add Rule*.
   f. Enter an identifier (1-65535), select *Deny* or *Permit* to specify if the rule will block or allow the specified IP addresses, and enter the Cisco-style wildcard filter.
   g. Select *Add Rule* if you want to add more rules.
   h. After you have added all of the rules that you want in the access list, select *Update* to save the rules you added.

4. Go to *Router* > *Config* > *RIP* > *Distances* and select *Add RIP Distance*.



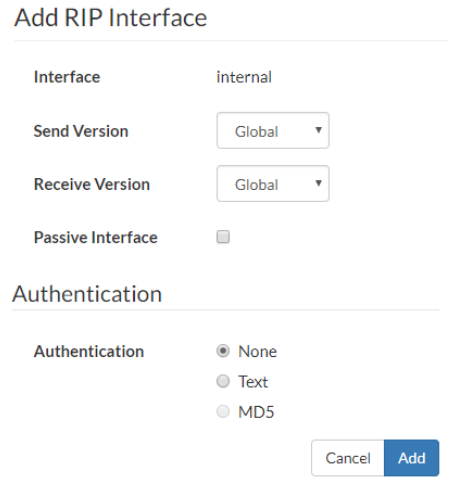
   a. Enter the distance identifier in the Distance ID field.
   b. Enter the distance.
   c. Select the access list that you added in the previous step.
   d. Enter the IP address and netmask, separated with a space or with a slash. For example, enter `1.2.3.4/5` or `1.2.3.4 248.0.0.0`.
   e. Select *Add*.

5. Go to *Router* > *Config* > *RIP* > *Networks* and select *Add Network*.



   a. Enter a unique value to identify this network configuration.
   b. Enter an IP address and netmask for your RIP network, separated with a slash, and select *Add*. For example, enter 172.168.200.0/255.255.255.0. **NOTE:** Select an IP address for a network that includes all SVIs that you want to use. You can configure multiple network ranges to cover all SVIs that will be using RIP routing.

6. Go to *Router* > *Config* > *RIP* > *Interfaces* and select *Configure RIP* for the appropriate interface.



   a. If you want to change the RIP version used to send and receive routing updates, select from the *Send Version* and *Receive Version* drop-down menus.
   b. If you do not want to send RIP updates from this interface, select *Passive Interface*.
   c. If you want to use authentication, select *Text* or *MD5*.
   d. Select *Add*.

Using the CLI for IPv4 traffic:

```
config router access-list
   edit <access_list_name>
      set comments <comments>
      config rule
         edit <rule_int>
            set action {deny | permit}
            set prefix {<xxx.xxx.xxx.xxx> <xxx.xxx.xxx.xxx> | any}
            set wildcard <IP_address>
            set exact-match {enable | disable}
         end
      end

config router rip
   set bfd {disable | enable}
   set default-information-originate {disable | enable}
```

```
      set garbage-timer <5-2147483647 seconds>
      set timeout-timer <5-2147483647 seconds>
      set update-timer <5-2147483647 seconds>
      set default-metric <1-16>
      config redistribute {bgp | connected | isis | ospf | static}
         set status {disable | enable}
         set metric <0-16>
      end
      config distance
         edit <distance_ID>
            set access-list <access_list_name>
            set distance <1-255>
            set prefix <IPv4_address> <netmask>
         end
      config network
         edit <network identifier>
            set prefix <IPv4_address> <netmask>
         end
      config interface
         edit <interface_name>
            set auth-keychain <keychain_str>
            set auth-mode {md5 | none |text}
            set auth-string <password_str>
            set receive-version {1 | 2 | both | global}
            set send-version {1 | 2 | both | global}
         end
      end
   end
```

Using the CLI for IPv6 traffic:

```
config router access-list6
   edit <access_list_name>
      set comments <comments>
      config rule
         edit <rule_int>
            set action {deny | permit}
            set prefix6 {<xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx> | any}
            set exact-match {enable | disable}
         end
      end

config router ripng
   set bfd {disable | enable}
   set default-information-originate {disable | enable}
   set garbage-timer <5-2147483647 seconds>
   set timeout-timer <5-2147483647 seconds>
   set update-timer <5-2147483647 seconds>
   set default-metric <1-16>
   config redistribute {bgp | connected | isis | ospf6 | static}
      set status {disable | enable}
      set metric <0-16>
   end
   config offset-list
      edit <offset-list_name>
         set access-list6 <access-list_name>
         set direction {in | out}
```

```
        set interface {in | out}
        set offset <1-16>
        set status {disable | enable}
      end
    config aggregate-address
      edit <aggregate-address_entry_ID>
        set prefix6 <xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx/xxx>
      end
    config interface
      edit <interface_name>
        set passive {disable | enable}
        set split-horizon-statsus {disable | enable}
        set split-horizon {poisoned |regular}
      end
    end
end
```

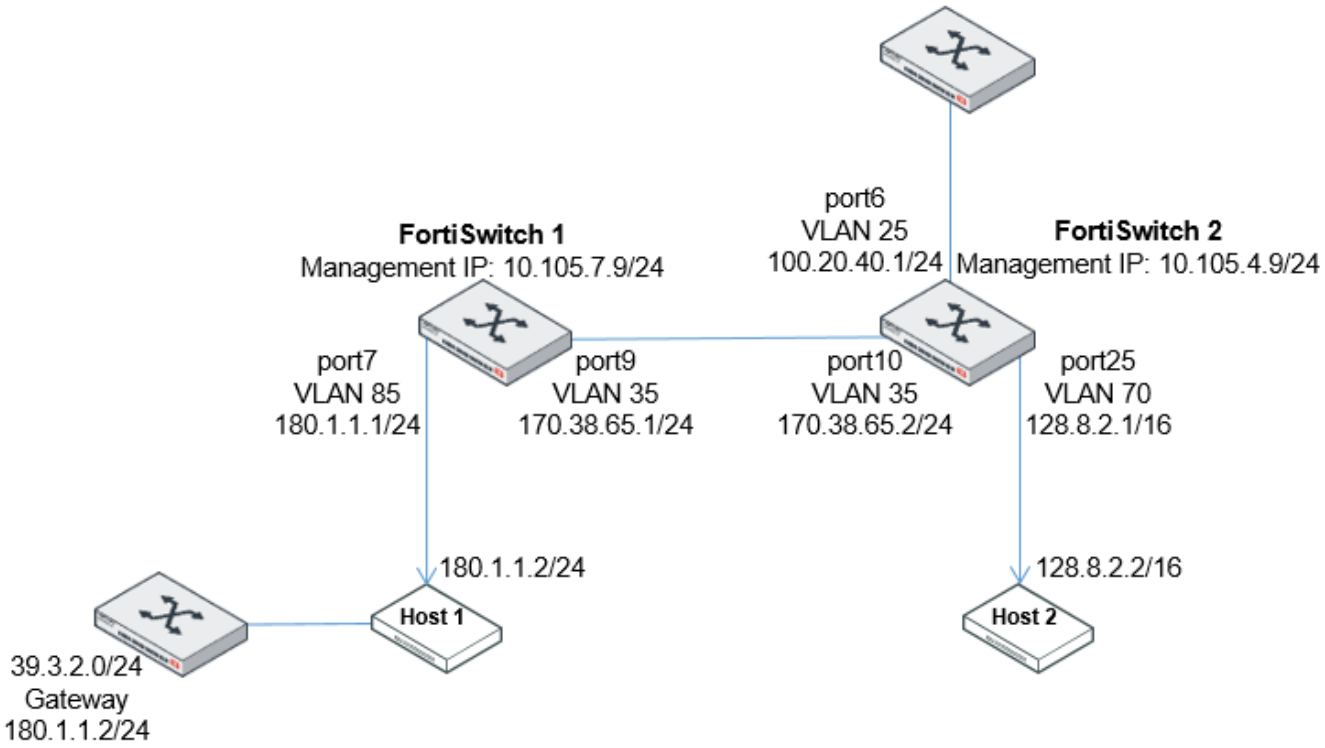
Checking the RIP configuration

The `get router info rip` and `get router info6 rip` commands have options to display different aspects of the RIP configuration and status. For example, there are options to display the RIP general information and the RIP database:

```
get router info rip status
get router info6 rip status
get router info rip database
get router info6 rip database
```

Example configuration

The following example shows a very simple RIP network:



Switch 1: Configure the switch interface

```
config switch interface
   edit "port9"
      set allowed-vlans 35
   next
   edit "port7"
      set allowed-vlans 85
   next
end
```

Switch 1: Configure the system interface

```
config system interface
   edit "vlan35"
      set ip 170.38.65.1/24
      set allowaccess ping https http ssh snmp telnet
      set vlanid 35
   next
   edit "vlan85"
      set ip 180.1.1.1/24
      set allowaccess ping https http ssh snmp telnet
      set vlanid 85
   next
end
```

Switch 1: Configure the RIP router; add authentication between FortiSwitch 1 and FortiSwitch 2

```
config router rip
   config network
      edit 1
         set prefix 170.38.65.0/24
      next
      edit 2
         set prefix 180.1.1.0/24
      next
   end
   config interface
      edit "vlan35"
         set auth-mode text
         set auth-string simplepw1
      next
   end
end
```

Switch 1: Add a static route and redistribute it

```
config router static
   edit 1
      set dst 39.3.2.0 255.255.255.0
      set gateway 180.1.1.2
      set status enable
   next
end

config router rip
   config redistribute "static"
      set status enable
   next
end
```

Switch 2: Configure the switch interface

```
config switch interface
   edit "port10"
      set allowed-vlans 35
   next
   edit "port25"
      set allowed-vlans 70
   next
end
```

Switch 2: Configure the system interface

```
config system interface
   edit "vlan35"
      set ip 170.38.65.2/24
      set allowaccess ping https http ssh snmp telnet
      set vlanid 35
   next
   edit "vlan70"
```

```
      set ip 128.8.2.1/16
      set allowaccess ping https http ssh snmp telnet
      set vlanid 70
   next
end
```

Switch 2: Configure the RIP router; add authentication between FortiSwitch 1 and FortiSwitch 2

```
config router rip
   config network
      edit 1
         set prefix 170.38.65.0/24
      next
      edit 2
         set prefix 128.8.0.0/16
      next
   end
   config interface
      edit "vlan35"
         set auth-mode text
         set auth-string simplepw1
      next
   end
end
```

Switch 2: Add a connected route and redistribute it

```
config switch interface
   edit "port6"
      set allowed-vlans 25
   next
end
config system interface
   edit "vlan25"
      set ip 100.20.40.1/24
      set allowaccess ping https http ssh snmp telnet
      set vlanid 25
   next
end

config router rip
   config redistribute "connected"
      set status enable
   next
end
```

VRRP

NOTE: You must have an advanced features license to use VRRP.

The Virtual Router Redundancy Protocol (VRRP) uses virtual routers to control which physical routers are assigned to an access network. A VRRP group consists of a master router and one or more backup routers that share a virtual IP address. If the master router fails, the VRRP automatically assigns one of the backup routers without affecting network traffic. When the failed router is functioning again, it becomes the master router again. VRRP provides this redundancy without user intervention or additional configuration to any of the devices on the network.

To create a VRRP group, you need to create a VRRP virtual MAC address, which is a shared MAC address adopted by the VRRP master. The VRRP virtual MAC address feature is disabled by default. You must enable the VRRP virtual MAC address feature on all members of a VRRP group.

The VRRP master router sends VRRP advertisement messages to the backup routers. When the VRRP master router fails to send advertisement messages, the backup router with the highest priority takes over as the master router.

This chapter covers the following topics:

Configuring VRRP

Using the GUI:

1. Go to *System* > *Network* > *Interface* > *Physical*.
2. Select *Edit* for the appropriate interface.
3. Select *Add VRRP* to add a virtual router.
   - Enter the unique virtual router identifier (VRID).
   - Enter the VRRP group number.
   - Enter the priority. If the highest priority value of 255 is entered, the virtual router becomes the master router.
   - Select *Preempt* if you want the router to preempt the master virtual router if the priority changes.
   - Enter the source virtual IP address that will be shared across the VRRP group.
   - Enter one or two IP addresses that the master router must track. The maximum number of IP addresses is two. If these IP addresses cannot be reached by the master router, the priority of the master router changes to 0.
   - Select *Add VRRP* to add each additional virtual router.
4. After filling in the fields for the virtual routers, select *Update*.

Using the CLI:

```
config system interface
   edit <VLAN name>
      set ip <IP address> <netmask>
      set allowaccess <access_types>
      set vrrp-virtual-mac enable
         config vrrp
```

```
            edit <VRRP router identifier>
               set adv-interval <seconds>
               set preempt {enable | disable}
               set priority <priority_number>
               set start-time <seconds>
               set status {enable | disable}
               set version {2 | 3}
               set vrdst <IPv4_address>
               set vrgrp <VRRP_group_number>
               set vrip <IPv4_address>
            next
         end
      set snmp-index <index number>
      set vlanid <VLAN identifier>
      set interface "internal"
   next
end
```

NOTE: You can also configure VRRP using IPv6 with the `config ipv6` and `config vrrp6` commands under the `config system interface` command.

Example of configuring VRRP using IPv4

In this example, the two FortiSwitch units, FSW-1 and FSW-2, function as both master and backup routers. For VRRP 10, FSW-1 is the master router, and FSW-2 is the backup router. For VRRP, FSW-1 is that standby router, and FSW-2 is the master router. This configuration allows the switches to balance the load and provide redundancy to each other. The downstream clients can split their gateways into two virtual routers, 10.10.10.255 and 10.10.20.255.

For the FSW-1 switch, VRID 10 has the highest priority of 255, so it is the master router; VRID 20 is the backup router.

```
config system interface
   edit "vlan-8"
      set ip 10.10.1.1 255.255.0.0
      set allowaccess ping https http ssh telnet snmp
      set vrrp-virtual-mac enable
      config vrrp
         edit 10
            set priority 255
            set vrip 10.10.10.255
         next
         edit 20
            set vrip 10.10.20.255
         next
      end
      set snmp-index 20
      set vlanid 8
      set interface "internal"
   next
end
```

For the FSW-2 switch, VRID 10 is the backup router; VRID 20 has the highest priority of 255, so it is the master router.

```
config system interface
   edit "vlan-8"
      set ip 10.10.1.2 255.255.0.0
      set allowaccess ping https http ssh telnet snmp
      set vrrp-virtual-mac enable
```

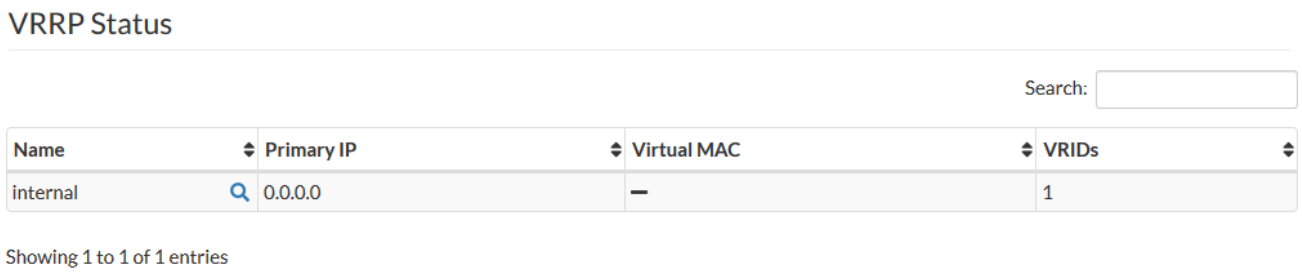
```
      config vrrp
         edit 10
            set vrip 10.10.10.255
         next
         edit 20
            set priority 255
            set vrip 10.10.20.255
         next
      end
      set snmp-index 20
      set vlanid 8
      set interface "internal"
   next
end
```

Checking the VRRP configuration

Using the GUI:

Go to *Router* > *Config* > *Interface* to see which interfaces have VRRP configured.

Go to *Router* > *Monitor* > *VRRP* to see the interface, source virtual IP address that is shared across the VRRP group, MAC address for the interface, and virtual router identifier for each VRRP configuration, as shown in the following figure.



Using the CLI:

```
get router info vrrp
```

BGP routing

NOTE: You must have an advanced features license to use BGP routing.

Border Gateway Protocol (BGP) contains two distinct subsets: internal BGP (iBGP) and external BGP (eBGP). iBGP is intended for use within your own networks. eBGP is used to connect many different networks together and is the main routing protocol for the Internet backbone. FortiSwitch units support iBGP, and eBGP only for communities.

BGP was first used in 1989. The current version, BGP-4, was released in 1995 and is defined in RFC 1771. That RFC has since been replaced by RFC 4271. The main benefits of BGP-4 are classless inter-domain routing and aggregate routes. BGP is the only routing protocol to use TCP for a transport protocol. Other routing protocols use UDP.

BGP makes routing decisions based on path, network policies, and rulesets instead of the hop-count metric as RIP does, or cost-factor metrics as OSPF does.

BGP-4+ supports IPv6. It was introduced in RFC 2858 and RFC 2545.

BGP is the routing protocol used on the Internet. It was designed to replace the old Exterior Gateway Protocol (EGP) which had been around since 1982, and was very limited. BGP enabled more networks to take part in the Internet backbone to effectively decentralize it and make the Internet more robust, and less dependent on a single ISP or backbone network.

Parts and terminology of BGP

In a BGP network, there are some terms that need to be explained before going ahead. Some parts of BGP are not explained here because they are common to other dynamic routing protocols. When determining your network topology, note that the number of available or supported routes is not set by the configuration but depends on the available memory on the FortiSwitch units.

BGP and IPv6

FortiSwitch units support IPv6 over BGP using the same `config router bgp` CLI command as IPv4 but different subcommands.

The main CLI keywords have IPv6 equivalents that are identified by the “6” on the end of the keyword, such as `config network6` or `set allowas-in6`. For more information about IPv6 BGP keywords, see the *FortiSwitchOS CLI Reference*.

Role of routers in BGP networks

Dynamic routing has a number of different roles that routers can fill. BGP has a number of custom roles that routers can fill. These include speaker routers, peer routers or neighbors, and route reflectors.

Speaker routers

Any router that is configured for BGP is considered a BGP speaker. This means that a speaker router advertises BGP routes to its peers.

Any routers on the network that are not speaker routers are not treated as BGP routers.

Peer routers or neighbors

In a BGP network, all neighboring BGP routers or peer routers are routers that are connected to a FortiSwitch unit. A FortiSwitch unit learns about all other routers through these peers.

You need to manually configure BGP peers on a FortiSwitch unit as neighbors. Otherwise, these routers are not seen as peers but simply as other routers on the network that do not support BGP. Optionally, you can use MD5 authentication to password-protect BGP sessions with those neighbors (see RFC 2385).

You can configure up to 1000 BGP neighbors on a FortiSwitch unit. You can clear all or some BGP neighbor connections (sessions), using the `execute router clear bgp` CLI command.

For example, if you have 10 routes in the BGP routing table and you want to clear the specific route to IP address 10.10.10.1, enter the following CLI command:

```
execute router clear bgp ip 10.10.10.1
```

To remove all routes for AS number 650001, enter the following CLI command:

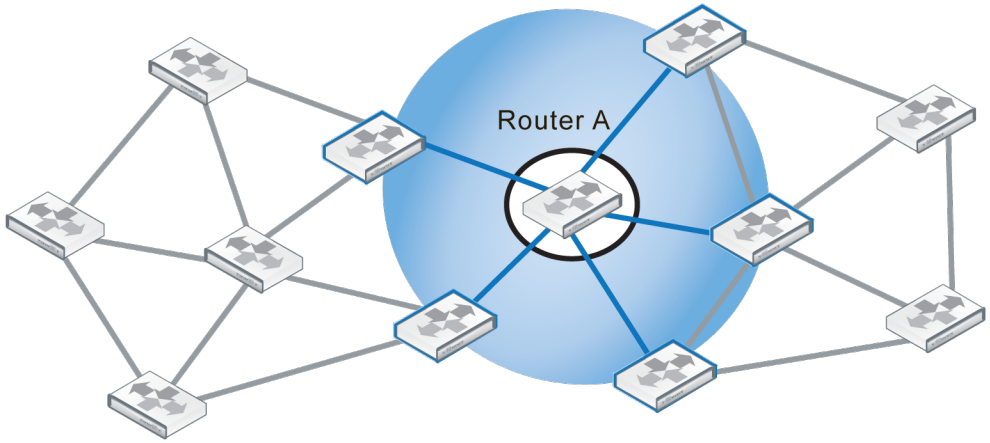
```
execute router clear bgp as 650001
```

To remove route flap dampening information for the 10.10.0.0/16 subnet, enter the following CLI command:

```
execute router clear bgp dampening 10.10.0.0/16
```

In the following diagram, Router A is directly connected to five other routers in a network that contains 12 routers. These routers (the ones in the blue circle) are Router A's peers or neighbors.

Router A and its five peer routers



As a minimum, when configuring BGP neighbors, you must enter their IP address and the AS number (remote-as). This is all of the information the GUI allows you to enter for a neighbor.

The following BGP commands are related to neighbors:

```
config router bgp
   config neighbor
      edit "<IPv4_IPv6_address>"
         set advertisement-interval <0-600>
         set allowas-in-enable {disable | enable}
            set allowas-in <1-10>
         set allowas-in-enable6 {disable | enable}
            set allowas-in6 <1-10>
         set attribute-unchanged {as-path | MED | next-hop}
         set attribute-unchanged6 {as-path | MED | next-hop}
         set activate {disable | enable}
         set activate6 {disable | enable}
         set bfd {disable | enable}
         set capability-dynamic {disable | enable}
         set capability-orf {both | none | receive | send}
         set capability-orf6 {both | none | receive | send}
         set capability-default-originate {disable | enable}
         set capability-default-originate6 {disable | enable}
         set dont-capability-negotiate {disable | enable}
         set ebgp-enforce-multihop {disable | enable}
            set ebgp-multihop-ttl <1-255>
            set ebgp-ttl-security-hops <1-254>
         set next-hop-self {disable | enable}
         set next-hop-self6 {disable | enable}
         set override-capability {disable | enable}
         set passive {disable | enable}
         set remove-private-as {disable | enable}
         set remove-private-as6 {disable | enable}
         set route-reflector-client {disable | enable}
         set route-reflector-client6 {disable | enable}
         set route-server-client {disable | enable}
         set route-server-client6 {disable | enable}
         set shutdown {disable | enable}
         set soft-reconfiguration {disable | enable}
         set soft-reconfiguration6 {disable | enable}
         set as-override {disable | enable}
         set as-override6 {disable | enable}
         set strict-capability-match {disable | enable}
         set description <string>
         set distribute-list-in <string>
         set distribute-list-in6 <string>
         set distribute-list-out <string>
         set distribute-list-out6 <string>
         set filter-list-in <string>
         set filter-list-in6 <string>
         set filter-list-out <string>
         set filter-list-out6 <string>
         set interface <interface_name>
         set maximum-prefix <1-4294967295>
         set maximum-prefix6 <1-4294967295>
         set prefix-list-in <string>
         set prefix-list-in6 <string>
         set prefix-list-out <string>
         set prefix-list-out6 <string>
         set remote-as <MANDATORY_1-4294967295>
         set route-map-in <string>
```

```
        set route-map-in6 <string>
        set route-map-out <string>
        set route-map-out6 <string>
        set send-community {both | disable | extended | standard}
        set send-community6 {both | disable | extended | standard}
        set keep-alive-timer <0-65535>
        set holdtime-timer <0, 3-65535>
        set connect-timer <0-65535>
        set unsuppress-map <string>
        set unsuppress-map6 <string>
        set update-source {interface_name}
        set weight <0-65535>
    end
  end
end
```

Route reflectors

Route reflectors (RR) in BGP concentrate route updates so other routers only need to talk to the RRs to get all of the updates. This results in smaller routing tables, fewer connections between routers, faster responses to network topology changes, and less administration bandwidth. BGP RRs are defined in RFC 1966.

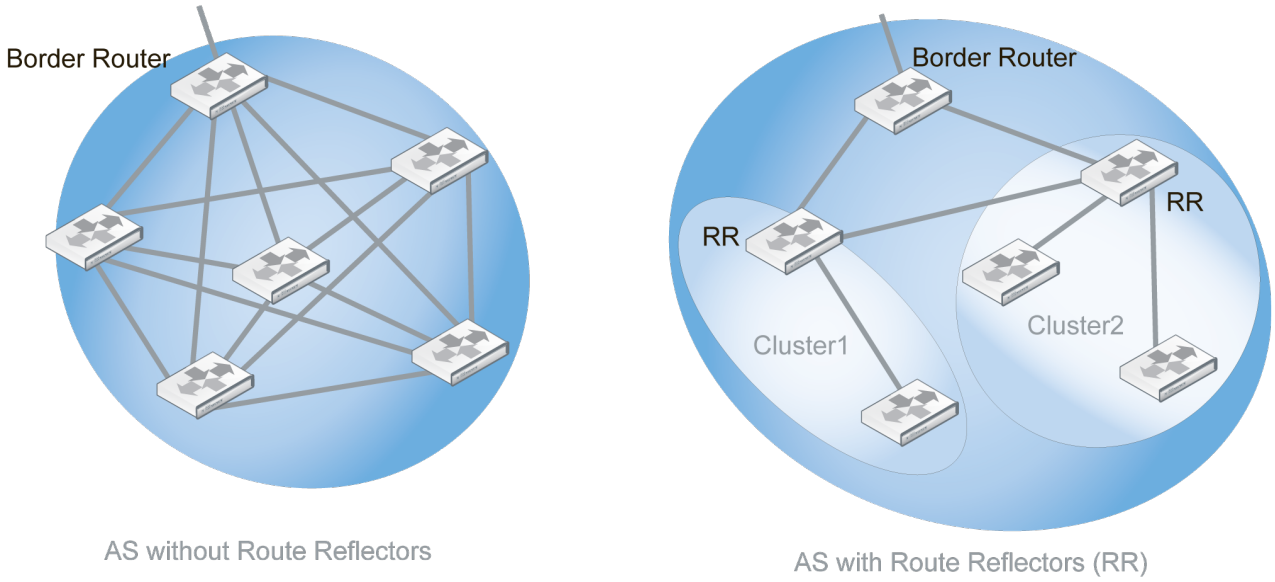
In a BGP RR configuration, the AS is divided into different clusters that each include client and reflector routers. The client routers supply the reflector routers with the client's route updates. The reflectors pass this information along to other RRs and border routers. Only the reflectors need to be configured, not the clients, because the clients find the closest reflector and communicate with it automatically. The reflectors communicate with each other as peers. A FortiSwitch unit can be configured as either reflectors or clients.

Because RRs are processing more than the client routers, the reflectors should have more resources to handle the extra workload.

Smaller networks running BGP typically do not require RRs. However, RRs are a useful feature for large companies, where their AS may include 100 routers or more. For example, a full mesh 20 router configuration within an AS, there would have to be 190 unique BGP sessions just for routing updates within the AS. The number of sessions jumps to 435 sessions for just 30 routers, or 4950 sessions for 100 routers. Based on these numbers, updating this many sessions will quickly consume the limited bandwidth and processing resources of the routers involved.

The following diagram illustrates how RRs can improve the situation when only six routers are involved. The AS without RRs requires 15 sessions between the routers. In the AS with RRs, the two RRs receive route updates from the reflector clients (unlabeled routers in the diagram) in their cluster, as well as other RRs, and pass them on to the border router. The RR configuration requires only six sessions. This example shows a reduction of 60% for the number of required sessions.

Required sessions within an AS with and without RRs



AS without Route Reflectors

AS with Route Reflectors (RR)

The BGP commands related to RRs include:

```
config router bgp
   config neighbor
      edit "<IPv4_IPv6_address>"
         set route-reflector-client {disable | enable}
         set route-reflector-client6 {disable | enable}
         set route-server-client {disable | enable}
         set route-server-client6 {disable | enable}
   end
end
```

Confederations

Confederations were introduced to reduce the number of BGP advertisements on a segment of the network and reduce the size of the routing tables. Confederations essentially break up an AS into smaller units. Confederations are defined in RFC 3065 and RFC 1965.

Within a confederation, all routers communicate with each other in a full mesh arrangement. Communications between confederations is more like inter-AS communications because many of the attributes are changed as they would be for BGP communications leaving the AS, or eBGP.

Confederations are useful when merging ASs. Each AS being merged can easily become a confederation, which requires few changes. Any additional permanent changes can then be implemented over time, as required. The diagram below shows the group of ASs before merging and the corresponding confederations afterward, as part of the single AS with the addition of a new border router. It should be noted that after merging, if the border router becomes a route reflector, then each confederation only needs to communicate with one other router instead of five others.

Confederations and RRs perform similar functions: they both sub-divide large ASs for more efficient operation. They differ in that route reflector clusters can include routers that are not members of a cluster, whereas routers in a confederation must belong to that confederation. Also, confederations place their confederation numbers in the AS_PATH attribute, making it easier to trace.

NOTE: While confederations essentially create sub-ASs, all the confederations within an AS appear as a single AS to external ASs.

Confederation related BGP commands include the following:

```
config router bgp
   set confederation-identifier <peerid_integer>
end
```

Network Layer Reachability Information

Network Layer Reachability Information (NLRI) is unique to BGP-4. It is sent as part of the update messages sent between BGP routers and contains information necessary to supernet, or aggregate route, information. The NLRI includes the length and prefix that, when combined, are the address of the aggregated routes referred to.

There is only one NLRI entry per BGP update message.

BGP attributes

Each route in a BGP network has a set of attributes associated with it. These attributes define the route and are modified, as required, along the route.

BGP can work well with mostly default settings, but if you're going to change settings you need to understand the roles of each attribute and how they affect those settings.

The BGP attributes include the ones listed in the following table.

Attribute	Description
AS_PATH	A list of ASs a route has passed through. For more information, see AS_PATH on page 262.
MULTI_EXIT_DESC (MED)	Which router to use to exit an AS with more than one external connection. For more information, see MULTI_EXIT_DESC on page 262.
COMMUNITY	Used to apply attributes to a group of routes. For more information, see COMMUNITY on page 263.
NEXT_HOP	Where the IP packets should be forwarded to, like a gateway in static routing. For more information, see NEXT_HOP on page 263.
ATOMIC_AGGREGATE	Used when routes have been summarized to tell downstream routers not to de-aggregate the route. For more information, see ATOMIC_AGGREGATE on page 263.
ORIGIN	Used to determine if the route is from the local AS or not. For more information, see ORIGIN on page 264.
LOCAL_PREF	Used only within an AS to select the best route to a location (like MED).

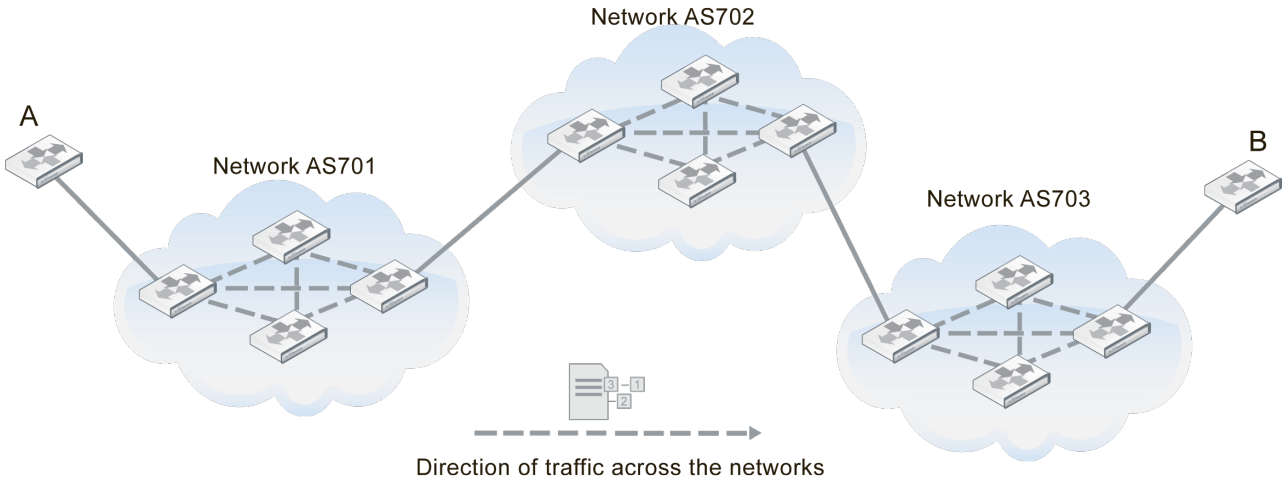
Inbound policies on FortiSwitch units can change the NEXT-HOP, LOCAL-PREF, MED, and AS-PATH attributes of an internal BGP (iBGP) route for its local route selection purposes. However, outbound policies on the device cannot affect these attributes.

AS_PATH

AS_PATH is the BGP attribute that keeps track of each AS that a route advertisement has passed through. AS_PATH is used by confederations and by exterior BGP (EBGP) to help prevent routing loops. A router knows there is a loop if it receives an AS_PATH with that router's AS in it. The diagram shows the route between Router A and Router B. The AS_PATH from A to B would read 701,702,703 for each AS that the route passes through.

As of the beginning of 2010, the industry upgraded from 2-byte to 4-byte AS_PATHs. This upgrade was due to the imminent exhaustion of 2-byte AS_PATH numbers. FortiOS supports 4-byte AS_PATHs in its BGP implementation.

AS_PATH of 701,702, 703 between routers A and B



The BGP commands related to AS_PATH include the following:

```
config router bgp
   set bestpath-as-path-ignore {enable | disable}
end
```

MULTI_EXIT_DESC

BGP AS systems can have one or more routers that connect them to other ASs. For ASs with more than one connecting router, the Multi-Exit Discriminator (MED) lists which router is best to use when leaving the AS. The MED is based on attributes, such as delay. It is a recommendation only, as some networks may have different priorities.

BGP updates advertise the best path to a destination network. When a FortiSwitch unit receives a BGP update, the FortiSwitch unit examines the MED attribute of potential routes to determine the best path to a destination network before recording the path in the local FortiSwitch routing table.

FortiSwitch units have the option to treat any routes without an MED attribute as the worst possible routing choice. This can be useful because a lack of MED information is a lack of routing information, which can be suspicious as a possible hacking attempt or an attack on the network. At best, it signifies an unreliable route to select.

The BGP commands related to MED include the following:

```
config router bgp
   set always-compare-med {enable | disable}
   set bestpath-med-confed {enable | disable}
   set bestpath-med-missing-as-worst {enable | disable}
```

```
   set deterministic-med {enable | disable}
   config neighbor
      edit "<IPv4_IPv6_address>"
         set attribute-unchanged [as-path] [med] [next-hop]
         set attribute-unchanged6 {as-path | MED | next-hop}
      end
   end
end
```

COMMUNITY

A community is a group of routes that have the same routing policies applied to them. This saves time and resources. A community is defined by the COMMUNITY attribute of a BGP route.

A FortiSwitch unit can set the COMMUNITY attribute of a route to assign the route to predefined paths (see RFC 1997). The FortiSwitch unit can examine the COMMUNITY attribute of learned routes to perform local filtering and/or redistribution.

The BGP commands related to COMMUNITY include the following:

```
config router bgp
   set send-community {both | disable | extended | standard}
   set send-community6 {both | disable | extended | standard}
end
```

NEXT_HOP

The NEXT_HOP attribute says what IP address the packets should be forwarded to next. Each time the route is advertised, this value is updated. The NEXT_HOP attribute is much like a gateway in static routing.

FortiSwitch units allow you to change the advertising of the FortiSwitch unit's IP address (instead of the neighbor's IP address) in the NEXT_HOP information that is sent to IBGP peers. This is changed with the `config neighbor`, `set next-hop-self` command.

The BGP commands related to NEXT_HOP include the following:

```
config router bgp
   config neighbor
      edit "<IPv4_IPv6_address>"
         set attribute-unchanged [as-path] [med] [next-hop]
         set attribute-unchanged6 {as-path | MED | next-hop}
         set next-hop-self {enable | disable}
         set next-hop-self6 {disable | enable}
      next
   end
end
```

ATOMIC_AGGREGATE

The ATOMIC_AGGREGATE attribute is used when routes have been summarized. It indicates which AS and which router summarize the routes. It also tells downstream routers not to de-aggregate the route. Summarized routes are routes with similar information that have been combined, or aggregated, into one route that is easier to send in updates for. When it reaches its destination, the summarized routes are split back up into the individual routes.

The FortiSwitch unit does not specifically set this attribute in the BGP router command, but it is used in the route map command.

The CLI commands related to ATOMIC_AGGREGATE include the following:

```
config router route-map
   edit <route_map_name>
      set protocol bgp
      config rule
         edit <route_map_rule_id>
            set set-aggregator-as <id_integer>
            set set-aggregator-ip <address_ipv4>
            set set-atomic-aggregate {enable | disable}
         end
      end
   end
```

ORIGIN

The ORIGIN attribute records where the route came from. The options can be IBGP, EBGP, or incomplete. This information is important because internal routes (IBGP) are, by default, higher priority than external routes (EBGP). However, incomplete ORIGINs are the lowest priority of the three.

The CLI commands related to ORIGIN include the following:

```
config router route-map
   edit <route_map_name>
      set protocol bgp
      config rule
         edit <route_map_rule_id>
            set match-origin {egp | igp | incomplete | none}
         end
      end
   end
```

How BGP works

BGP is a link-state routing protocol and keeps link-state information about the status of each network link it has connected. A BGP router receives information from its peer routers that have been defined as neighbors. BGP routers listen for updates from these configured neighboring routers on TCP port 179.

A BGP router is a finite state machine with six various states for each connection. As two BGP routers discover each other and establish a connection, they go from the idle state and through the various states until they reach the established state. An error can cause the connection to drop and the state of the router to reset to either active or idle. These errors can be caused by TCP port 179 not being open, a random TCP port above port 1023 not being open, the peer address being incorrect, or the AS number being incorrect.

When BGP routers start a connection, they negotiate which (if any) optional features will be used, such as multiprotocol extensions, that can include IPv6 and VPNs.

IBGP versus EBGP

When you read about BGP, you often see EBGP or IBGP mentioned. These are both BGP routing, but BGP used in different roles. Exterior BGP (EBGP) involves packets crossing multiple autonomous systems (ASs) and interior BGP (IBGP) involves packets that stay within a single AS. For example, the AS_PATH attribute is only useful for EBGP where routes pass through multiple ASs.

These two modes are important because some features of BGP are used only for one of EBGP or IBGP. For example, confederations are used in EBGP and RRs are used only in IBGP. Also, routes learned from IBGP have priority over routes learned from EBGP.

FortiSwitch units have some commands that are specific to EBGP, including the following:

- automatically resetting the session information to external peers if the connection goes down:`set fast-external-failover {enable | disable}`
- setting an administrative distance for all routes learned from external peers (you must also configure local and internal distances if this is set):`set distance-external <distance_integer>`
- enforcing EBGP multihops and their TTL (number of hops): `set ebgp-enforce-multihop {enable | disable}` and `set ebgp-multihop-ttl <seconds_integer>`

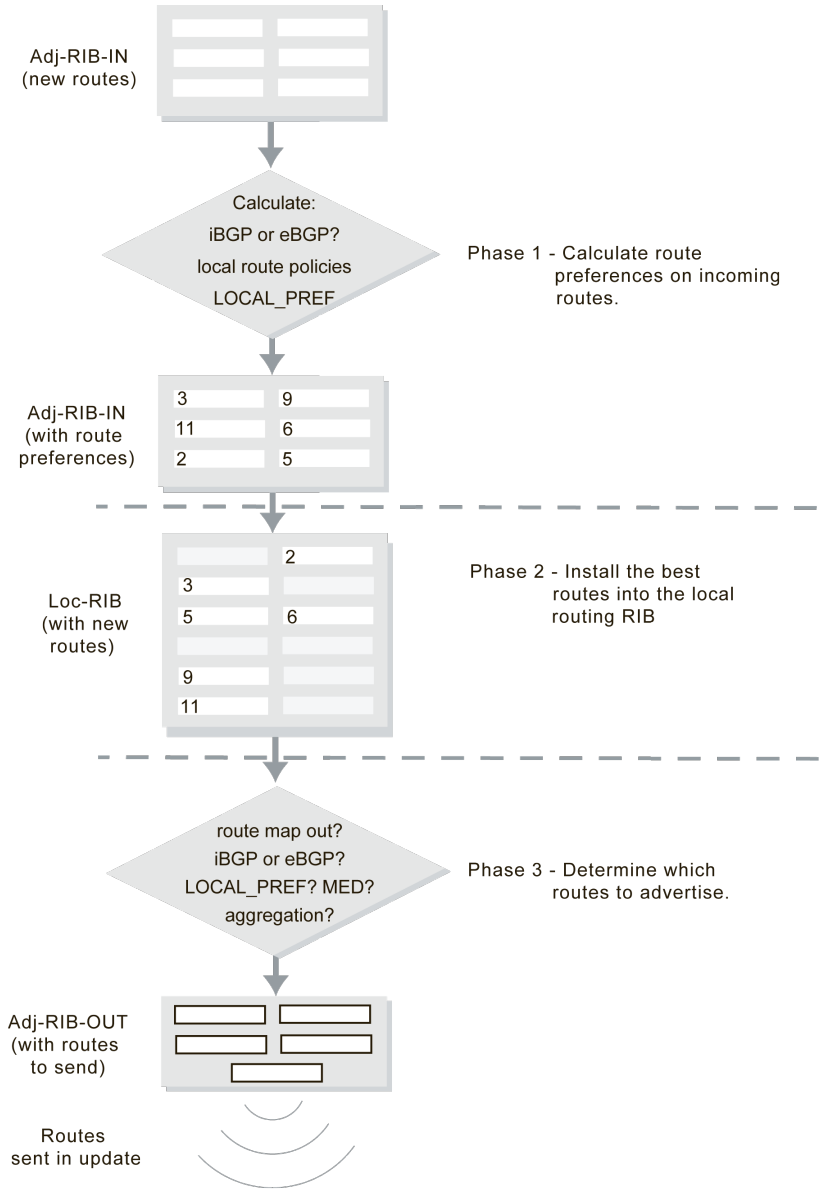
BGP path determination: Which route to use

Firstly, recall that the number of available or supported routes is not set by the configuration but depends on the available memory on the FortiSwitch unit. All learned routes and their attributes come into the BGP router in raw form. Before routes are installed in the routing table or are advertised to other routers, three levels of decisions must be made.

The three phases of BGP best path determination do not change. However, some manufacturers have added more information to the process, such as Cisco's WEIGHT attribute, to allow an administrator to force one route's selection over another.

There is one Adj-RIB-IN and Adj-RIB-OUT for each configured neighbor. They are updated when the FortiSwitch unit receives BGP updates or when the FortiSwitch unit sends out BGP updates.

The three phases of a BGP routing decision



Decision phase 1

At this phase, the decision is to calculate how preferred each route and its NRLI are the Adjacent Routing Information Base Incoming (Adj-RIBs-In) compared to the other routes. For internal routes (IBGP), policy information or LOCAL_PREF is used. For external peer learned routes, it is based strictly on policy. These rules set up a list of which routes are most preferred going into Phase 2.

Decision phase 2

Phase 2 involves installing the best route to each destination into the local Routing Information Base (Loc-RIB). Effectively, the Loc-RIB is the primary routing table. Each route from Phase 1 has their NEXT_HOP checked to ensure the destination is reachable. If it is reachable, the AS_PATH is checked for loops. After that, routes are installed based on the following decision process:

- If there is only one route to a location, it is installed.
- If there are multiple routes to the same location, use the most preferred route from Level 1.
- If there is a tie, break the tie based on the following, in descending order of importance: shortest AS_PATH, smallest ORIGIN number, smallest MED, EBGP over IBGP, smallest metric or cost for reaching the NEXT_HOP, BGP identifier, and lowest IP address.

Note that the new routes that are installed into the Loc-RIB are in addition to any existing routes in the table. Once Phase 2 is completed, the Loc-RIB will consist of the best of both the new and older routes.

Decision phase 3

Phase 3 is route distribution or dissemination. This is the process of deciding which routes the router will advertise. If there is any route aggregation or summarizing, it happens here. Also, any route filtering from route maps happens here.

Once Phase 3 is complete, an update can be sent out to update the neighbor of new routes.

Aggregate routes and addresses

BGP-4 allows classless routing, which uses netmasks as well as IP addresses. This classless routing allows the configuration of aggregate routes by stating the address bits the aggregated addresses have in common.

The ATOMIC_AGGREGATE attribute informs routers that the route has been aggregated and should not be de-aggregated. An associated AGGREGATOR attribute include the information about the router that did the aggregating including its AS.

The BGP commands associated with aggregate routes and addresses are the following:

```
config router bgp
   config aggregate-address
      edit <aggr_addr_id>
         set as-set {enable | disable}
         set prefix <address_ipv4mask>
         set summary-only {enable | disable}
      end
   end
   config aggregate-address6
      edit <aggr_addr_id>
         set as-set {enable | disable}
         set prefix6 <address_ipv6mask>
         set summary-only {enable | disable}
      end
   end
```

Troubleshooting BGP

There are some features in BGP that are used to deal with problems that may arise. Typically, the problems with a BGP network that has been configured involve routes going offline frequently. This is called route flap and causes problems for the routers using that route.

Clearing routing table entries

To see if a new route is being properly added to the routing table, you can clear all or some BGP neighbor connections (sessions) using the `execute router clear bgp` command.

For example, if you have 10 routes in the BGP routing table and you want to clear the specific route to IP address 10.10.10.1, enter the following CLI command:

```
execute router clear bgp ip 10.10.10.1
```

To remove all routes for AS number 650001, enter the following CLI command:

```
execute router clear bgp as 650001
```

Route flap

When routers or hardware along a route go offline and back online that is called a route flap. Flapping is the term that is used if these outages continue, especially if they occur frequently.

Route flap is a problem in BGP because each time a peer or a route goes down, all the peer routers that are connected to that out-of-service router advertise the change in their routing tables. This creates a lot of administration traffic on the network and the same traffic re-occurs when that router comes back online. If the problem is something like a faulty network cable that wobbles online and offline every 10 seconds, there could easily be an overwhelming amount of routing updates sent out unnecessarily.

Another possible reason for route flap occurs with multiple FortiSwitch units in HA mode. When an HA cluster fails over to the secondary unit, other routers on the network may see the HA cluster as being offline, resulting in route flap. While this does not occur often, or more than once at a time, it can still result in an interruption in traffic that is unpleasant for network users. The easy solution for this problem is to increase the timers on the HA cluster, such as TTL timers, so they do not expire during the failover process. Also, configuring graceful restart on the HA cluster helps with a smooth failover.

The first method of dealing with route flap is to check your hardware. If a cable is loose or bad, it can easily be replaced and eliminate the problem. If an interface on the router is bad, either avoid using that interface or swap in a functioning router. If the power source is bad on a router, either replace the power supply or use a power conditioning backup power supply. These quick and easy fixes can save you from configuring more complex BGP options. However, if the route flap is from another source, configuring BGP to deal with the outages will ensure your network users uninterrupted service.

Some methods of dealing with route flap in BGP include:

- Holdtime timer
- Dampening
- BFD

Holdtime timer

The first line of defense to a flapping route is the holdtime timer. This timer reduces how frequently a route going down will cause a routing update to be broadcast.

After it is activated, the holdtime timer does not allow the FortiSwitch unit to accept any changes to that route for the duration of the timer. If the route flaps five times during the timer period, only the first outage is recognized by the FortiSwitch unit. For the duration of the other outages, there will not be changes because the FortiSwitch unit is essentially treating this router as down. If the route is still flapping after the timer expires, it'll happen all over again.

Even if the route is not flapping (for example, if it goes down, comes up, and stays back up) the timer still counts down and the route is ignored for the duration of the timer. In this situation, the route is seen as down longer than it really is but there will be only the one set of route updates. This is not a problem in normal operation because updates are not frequent.

Also, the potential for a route to be treated as down when it is really up can be viewed as a robustness feature. Typically, you do not want most of your traffic being routed over an unreliable route. So if there is route flap going on, it is best to avoid that route if you can. This is enforced by the holdtime timer.

How to configure the holdtime timer

There are three different route flapping situations that can occur: the route goes up and down frequently, the route goes down and back up once over a long period of time, or the route goes down and stays down for a long period of time. These can all be handled using the holdtime timer.

For example, your network has two routes that you want to set the timer for. One is your main route (to 10.12.101.4) that all of your Internet traffic goes through, and it cannot be down for long if it is down. The second is a low speed connection to a custom network that is used infrequently (to 10.13.101.4). The timer for the main route should be fairly short (for example, 60 seconds). The second route timer can be left at the default because it is rarely used. In your BGP configuration, this looks like the following:

```
config router bgp
   config neighbor
      edit 10.12.101.4
         set holdtime-timer 60
      next
      edit 10.13.101.4
         set holdtime-timer 180
      next
   end
end
```

Dampening

Dampening is a method that is used to limit the amount of network problems due to flapping routes. With dampening, the flapping still occurs but the peer routers pay less and less attention to that route as it flaps more often. One flap does not start dampening, but the second flap starts a timer where the router will not use that route because it is considered unstable. If the route flaps again before the timer expires, the timer continues to increase. There is a period of time called the reachability half-life, after which a route flap will be suppressed for only half the time. This half-life comes into effect when a route has been stable for a while but not long enough to clear all the dampening completely. For the flapping route to be included in the routing table again, the suppression time must expire.

If the route flapping was temporary, you can clear the flapping or dampening from the FortiSwitch unit's cache by using one of the `execute router clear bgp` CLI commands:

```
execute router clear bgp dampening {<ip_address> | <ip/netmask>}
```

For example, to remove route flap dampening information for the 10.10.0.0/16 subnet, enter the following CLI command:

```
execute router clear bgp dampening 10.10.0.0/16
```

The BGP commands related to route dampening are the following:

```
config router bgp
   set dampening {enable | disable}
   set dampening-max-suppress-time <minutes_integer>
   set dampening-reachability-half-life <minutes_integer>
   set dampening-reuse <reuse_integer>
   set dampening-suppress <limit_integer>
end
```

BFD

Bidirectional Forwarding Detection (BFD) is a protocol that you can use to quickly locate hardware failures in the network. Routers running BFD communicate with each other and if a timer runs out on a connection then that router is declared down. BFD then communicates this information to the routing protocol and the routing information is updated. For more information about BFD, see Bidirectional forwarding detection on page 218.

Configuring BGP

Configuring BGP on the FortiSwitch unit includes the following major steps:

1. Enter the BGP configuration mode.
2. Set the autonomous system and router identifier.
3. Configure a BGP neighbor.
4. Redistribute non-BGP routes. Advertise these non-BGP routes within BGP.

1. Enter the BGP configuration mode

Enter the BGP configuration mode to access all of the BGP configuration commands:

```
# config router bgp
```

2. Set the autonomous system and router identifier

Set the autonomous system. For IBGP, the AS value needs to match the `remote-as` value in the neighbor router. For EBGP, the AS value differs from the `remote-as` value in the neighbor router. You also need to specify a fixed router identifier for the FortiSwitch unit. These two commands are mandatory.

```
# set as <AS number>
# set router-id <IP_address>
```

3. Configure the BGP neighbors

Configure the BGP neighbors.

NOTE: For IBGP, if the IP address of the BGP neighbor is a loopback address, you must use the `set update-source cmd` command to specify which interface address will be used as the source IP address in the outgoing BGP packet.

```
config neighbor
   edit "<IPv4_or_IPv6 address>"
      set remote-as <1-4294967295>
   end
```

4. Redistribute non-BGP routes

Redistribute non-BGP IPv4 or IPv6 routes within BGP:

```
   config redistribute {connected | isis | ospf | rip | static}
      set status enable
      set route-map <string>
   end

   config redistribute6 {connected | isis | ospf | rip | static}
      set status {disable | enable}
      set route-map <string>
   end
```

Other BGP commands

Clearing the BGP routes

Use the following commands to clear the BGP routes:

```
execute router clear bgp all
execute router clear bgp ip <IPv4_or_IPv6_address>
execute router clear bgp ipv6 <IPv4_or_IPv6_address>
execute router clear bgp as <AS_number>
execute router clear bgp dampening <IP_address>
```

Checking the BGP configuration

The `get router info bgp` and `get router info6 bgp` commands have options to display different aspects of the BGP configuration and status.

For example:

```
get router info bgp neighbors
get router info bgp network
get router info6 bgp filter-list
get router info6 bgp route-map
```

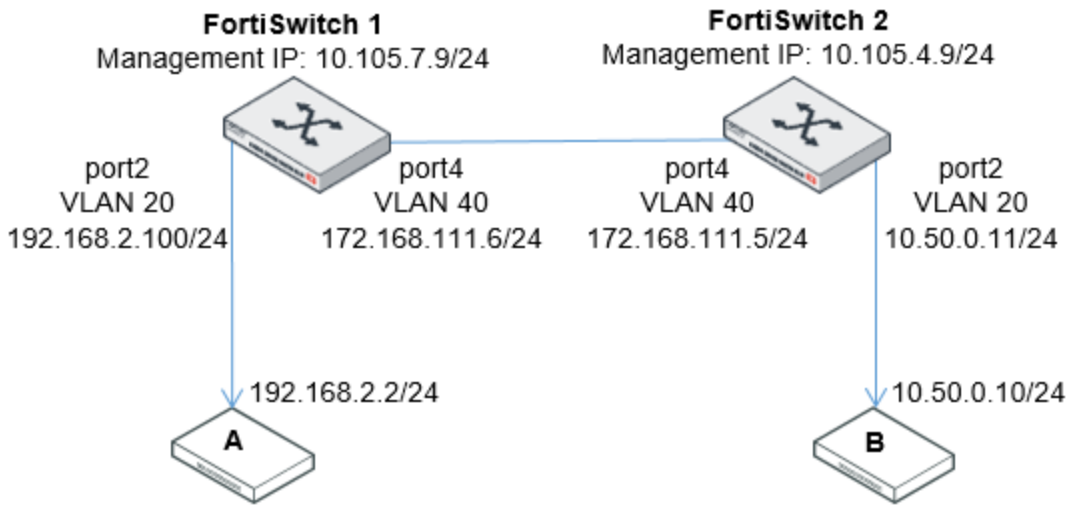
Changing the maximum number of paths for ECMP

If you are using equal-cost multi-path (ECMP) routing with the EBGP or IBGP, the maximum number of paths is 1 by default. Use the following commands to change the default:

```
config router bgp
   set maximum-paths-ebgp <1-64>
   set maximum-paths-ibgp <1-64>
end
```

Sample configurations

Here is an example of a BGP routing configuration:



Configure system interfaces

Interface configuration for FortiSwitch 1:

```
config system interface
   edit mgmt
      set ip 10.105.7.9 255.255.255.0
      set allowaccess ping https http ssh telnet
      set type physical
   next
   edit internal
      set type physical
   next
   edit vlan20-p2
      set ip 192.168.2.100 255.255.255.0
      set allowaccess ping https http ssh telnet
      set vlanid 20
      set interface internal
   next
```

```
   edit vlan40-p4
      set ip 172.168.111.6 255.255.255.0
      set allowaccess ping https http ssh telnet
      set vlanid 40
      set interface internal
end
config switch interface
   edit "port2"
      set native-vlan 20
      set stp-state disabled
   next
   edit "port4"
      set native-vlan 40
      set stp-state disabled
   next
   edit "internal"
      set allowed-vlans 1,20, 40, 4094
      set stp-state disabled
   next
end
```

Internal BGP

In this example, the two neighboring switches are in the same autonomous system.

Configuration for FortiSwitch 1:

```
config router bgp
   set as 6500
   set router-id 1.2.3.4
      config neighbor
         edit "172.168.111.5"
            set remote-as 6500
         next
      end
      config network
         edit 1
            set prefix 192.168.2.0 255.255.255.0
         next
      end
      config redistribute "connected"
      end
   end
end
```

Configuration for FortiSwitch 2:

```
config router bgp
   set as 6500
   set router-id 5.6.7.8
      config neighbor
         edit "172.168.111.6"
            set remote-as 6500
         next
      end
      config network
```

```
        edit 1
           set prefix 10.50.2.0 255.255.255.0
        next
      end
      config redistribute "connected"
      end
   end
end
```

External BGP

In this example, the two neighboring switches are in separate autonomous systems.

Configuration for FortiSwitch 1:

```
config router bgp
   set as 6500
   set router-id 1.2.3.4
      config neighbor
         edit "172.168.111.5"
            set remote-as 7500
         next
      end
      config network
         edit 1
            set prefix 192.168.2.0 255.255.255.0
         next
      end
      config redistribute "connected"
      end
   end
end
```

Configuration for FortiSwitch 2:

```
config router bgp
   set as 7500
   set router-id 5.6.7.8
      config neighbor
         edit "172.168.111.6"
            set remote-as 6500
         next
      end
      config network
         edit 1
            set prefix 10.50.2.0 255.255.255.0
         next
      end
      config redistribute "connected"
      end
   end
end
```

Using the following command, you can check the BGP status on the local switch:

```
# get router info bgp summary
```

To check the details about the BGP neighbors:

```
# get router info bgp neighbors
```

To check the routes learned by BGP, use the following command:

```
# get router info routing-table details
```

PIM routing

NOTES:

- You must have an advanced features license to use PIM routing.
- This feature is supported only on the SVI.

A FortiSwitch unit can operate as a Protocol Independent Multicast (PIM) version-4 router. FortiSwitchOS supports PIM source-specific multicast (SSM) and version 3 of Internet Group Management Protocol (IGMP).

You can configure a FortiSwitch unit to support PIM using the `config router multicast` CLI command. When PIM is enabled, the FortiSwitch unit allocates memory to manage mapping information. The FortiSwitch unit communicates with neighboring PIM routers to acquire mapping information and, if required, processes the multicast traffic associated with specific multicast groups.

NOTE:

- Access lists, prefix lists, and route maps are not supported.
- Bidirectional forwarding detection (BFD) is not supported.
- You cannot use PIM and the IGMP querier at the same time on the same switch virtual interface.
- PIM and IGMP snooping work independently.
- IPv6 is not supported.
- IGMP version-3 explicit membership tracking is not supported.
- SSM mapping is not supported.
- The multicast routing information base (MRIB) is not supported.
- The PIM management information base (MIB) is not supported.

This chapter covers the following topics:

Terminology

PIM domain: A PIM domain is a logical area comprising a number of contiguous networks. The domain contains at least one Boot Strap Router (BSR) and a number of Rendezvous Points (RPs) and Designated Routers (DRs).

RP: An RP represents the root of a non-source-specific distribution tree to a multicast group.

Configuring PIM

To configure a PIM domain:

1. Determine the appropriate paths for multicast packets.
2. Make a note of the interfaces that will be PIM enabled. These interfaces can run a unicast routing protocol.
3. If you want multicast packets to be handled by specific (static) rendezvous points (RPs), record the IP addresses of the PIM-enabled interfaces on those RPs.
4. Enable PIM version 4 on all participating routers between the source and receivers. Use the `config router multicast` command to set global operating parameters.
5. Configure the PIM routers that have good connections throughout the PIM domain to be candidate boot strap routers (BSRs).
6. Configure one or more of the PIM routers to be candidate RPs.
7. If required, adjust the default settings of PIM-enabled interface(s).

To configure the source allowed for a multicast flow:

```
config router multicast-flow
   edit <name>
      set comments <string>
      config flows
         edit <muliticast-flow_entry_identifier>
            set group-addr <224-239.xxx.xxx.xxx>
            set source-addr <IP_address>
         end
      end
```

To configure a FortiSwitch unit to support PIM:

```
config router multicast
   set multicast-routing {disable | enable}
   config interface
      edit {interface_name | internal | mgmt}
         set pim-mode ssm-mode
         set hello-interval <1-180>
         set dr-priority <1-4294967295>
         set multicast-flow <string>
         config igmp
            set query-interval <1-65535>
            set query-max-response-time <1-25>
      end
   end
```

Checking the PIM configuration

Use the following commands to check your PIM configuration:

```
get router info multicast config
get router info multicast igmp {groups | sources | querier | interface | join | parameters}
get router info multicast pim {neighbour | interface}
```

IS-IS routing

NOTES:

- You must have an advanced features license to use IS-IS routing.
- This feature is supported only on the SVI.

Intermediate System to Intermediate System Protocol (IS-IS) allows routing of ISO's OSI protocol stack Connectionless Network Service (CLNS). IS-IS is an Interior Gateway Protocol (IGP) that is not intended to be used between Autonomous Systems (AS).

IS-IS is a link state protocol that is well-suited to smaller networks. It is in widespread use and has near universal support on routing hardware. It is quick to configure and works well if there are no redundant paths. However, IS-IS updates are sent out node-by-node, so it can be slow to find a path around network outages. IS-IS also lacks good authentication, can not choose routes based on different quality-of-service methods, and can create network loops if you are not careful. IS-IS uses Djikstra's algorithm to find the best path, like OSPF.

While OSPF is more widely known, IS-IS is a viable alternative to OSPF in enterprise networks and ISP infrastructures, largely due to its native support for IPv6 and its nondisruptive methods for splitting, merging, migrating, and renumbering network areas.

This chapter covers the following topics:

Terminology

TLV: IS-IS uses type-length-value (TLV) parameters to carry information in Link-State PDUs (LSPs). The TLV field consists of one octet of type (T), one octet of length (L), and "L" octets of value (V).

Link-state PDU (LSP): The LSP contains information about each router in an area and its connected interfaces.

Complete sequence number PDU (CSNP): CSNPs contain a list of all LSPs in the current LSDB.

Authentication keychain: A keychain is a list of one or more authentication keys including the send and receive lifetimes for each key. Keys are used for authenticating routing packets only during the specified lifetimes.

Configuring IS-IS

Configuring IS-IS on the FortiSwitch unit includes the following major steps:

1. Enter the IS-IS configuration mode.
2. Configure the interface.

3. Configure the network.
4. Redistribute non-IS-IS routes. Advertise these non-IS-IS routes within IS-IS.

1. Enter the IS-IS configuration mode

Enter the IS-IS configuration mode to access all of the IS-IS configuration commands:

```
# config router isis
```

2. Configure the interface

Enable the `status` option for IPv4 traffic or the `status6` option for IPv6 traffic on the specified interface:

```
config interface
   edit <IS-IS interface name>
      set auth-keychain-hello <string>
      set auth-mode-hello {md5 | password}
      set auth-password-hello <password>
      set bfd {enable | disable}
      set bfd6 {enable | disable}
      set circuit-type {level-1 | level-1-2 | level-2}
      set csnp-interval-l1 <1-65535 seconds>
      set csnp-interval-l2 <1-65535 seconds>
      set hello-interval-l1 <1-65535 seconds; 0 to use 1-second hold time>
      set hello-interval-l2 <1-65535 seconds; 0 to use 1-second hold time>
      set hello-multiplier-l1 <2-100>
      set hello-multiplier-l2 <2-100>
      set hello-padding {disable | enable}
      set metric-l1 <1-63>
      set metric-l2 <1-63>
      set passive {disable | enable}
      set priority-l1 <0-127>
      set priority-l2 <0-127>
      set status {disable | enable}
      set status6 {disable | enable}
      set wide-metric-l1 <1-16777214>
      set wide-metric-l2 <1-16777214>
   end
```

3. Configure the network

Configure the IS-IS network:

```
config net
   edit <identifier>
      set <IS-IS net xx.xxxx. ... .xxxx.xx>
   end
```

4. Redistribute non-IS-IS routes

Redistribute non-IS-IS routes within IS-IS for IPv4 traffic or for IPv6 traffic:

```
config redistribute {bgp | connected | ospf | rip | static}
   set status {disable | enable}
```

```
   set metric <0-4261412864>
   set metric-type {external | internal}
   set level {level-1 | level-1-2 | level-2}
   set routemap <string>
end

config redistribute6 {bgp6 | connected | ospf6 | ripng | static}
   set status {disable | enable}
   set metric <0-4261412864>
   set level {level-1 | level-1-2 | level-2}
   set routemap <string>
end
```

The following is an example of an IS-IS configuration for IPv4 traffic:

```
config router isis
   set default-information-metric 60
      config interface
         edit "vlan100"
            set circuit-type level-1
            set priority-l1 80
            set wide-metric-l1 200
         next
         edit "vlan102"
            set circuit-type level-2
         next
      end
      config net
         edit 1
            set net 49.0002.0000.0000.1048.00
      next
   end
   set metric-style wide
      config redistribute "connected"
            set status enable
         end
         config redistribute "rip"
         end
         config redistribute "ospf"
         end
         config redistribute "bgp"
         end
         config redistribute "static"
      end
   end
```

The following is an example of an IS-IS configuration for IPv6 traffic:

```
config router isis
   config interface
      edit "vlan10"
      next
   end
   config net
      edit 1
         set net 49.0000.0010.0100.1001.00
      next
   end
```

```
   config redistribute "connected"
   end
   config redistribute "rip"
   end
   config redistribute "ospf"
   end
   config redistribute "bgp"
   end
   config redistribute "static"
   end
   config redistribute6 "connected"
   end
   config redistribute6 "static"
   end
   config redistribute6 "ospf6"
   end
   config redistribute6 "ripng"
   end
end
```

Configuring BFD for IS-IS

You can use bidirectional forwarding detection (BFD) for the IS-IS routing protocol using IPv4 or IPv6 addresses:

```
config router isis
   config interface
      edit <IS-IS interface name>
         set bfd {enable| disable}
         set bfd6 {enable| disable}
      next
   end
end
```

For example, if you want to enable IPv4 BFD on vlan100:

```
config router isis
   config interface
      edit "vlan100"
         set bfd enable
      next
   end
end
```

Checking the IS-IS configuration

Use the following commands to check your IS-IS configuration:

```
get router info isis interface
get router info isis route
get router info isis summary
get router info isis topology
get router info6 isis interface
get router info6 isis route
```

```
get router info6 isis summary
get router info6 isis topology
```

Users and user groups

The FortiSwitch unit provides authentication mechanisms to control user access to the system (based on the user group associated with the user). The members of user groups are user accounts. Local users and peer users are defined on the FortiSwitch unit. User accounts can also be defined on remote authentication servers.

This section describes how to configure local users and peer users and how to configure user groups. For information about configuring the authentication servers, see Remote authentication servers on page 40.

This chapter covers the following topics:

Users

A user account consists of a user name, password, and potentially other information, configured in a local user database or on an external authentication server.

Users can access resources that require authentication only if they are members of an allowed user group.

Using the GUI:

1. Go to *System* > *User* > *Definition*.
2. Select *Add User*.
3. Enter the user name.
4. Select *Enable* to make the user account active.
5. Enter the password for the user account. Passwords can be up to 64 characters in length.
6. Select *Add*.

Using the CLI:

```
config user local
   edit <user_name>
      set ldap-server <server_name>
      set passwd <password_string>
      set radius-server <server_name>
      set tacacs+-server <server_name>
      set status {enable | disable}
      set type <auth-type>
   end
```

Field	Description
user_name	Identifies the user
password_string	A password for the local user. Passwords can be up to 64 characters in length.
ldap-server <server_name>	To authenticate this user using a password stored on a remote authentication server, select the type of server and then select the server from the list. You can select only a server that has already been added to the FortiSwitch configuration.
radius-server <server_name>	To authenticate this user using a password stored on a remote authentication server, select the type of server and then select the server from the list. You can select only a server that has already been added to the FortiSwitch configuration.
tacacs+-server <server_name>	To authenticate this user using a password stored on a remote authentication server, select the type of server and then select the server from the list. You can select only a server that has already been added to the FortiSwitch configuration.
status	Enable or disable this user.

User groups

A user group contains a list of local and remote users.

Security policies allow access to specified user groups only. This restricted access enforces Role Based Access Control (RBAC) to your organization's network and its resources. Users must be in a group and that group must be part of the security policy.

Using the GUI:

1. Go to *System* > *User* > *Group*.
2. Select *Add Group*.
3. Enter the group name.
4. Select which available users will be members of the new user group.
5. *Enable* to make the user account active.
6. If you want to use an authentication server, select *Add Server*.
   - Select the server name. If no server name is available, go to *System* > *Authentication* to add an authentication server.
   - Enter a group name or select *Any*.
7. Select *Add Group*.

Using the CLI:

```
config user group
   edit <groupname>
      set authtimeout <timeout>
```

```
    set group-type <grp_type>
    set http-digest-realm <attribute>
    set member <names>
    config match
       edit <match_id>
          set group-name <gname_str>
          set server-name <srvname_str>
    end
end
```

The following table describes the parameters:

Field	Description
groupname	Identifies the user group.
authtimeout <timeout>	Sets the authentication timeout for the user group. The range is 1 to 480 minutes. If this field is set to 0, the global authentication timeout value is used.
group-type <grp_type>	Enter the group type. <grp_type> determines the type of users and is one of the following: • `firewall`—FortiSwitch users defined in user local, user ldap, or user radius • `fsso-service`—Directory Service users
http-digest-realm <attribute>	Enter the realm attribute for MD5-digest authentication.
member <names>	Enter the names of users, peers, LDAP servers, or RADIUS servers to add to the user group. Separate the names with spaces. To add or remove names from the group, you must re-enter the whole list with the additions or deletions required.
config match fields	
<match_id>	Enter an ID for the entry.
group-name <gname_str>	Identifies the matching group on the remote authentication server.
server-name <srvname_str>	Specifies the remote authentication server.

MACsec

Media Access Control security (MACsec) secures each switch-to-switch link by encrypting all network traffic within an Ethernet LAN.

MACsec uses the static connectivity association key (CAK) mode. You specify the connectivity association key (CAK) and the connectivity association name (CKN) for the pre-shared key in the MACsec profile and then apply the profile to a switch port.

Notes:

- SNMP is not supported.
- The `port-security-mode` must be set to `macsec` for each interface that you want to apply MACsec to.
- The MACsec profile must be applied at the port level.
- For this release, FortiSwitchOS supports static CAK mode. Dynamic CAK mode and static secure association key (SAK) mode are not supported.

To use MACsec:

1. Create a MACsec profile.
2. Apply the MACsec profile to a port.
3. View the MACsec details.
4. Optional. Clear or reset the MACsec statistics.

Creating the MACsec profile

To create a MACsec profile:

```
config switch macsec profile
   edit <MACsec_profile_name>
      set cipher_suite GCM_AES_128
      set confident-offset {0 | 30 | 50}
      set encrypt-traffic {enable | disable}
      set include-macsec-sci {enable | disable}
      set include-mka-icv-ind enable
      set macsec-mode static-cak
      set macsec-validate strict
      set mka-priority <0-255>
      set replay-protect {enable | disable}
      set replay-window <0-16777215>
      set status {enable | disable}
      config mka-psk
         edit <pre-shared key name>
            set crypto-algAES_128_CMAC
            set mka-cak <string>
            set mka-ckn <string>
            set status active
```

```
        next
      end
      config traffic-policy
         edit <traffic_policy_name>
            set security-policy must-secure
            set status enable
         next
      end
   next
end
```

Variable	Description	Default
<profile_name>	Enter a name for the MACsec profile.	No default
cipher_suite GCM_AES_128	Only the GCM-AES-128 cipher suite is available currently for encryption.	GCM_AES_128
confident-offset {0 | 30 | 50}	Select the number of bytes for the MACsec traffic confidentiality offset. Selecting 0 means that all of the MACsec traffic is encrypted. Selecting 30 or 50 bytes means that the first 30 or 50 bytes of MACsec traffic are not encrypted.	0
encrypt-traffic {enable | disable}	Enable or disable whether MACsec traffic is encrypted.	enable
include-macsec-sci {enable | disable}	Enable or disable whether to include the MACsec transmit secure channel identifier (SCI).	enable
include-mka-icv-ind enable	The MACsec Key Agreement (MKA) integrity check value (ICV) indicator is always included.	enable
macsec-mode static-cak	The MACsec mode is always static connectivity association key (CAK).	static-cak
macsec-validate strict	The MACsec validation is always strict.	strict
mka-priority <0-255>	Enter the MACsec MKA priority.	255
replay-protect {enable | disable}	Enable or disable MACsec replay protection. MACsec replay protection drops packets that arrive out of sequence, depending on the `replay-window` value.	disable
replay-window <0-16777215>	Enter the number of packets for the MACsec replay window size. If two packets arrive with the difference between their packet identifiers more then the replay window size, the most recent packet of the two is dropped. The range is 0-16777215 packets. Enter 0 to ensure that all packets arrive in order without any repeats.	32
status {enable | disable}	Enable or disable this MACsec profile.	enable
config mka-psk	Configure the MACsec MKA pre-shared key.	
<pre-shared key name>	Enter a name for this MACsec MKA pre-shared key configuration.	No default
crypto-alg AES_128_CMAC	Only the AES_128_CMAC algorithm is available for encrypting the pre-shared key.	AES_128_CMAC

Variable	Description	Default
mka-cak <string>	Enter the string of hexadecimal digits for the connectivity association key (CAK). The string can be up to 32-bytes long.	No default
mka-ckn <string>	Enter the string of hexadecimal digits for the connectivity association name (CKN). The string can be 1-byte to 64-bytes long.	No default
status active	The status of the pre-shared key pair is always active.	active
config traffic-policy	Configure the MACsec traffic policy.	
<traffic_policy_name>	Enter a name for this MACsec traffic policy.	No default
security-policy must-secure	The policy must secure traffic for MACsec.	must-secure
status enable	The status of this MACsec traffic policy is always enabled.	enable

For example:

```
config switch macsec profile
   edit "2"
      set cipher_suite GCM_AES_128
      set confident-offset 0
      set encrypt-traffic enable
      set include-macsec-sci enable
      set include-mka-icv-ind enable
      set macsec-mode static-cak
      set macsec-validate strict
      set mka-priority 199
      config mka-psk
         edit "2"
            set crypto-alg AES_128_CMAC
            set mka-cak "0123456789ABCDEF0123456789ABCDEE"
            set mka-ckn "6162636465666768696A6B6C6D6E6F707172737475767778797A303132333436"
            set status active
         next
      end
      set replay-protect disable
      set replay-window 32
      set status enable
      config traffic-policy
         edit "2"
            set security-policy must-secure
            set status enable
         next
      end
   next
end
```

Applying the MACsec profile to a port

To apply the MACsec profile to a port:

```
config switch interface
   edit <port_name>
      config port-security
         set port-security-mode macsec
         set macsec-profile <MACsec_profile_name>
      end
   next
end
```

For example:

```
config switch interface
   edit port49
      set native-vlan 50
      set stp-state disabled
      set auto-discovery-fortilink enable
      set snmp-index 49
      config port-security
         set port-security-mode macsec
         set macsec-profile "macsec_profile1"
      end
   next
end
```

Viewing the MACsec details

You can view the MACsec status and the MACsec traffic statistics for a specific port:

- `diagnose switch macsec status <port_name>`
- `diagnose switch macsec statistics <port_name>`

You can view the creation and deletion of secure associations:

```
diagnose debug kernel level 8
```

Clearing or resetting the MACsec statistics

You can clear all MACsec statistics on a single interface:

```
execute macsec clearstat interface <interface_name>
```

You can reset the MACsec session on a single interface:

```
execute macsec reset interface <interface_name>
```

For example:

```
execute macsec clearstat interface port15
execute macsec reset interface port15
```

802.1x authentication

To control network access, the FortiSwitch unit supports IEEE 802.1x authentication. A supplicant connected to a port on the switch must be authenticated by a RADIUS server to gain access to the network. The supplicant and the authentication server communicate using the switch using EAP. The FortiSwitch unit supports EAP-PEAP, EAP-TTLS, EAP-TLS, and EAP-MD5.

To use the RADIUS server for authentication, you must configure the server before configuring the users or user groups on the FortiSwitch unit.

The FortiSwitch unit implements MAC-based authentication. The switch saves the MAC address of each supplicant's device. The switch provides network access only to devices that have successfully been authenticated.

The FortiSwitch unit supports up to 20 devices per port for 802.1x MAC-based authentication. System-wide, the FortiSwitch unit now supports a total of 10 times the number of interfaces for 802.1x MAC-based authentication:

Model	Total number of devices supported per switch
108	80
112	120
124/224/424/524/1024	240
148/248/448/548/1048	480
3032	320

You can enable the MAC Authentication Bypass (MAB) option for devices (such as network printers) that cannot respond to the 802.1x authentication request. With MAB enabled on the port, the system will use the device MAC address as the user name and password for authentication.

Optionally, you can configure a guest VLAN for unauthorized users, a VLAN for users whose authentication was unsuccessful, and a VLAN for users when the authentication server is unavailable.

When the authentication server is unavailable after the server timeout period expires:

- You can control how many seconds the authentication server tries to authenticate users for before assigning them to the specified VLAN:

```
config switch interface
   edit <interface_name>
      config port-security
         set port-security-mode {802.1X | 802.1X-mac-based}
         set authserver-timeout-period <3-15 seconds>
         set authserver-timeout-vlan {enable | disable}
         set authserver-timeout-vlanid <1-4094>
      end
      set security-groups <security-group-name>
   next
end
```

- You can control how often the server checks if the RADIUS server is available:

```
config user radius
   edit <RADIUS_user_name>
      set link-monitor {enable | disable}
      set link-monitor-interval <5-120 seconds>
   next
end
```

When you are testing your system configuration for 802.1x authentication, you can use the monitor mode to allow network traffic to flow, even if there are configuration problems or authentication failures.

This chapter covers the following topics:

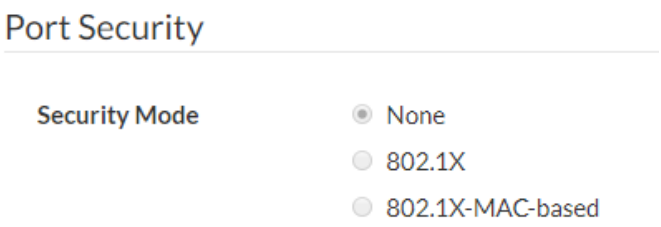
Dynamic VLAN assignment

You can configure the RADIUS server to return a VLAN in the authentication reply message:

1. On the FortiSwitch unit, select port-based authentication or MAC-based authentication and a security group.
2. On the RADIUS server, configure the attributes.

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select a port and then select *Edit*.
3. Select *802.1X* for port-based authentication or select *802.1X-MAC-based* for MAC-based authentication.



4. Select one or more security groups.
5. Select *OK*.

Using the CLI:

To select port-based authentication and the security group on the FortiSwitch unit:

```
config switch interface
   edit <interface_name>
      config port-security
         set port-security-mode 802.1X
      end
      set security-groups <security-group-name>
   end
```

The FortiSwitch unit will change the native VLAN of the port to that of the VLAN from the server.

To select MAC-based authentication and the security group on the FortiSwitch unit:

```
config switch interface
   edit <interface_name>
      config port-security
         set port-security-mode 802.1X-mac-based
      end
      set security-groups <security-group-name>
   end
```

Here, the switch assigns the returned VLAN only to this user's MAC address. The native VLAN of the port remains unchanged.

Use the following configuration command to view the MAC-based VLAN assignments:

```
diagnose switch vlan assignment mac list [sorted-by-mac | sorted-by-vlan]
```

Configure the following attributes in the RADIUS server:

- Tunnel-Private-Group-Id—VLAN ID or name (10)
- Tunnel-Medium-Type—IEEE-802 (6)
- Tunnel-Type—VLAN (13)

NOTE: If the Tunnel-Private-Group-Id attribute is set to the VLAN name, the same string must be specified in the `set description` command under the `config switch vlan` command. For example:

```
config switch vlan
   edit 100
      set description "local_vlan"
   next
end
```

MAC authentication bypass (MAB)

Devices such as network printers, cameras, and sensors might not support 802.1x authentication. If you enable the MAB option on the port, the system will use the device MAC address as the user name and password for authentication.

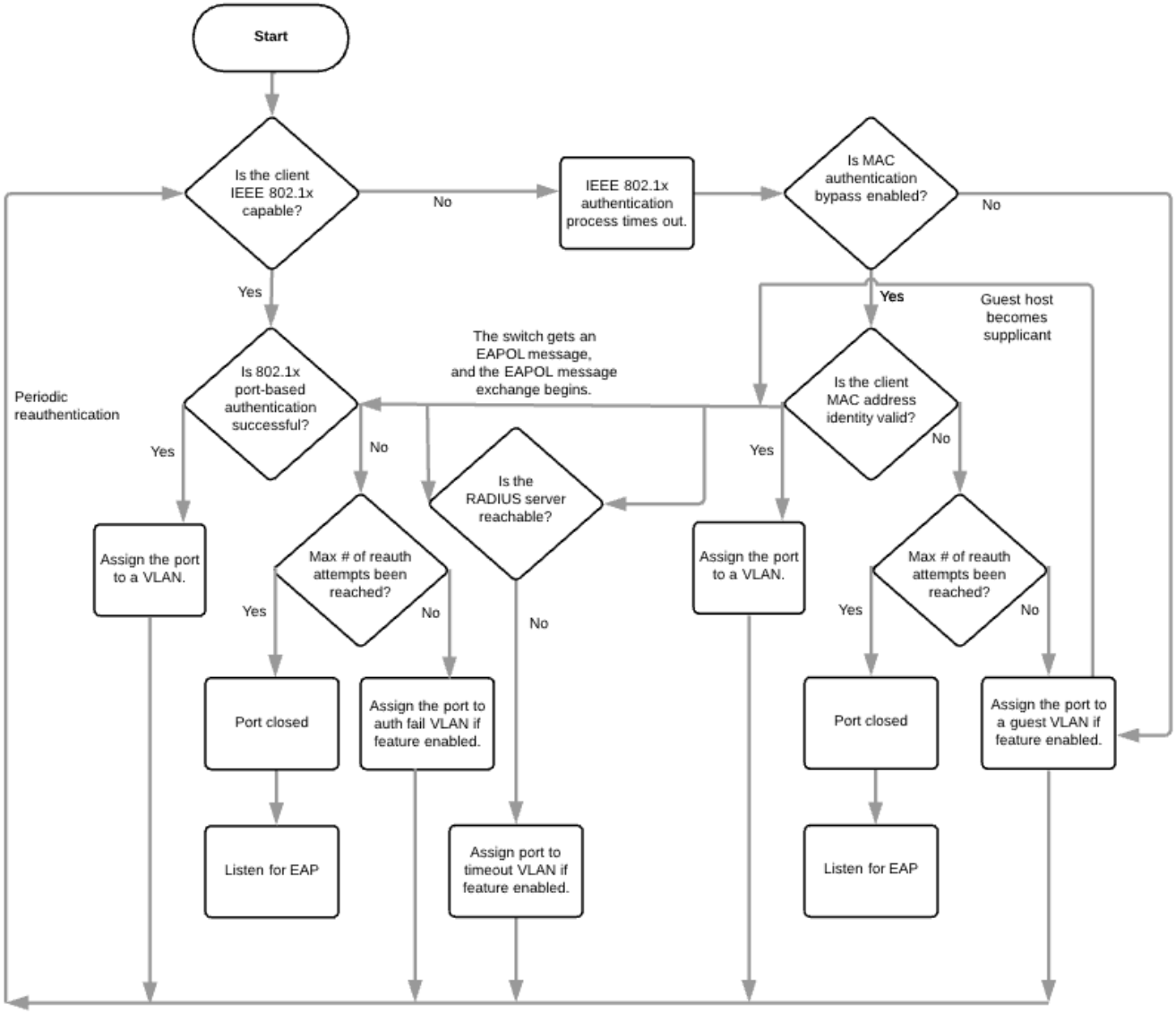
MAB retries authentication three times before the device is assigned to a guest VLAN for unauthorized users. By default, reauthentication is disabled. Use the following commands if you want to change the default behavior:

```
config switch global
```

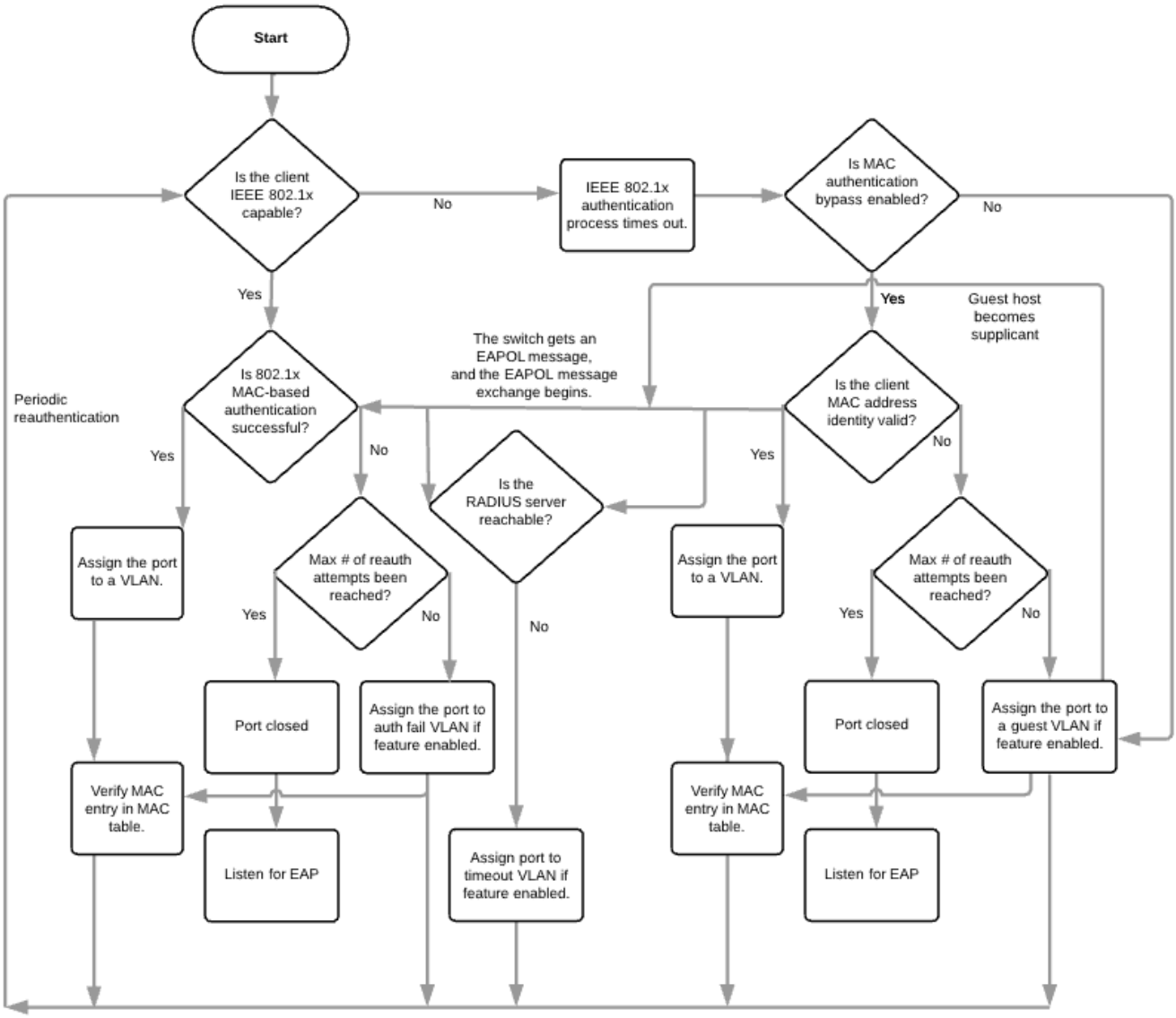
```
config port-security
   set mab-reauth enable
end
```

You must provision the RADIUS server to authenticate the devices that use MAB, either by adding the MAC addresses as regular users or by implementing additional logic to resolve the MAC addresses in a network inventory database.

The following flowchart shows the FortiSwitch 802.1x port-based authentication with MAB enabled:



The following flowchart shows the FortiSwitch 802.1x MAC-based authentication with MAB enabled:



Configuring global settings

To select which 802.1x certificate and certificate authority that the FortiSwitch unit uses, see SSL configuration on page 60.

If a link goes down, you can select whether the impacted devices must reauthenticate. If reauthentication is unnecessary, select *Do Not Require Re-Authentication*. To revert all devices to the unauthenticated state and force each device to reauthenticate, select *Require Re-Authentication*.

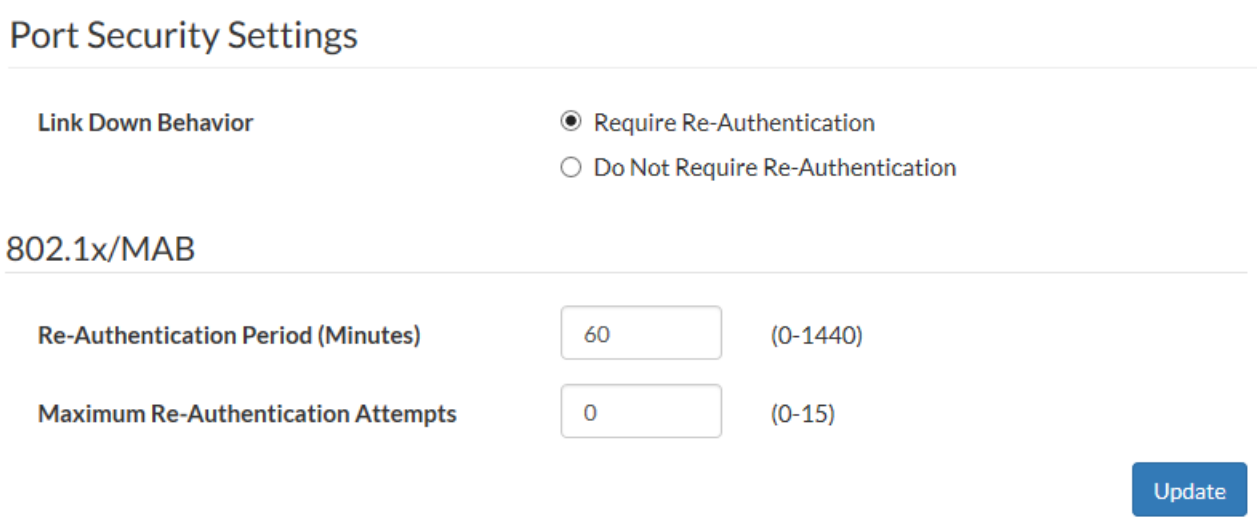
MAB retries authentication before assigning a device to a guest VLAN for unauthorized users. MAB is disabled by default in the CLI.

The Re-Authentication Period (Minutes) field defines how often the device needs to reauthenticate (that is, if a session remains active beyond this number of minutes, the system requires the device to reauthenticate). Set the value to 0 to disable reauthentication.

If 802.1x authentication fails, the Maximum Re-Authentication Attempts field caps the number of attempts that the system will initiate. Set the value to 0 to disable the reauthentication attempts.

Using the GUI:

1. Go to *Switch* > *Interface* > *Port Security*.



2. Select *Require Reauthentication* to revert all devices to the unauthenticated state if the link goes down or select *Do Not Require Reauthentication* if reauthentication is unnecessary if the link goes down.
3. In the Re-Authentication Period (Minutes) field, enter the number of minutes before the system requires the device to reauthenticate.
4. In the Maximum Re-Authentication Attempts field, enter the maximum number of times that the system tries to reauthorize the session.
5. Select *Update*.

Using the CLI:

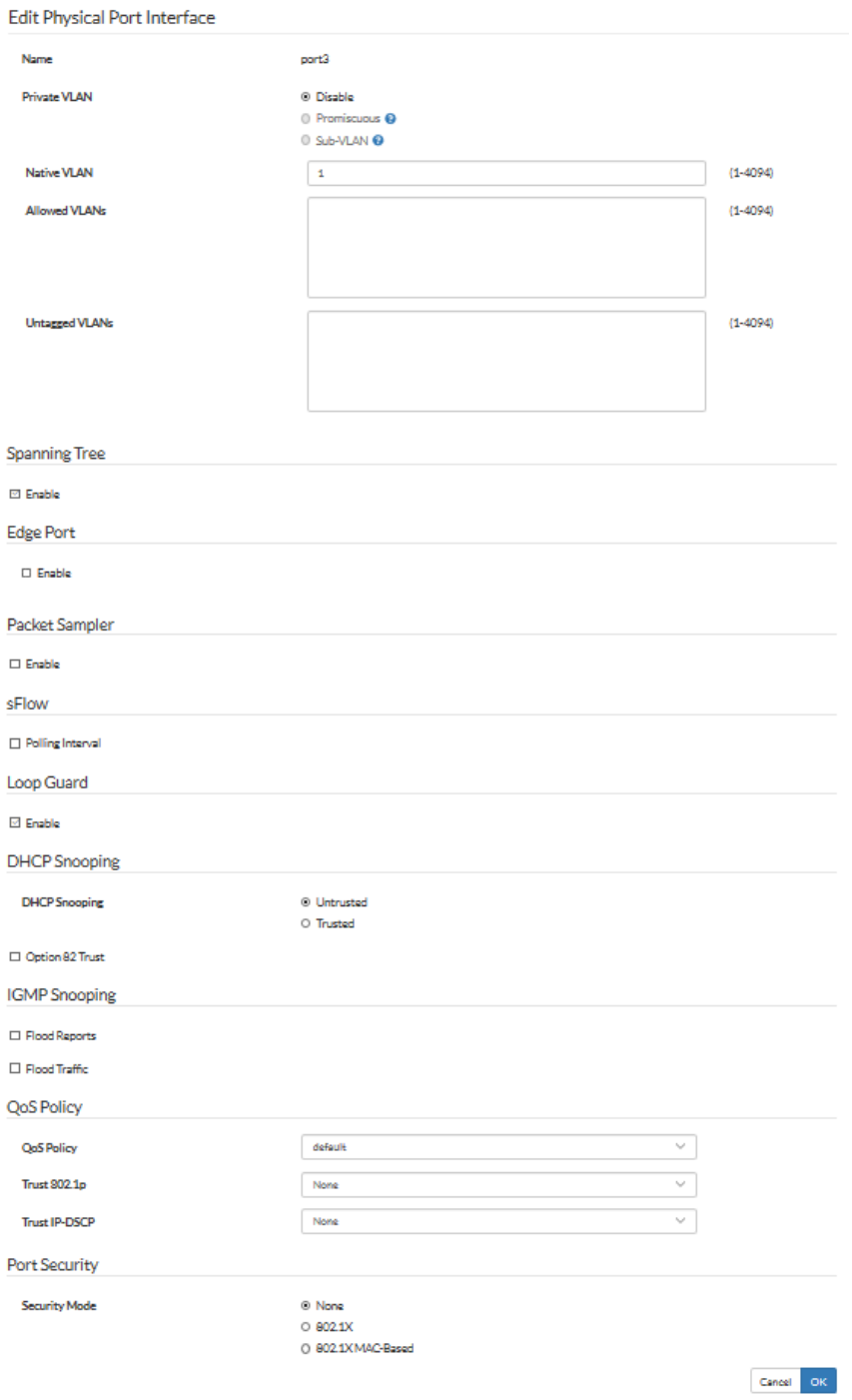
```
config switch global
   config port-security
      set link-down-auth {no-action | set-unauth}
      set mab-reauth {enable | disable}
      set max-reauth-attempt <0-15>
      set reauth-period <0-1440>
   end
```

NOTE: Changes to global settings only take effect when new 802.1x/MAB sessions are created.

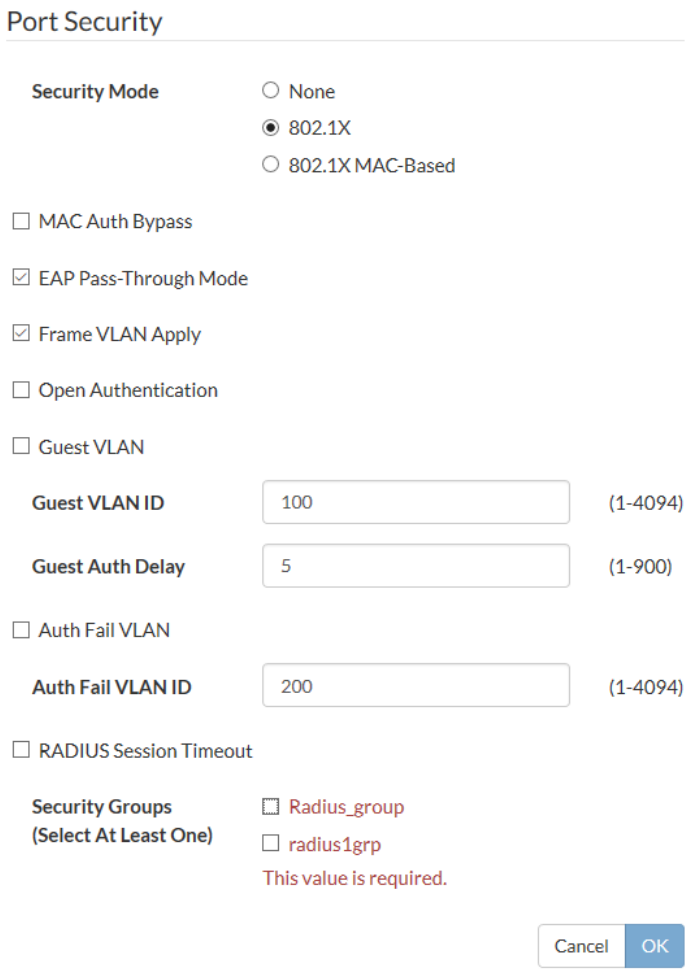
Configuring the 802.1x settings on an interface

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select a port and then select *Edit*.



3. Select *802.1X* for port-based authentication or select *802.1X-MAC-based* for MAC-based authentication. The Port Security section displays additional options.



4. Select *MAC Auth Bypass*.
5. Select *EAP Pass-Through Mode*.
   NOTE: *EAP Pass-Through Mode* is enabled by default, which is the recommended setting. If the RADIUS authentication server does not support EAP-TLS, the *EAP Pass-Through Mode* needs to be disabled.
6. Select *Frame VLAN Apply* to apply the EAP/MAB frame VLAN to the port native VLAN.
   NOTE: For phone and PC configuration only, clear the checkbox to preserve the native VLAN when the data traffic is expected to be untagged.
7. Select *Open Authentication* to enable open authentication (monitor mode) on this interface. Use the monitor mode to test your system configuration for 802.1x authentication. You can use monitor mode to test port-based authentication, MAC-based authentication, EAP pass-through mode, and MAC authentication bypass. After you enable monitor mode, the network traffic will continue to flow, even if the users fail authentication.
8. Select *Guest VLAN* if you want to assign a VLAN to unauthorized users. If you select *Guest VLAN*, enter the guest VLAN identifier in the *Guest VLAN ID* field and enter the number of seconds for an unauthorized user to have access as a guest before authorization fails in the *Guest Auth Delay* field.
9. Select *Auth Fail VLAN* if you want to assign a VLAN to users who attempted to authenticate but failed to provide valid credentials. If you select *Auth Fail VLAN*, enter the VLAN identifier in the *Auth Fail VLAN ID* field.
10. If you want to use the RADIUS-provided reauthentication time, select *RADUS Session Timeout*.
11. If you are using port-based authentication or MAC-based authentication, select one or more security groups.

12. Select *OK*.

Using the CLI:

```
config switch interface
   edit <port>
      config port-security
         set port-security-mode {none | 802.1X | 802.1X-mac-based}
            set framevid-apply {disable | enable}
            set auth-fail-vlan {enable | disable}
            set auth-fail-vlanid <vlanid>
            set authserver-timeout-period <3-15>
            set authserver-timeout-vlan {enable | disable}
            set authserver-timeout-vlanid <1-4094>
            set eap-passthru {enable | disable}
            set guest-auth-delay <integer>
            set guest-vlan {enable | disable}
            set guest-vlanid <vlanid>
            set mac-auth-bypass {enable | disable}
            set open-auth {enable | disable}
            set radius-timeout-overwrite {enable | disable}
      end
      set security-groups <security-group-name>
   end
```

Viewing the 802.1x details

Using the GUI:

Go to *Switch >Monitor > 802.1x Status*.

Using the CLI:

Use the following command to show diagnostics on one or all ports:

```
diagnose switch 802-1x status [<port>]
```

```
port3 : Mode: port-based (MAC by-pass disable)
       Link: Link up
       Port State: authorized
       Dynamic Authorized Vlan: 10
       Native vlan: 10
       Allowed vlan list: 1-10
       Untagged vlan list:
       Guest vlan:
       AuthFail vlan:

       Sessions info:
       STA=00:24:9b:1b:20:65 Type=802.1X EAP PEAP state=AUTHENTICATED

port7 : Mode: mac-based (mac-by-pass disable)
       Link: Link up
```

```
        Port State: authorized ( )
        EAP pass-through mode : Enable
        Native Vlan : 1
        Allowed Vlan list: 1
        Untagged Vlan list: 1
        Guest VLAN :

        Client MAC Type Vlan Dynamic-Vlan
        0a:0a:0b:0b:0a:0a 802.1x 1 0
        0a:0a:0b:0b:0a:09 802.1x 1 0
        0a:0a:0b:0b:0a:08 802.1x 1 0
        0a:0a:0b:0b:0a:07 802.1x 1 0
        0a:0a:0b:0b:0a:06 802.1x 1 0
        0a:0a:0b:0b:0a:05 802.1x 1 0
        0a:0a:0b:0b:0a:04 802.1x 1 0
        0a:0a:0b:0b:0a:03 802.1x 1 0
        0a:0a:0b:0b:0a:02 802.1x 1 0
        0a:0a:0b:0b:0a:01 802.1x 1 0

        Sessions info:
        0a:0a:0b:0b:0a:0a Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:09 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:08 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:07 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=2896
        0a:0a:0b:0b:0a:06 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:05 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:04 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:03 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:02 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3 params:reAuth=3600
        0a:0a:0b:0b:0a:01 Type=802.1x,MD5,state=AUTHENTICATED,etime=2,eap_cnt=3
params:reAuth=3600h=120
```

Clearing port authorizations

Using the GUI:

1. Go to *Switch* > *Interface* > *Physical*.
2. Select one or more ports that you want to clear the authorization from.
3. Select *Clear Auth*.

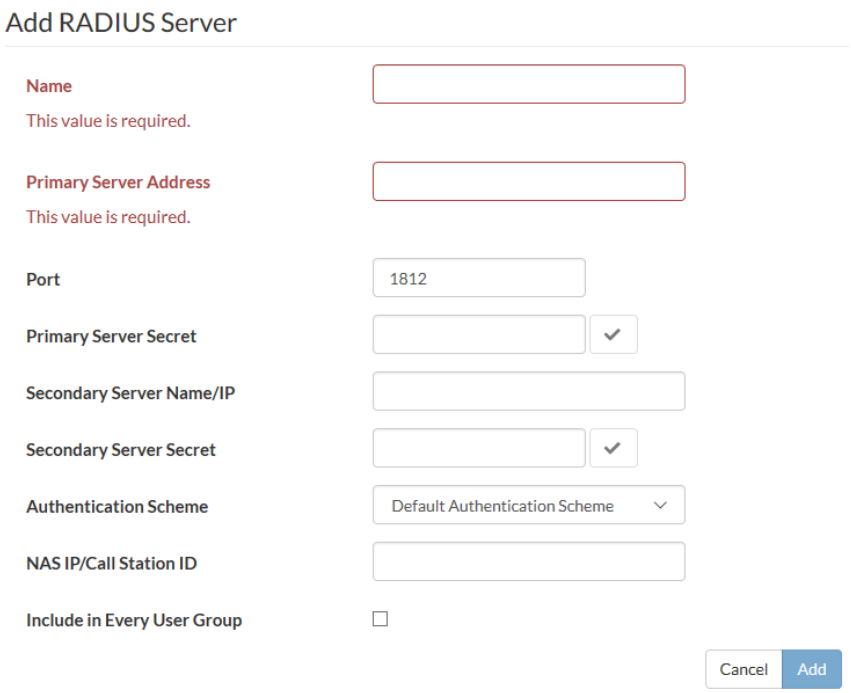
Using the CLI:

```
execute 802-1x clear interface <port>
```

Authenticating users with a RADIUS server

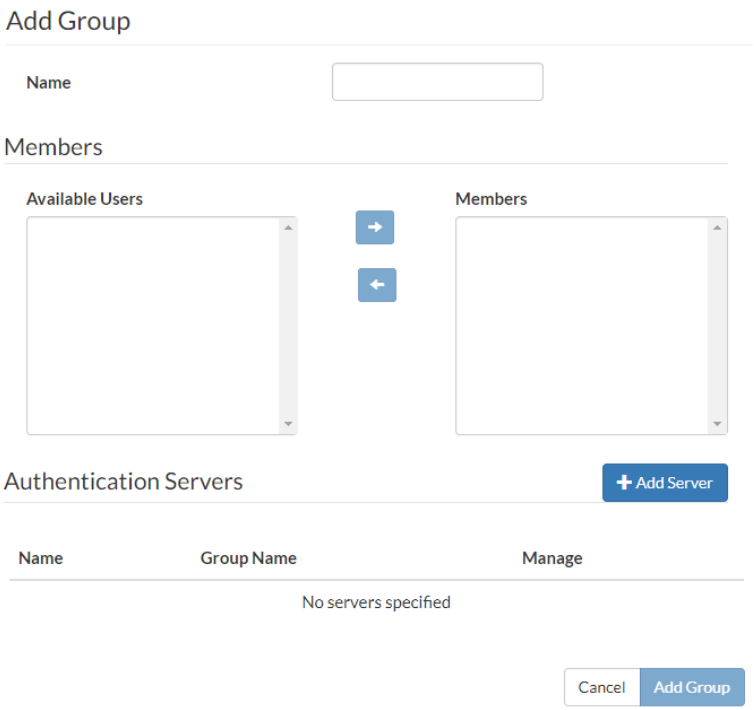
Using the GUI:

1. Define the RADIUS server:
   a. Go to *System* > *Authentication* > *RADIUS*.
   b. Select *Add Server*.



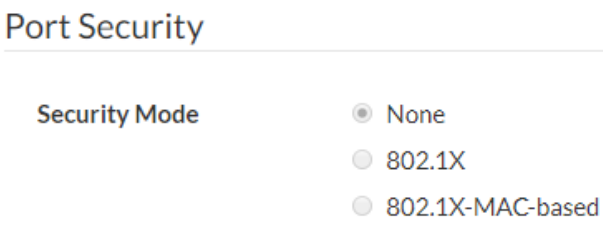
   c. In the *Name* field, enter a name for the RADIUS server.
   d. In the *Primary Server Address* field, enter the IP address for the RADIUS server.
   e. In the *Primary Server Secret* field, enter a password to use as a RADIUS key.
   f. Select *Add*.
2. Create a user group:
   a. Go to *System* > *User* > *Group*.

b. Select *Add Group*.

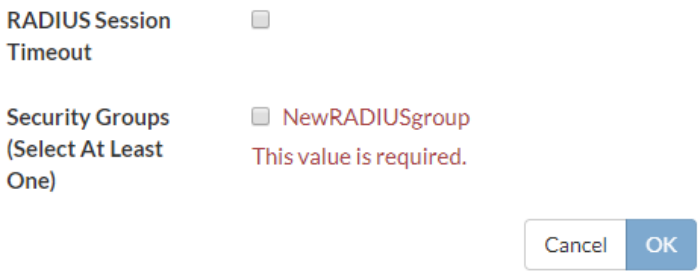


c. In the *Name* field, enter a name for the user group.
d. Select *Add Server*.
e. Select the name of the RADIUS server that you configured in step 1.
f. Select *Add Group*.

3. Configure the port security:
a. Go to *Switch* > *Interface* > *Physical*.
b. Select a port and then select *Edit*.
c. Select *802.1X* for port-based authentication or select *802.1X-MAC-based* for MAC-based authentication.



d. Select the user group that you configured in step 2.



e. Select *OK*.

Using the CLI:

1. Define an IPv4 or IPv6 RADIUS server:

```
config user radius
   edit <name>
      set addr-mode ipv4
      set server <IPv4_address>
      set source-ip <ipv4_address>
      set radius-port <radius_port_num>
      set secret <server_password>
      set auth-type {auto | chap | ms_chap | ms_chap_v2 | pap}
      set nas-ip <IPv4_address>
      set all-usergroup {enable | disable}
      set link-monitor {enable | disable}
      set link-monitor-interval <5-120 seconds>
   end
end

config user radius
   edit <name>
      set addr-mode ipv6
      set server <IPv6_address>
      set source-ip6 <ipv6_address>
      set radius-port <radius_port_num>
      set secret <server_password>
      set auth-type {auto | chap | ms_chap | ms_chap_v2 | pap}
      set nas-ip6 <IPv6_address>
      set all-usergroup {enable | disable}
      set link-monitor {enable | disable}
      set link-monitor-interval <5-120 seconds>
   end
end
```

2. Create a user group:

```
config user group
   edit <name>
      set member <list>
      config match
         edit 1
```

```
            set group-name <name>
            set server-name <name>
         end
      end
   end
end
```

3. Configure the switch interface for port-based or MAC-based 802.1x authentication:

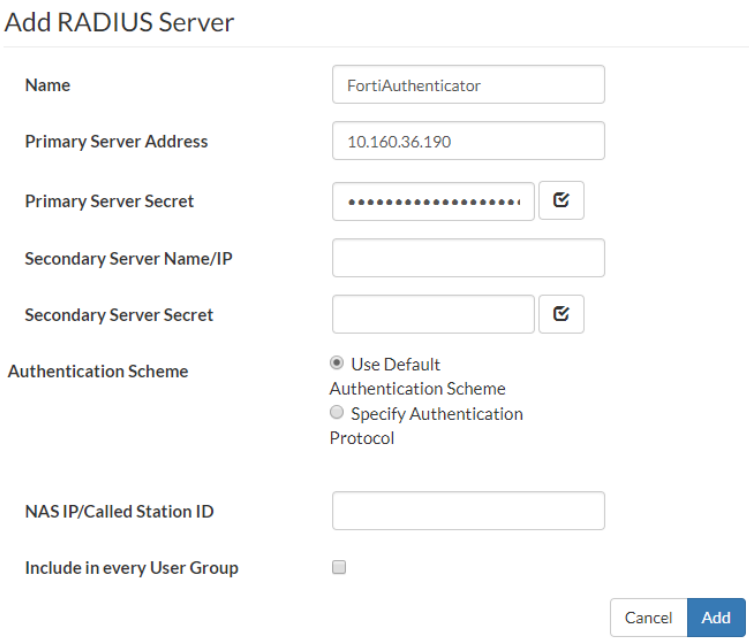
```
config switch interface
   edit <interface>
      config port-security
         set port-security-mode 802.1X
      end
      set security-groups <security-group-name>
   end
end

config switch interface
   edit <interface>
      config port-security
         set port-security-mode 802.1X-mac-based
      end
      set security-groups <security-group-name>
   end
end
```

Example: RADIUS user group

Using the GUI:

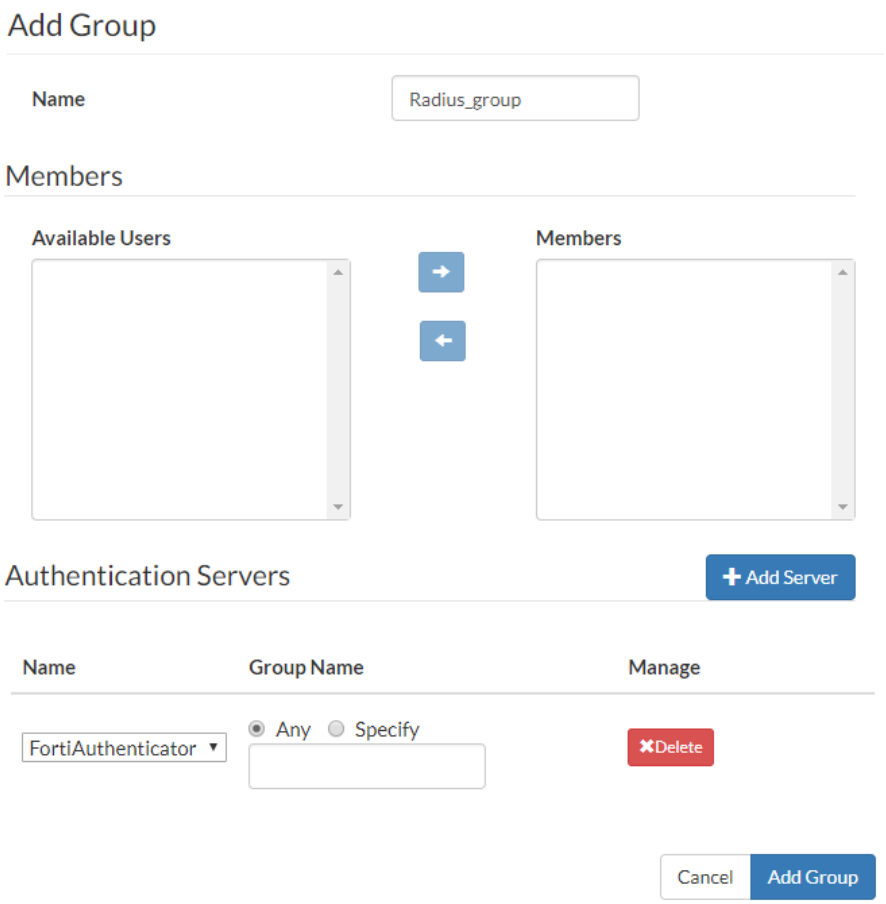
1. Define the RADIUS server:
   a. Go to *System* > *Authentication* > *RADIUS*.
   b. Select *Add Server*.
   c. In the *Name* field, enter `FortiAuthenticator`.
   d. In the *Primary Server Address* field, enter `10.160.36.190`.
   e. In the *Primary Server Secret* field, enter `6rF7O4/Zf3p2TutNyeSjPbQc73QrS21wNDmNXd/rg9k6nTR6yMhBRsJGpArhle6UOCb7b8InM3nrCeuVETr/a02LpILmIltBq5sUMCNqbR6zp2fS3r35Eyd3IIrzmve4Vusi52c1MrCqVhzzy2EfxkBrx5FhcRQWxStvnVt4+dzLYbHZ`.



   f. Select *Add*.

2. Create a user group:
   a. Go to *System* > *User* > *Group*.
   b. Select *Add Group*.
   c. In the *Name* field, enter `Radius_group`.
   d. Select *Add Server*.

e. Select *FortiAuthenticator* as the authentication server.

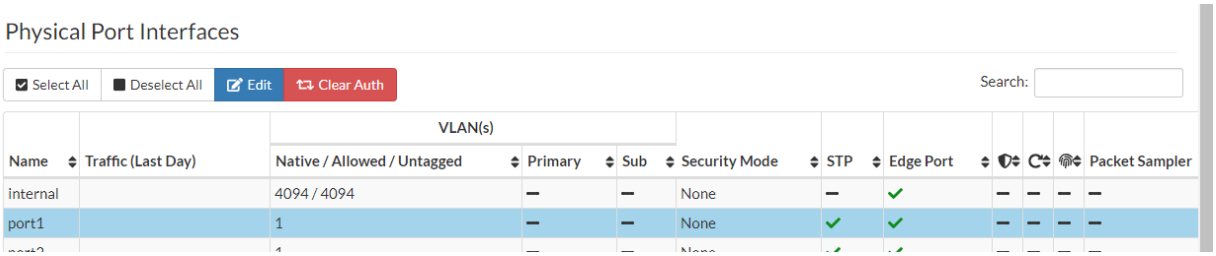


f. Select *Add Group*.

3. Configure the port security:

a. Go to *Switch* > *Interface* > *Physical*.

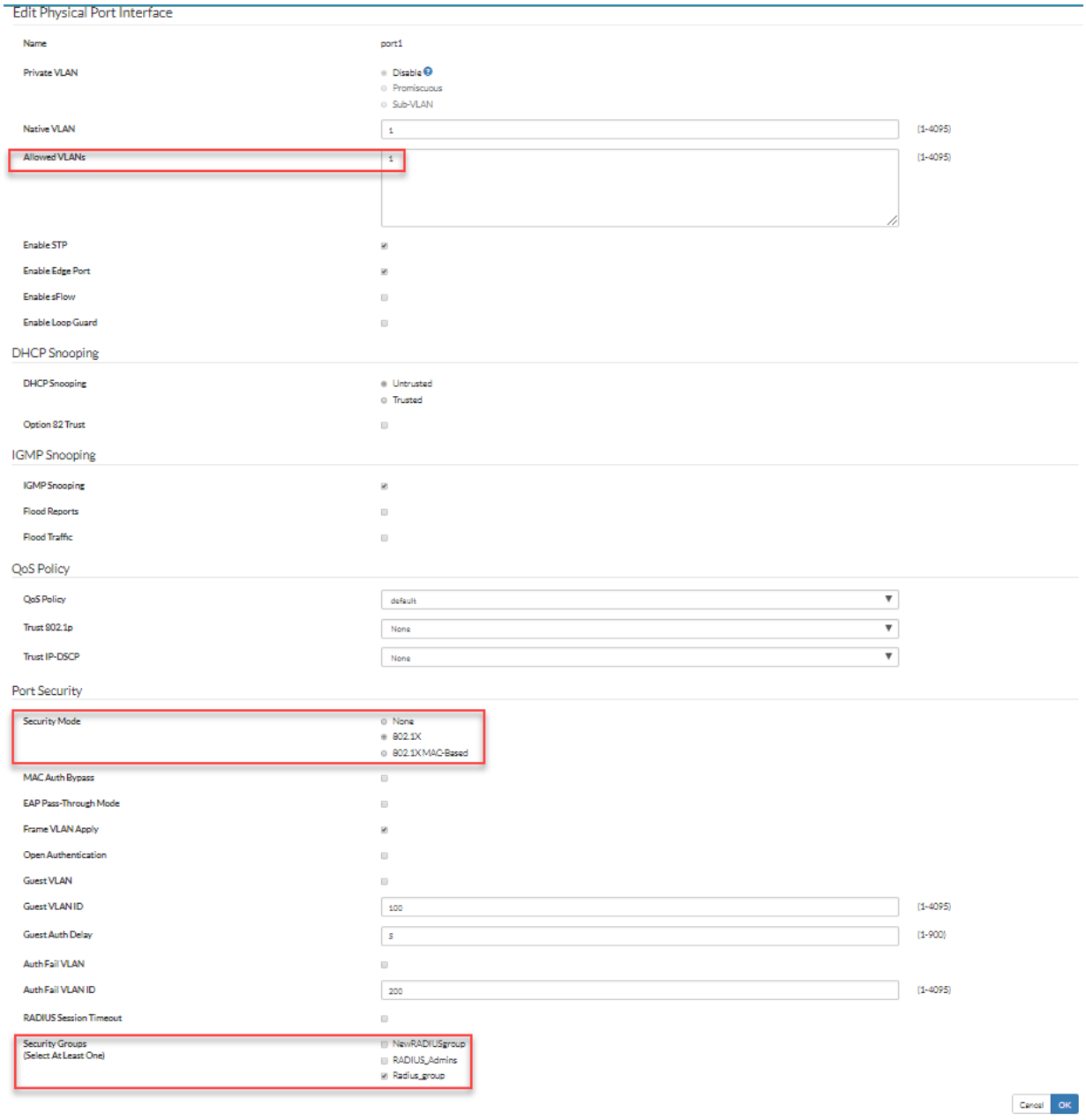
b. Select the *port1* row and then select *Edit*.



c. In the *Allowed VLANs* field, enter `1`.

d. Select *802.1X*.

e. Select *Radius_group*.



f. Select *OK*.

Using the CLI:

1. Define the RADIUS server:

```
config user radius
   edit "FortiAuthenticator"
      set secret ENC
           6rF7O4/Zf3p2TutNyeSjPbQc73QrS21wNDmNXd/rg9k6nTR6yMhBRsJGpArhle6UOCb7b8In
           M3nrCeuVETr/a02LpILmIltBq5sUMCNqbR6zp2fS3r35Eyd3IIrzmve4Vusi52c1MrCqVhzz
           y2EfxkBrx5FhcRQWxStvnVt4+dzLYbHZ
      set server "10.160.36.190"
      set addr-mode ipv4
   next
end
```

2. Create a user group:

```
config user group
   edit "Radius_group"
      set member "FortiAuthenticator"
   end
end
```

3. Configure the port security:

```
config switch interface
   edit "port1"
      set allowed-vlans 1
      config port-security
         set port-security-mode 802.1X
      end
      set security-groups "Radius_group"
   end
end
```

Example: dynamic VLAN

To assign VLAN dynamically for a port on which a user is authenticated, configure the RADIUS server attributes to return the VLAN ID when the user is authenticated. Assuming that the port security mode is set to 802.1X, the FortiSwitch unit will change the native VLAN of the port to the value returned by the server.

Ensure that the following attributes are configured on the RADIUS server:

- Tunnel-Private-Group-Id <integer or string> (the VLAN ID or VLAN name)
- Tunnel-Medium-Type IEEE-802 (6)
- Tunnel-Type VLAN (13)

NOTE: If the Tunnel-Private-Group-Id is set to the VLAN name, the same string must be specified in the `set description` command under the `config switch vlan` command.

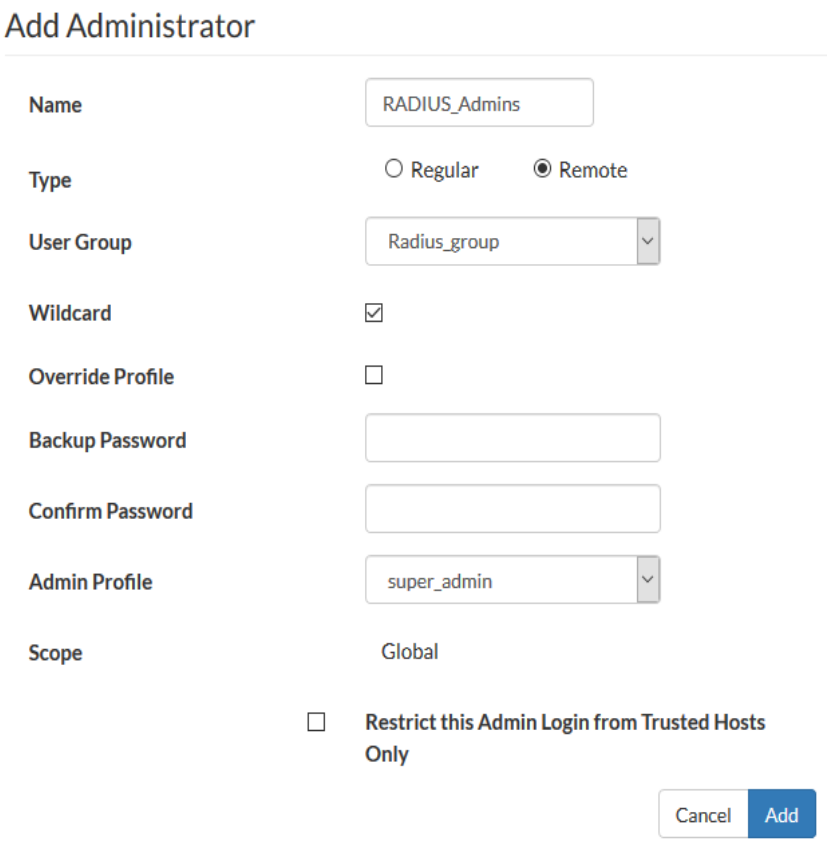
Authenticating an admin user with RADIUS

If you want to use a RADIUS server to authenticate administrators, you must configure the authentication before you create the administrator accounts. Do the following:

1. Configure the FortiSwitch unit to access the RADIUS server.
2. Configure an administrator to authenticate with a RADIUS server and match the user secret to the RADIUS server entry.
3. Create the RADIUS user group.

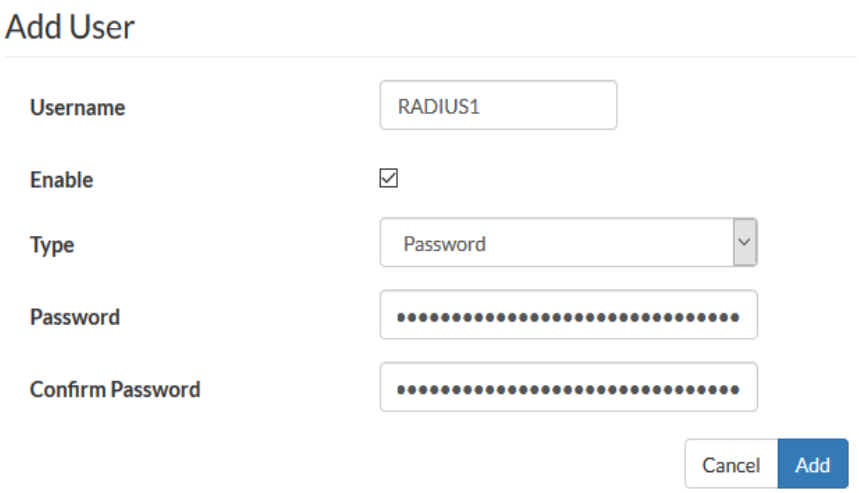
Using the GUI:

1. Create a RADIUS system admin group:
   a. Go to *System* > *Admin* > *Administrators*.
   b. Select *Add Administrator*.
   c. In the *Name* field, enter `RADIUS_Admins`.
   d. Select *Remote*.
   e. For the user group, select *Radius_group*.
   f. Select *Wildcard*.
   g. For the admin profile, select *super_admin*.



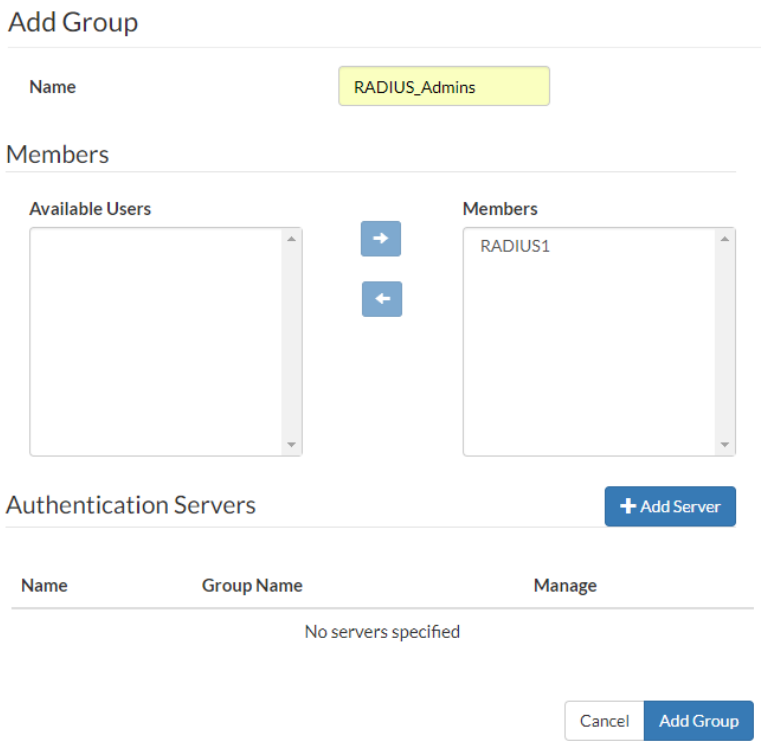
   h. Select *Add*.

2. Create a user:
   a. Go to *System* > *User* > *Definition*.
   b. Select *Add User*.
   c. In the *User Name* field, enter `RADIUS1`.
   d. Select *Password* from the *Type* field.
   e. In the *Password* field and *Confirm Password* field, enter `6rF7O4/Zf3p2TutNyeSjPbQc73QrS21wNDmNXd/rg9k6nTR6yMhBRsJGpArhle6UOCb7b8InM3nrCeuVETr/a02LpILmIltBq5sUMCNqbR6zp2fS3r35Eyd3IIrzmve4Vusi52c1MrCqVhzzy2EfxkBrx5FhcRQWxStvnVt4+dzLYbHZ`.



   f. Select *Add*.
3. Create a user group:
   a. Go to *System* > *User* > *Group*.
   b. Select *Add Group*.
   c. In the *Name* field, enter *RADIUS_Admins*.

d. Select *RADIUS1* in the Available Users box and select the right arrow to move it to the Members box.



e. Select *Add Group*.

Using the CLI:

1. Create a RADIUS system admin group:

```
config system admin
   edit "RADIUS_Admins"
      set remote-auth enable
      set accprofile "super_admin"
      set wildcard enable
      set remote-group "RADIUS_Admins"
   next
end
```

2. Create a user:

```
config user radius
   edit "RADIUS1"
      set secret ENC
           6rF7O4/Zf3p2TutNyeSjPbQc73QrS21wNDmNXd/rg9k6nTR6yMhBRsJGpArhle6UOCb7b8InM3n
           rCeuVETr/a02LpILmIltBq5sUMCNqbR6zp2fS3r35Eyd3IIrzmve4Vusi52c1MrCqVhzzy2Efxk
           Brx5FhcRQWxStvnVt4+dzLYbHZ
      set addr-mode ipv4
   next
end
```

3. Create a user group:

```
  config user group
   edit "RADIUS_Admins"
      set member "RADIUS1"
   next
end
```

RADIUS accounting and FortiGate RADIUS single sign-on

NOTE: To obtain a valid Framed-IP-Address attribute value, you need to manually configure DHCP snooping in the 802.1x-authenticated ports of your VLAN network for both port and MAC modes.

You can use your FortiSwitch unit for RADIUS single sign-on (RSSO) in two modes:

- Standalone mode
- FortiLink mode (FortiSwitch unit managed by FortiGate unit)

The FortiSwitch unit uses 802.1x-authenticated ports to send five types of RADIUS accounting messages to the RADIUS accounting server to support FortiGate RADIUS single sign-on:

- START—The FortiSwitch unit has been successfully authenticated, and the session has started.
- STOP—The FortiSwitch session has ended.
- INTERIM—Periodic messages sent based on the value set using the `set acct-interim-interval` command.
- ON—The FortiSwitch unit will send this message when the switch is turned on.
- OFF—The FortiSwitch unit will send this message when the switch is shut down.

NOTE: Starting in FortiSwitchOS 6.2.1, RADIUS accounting and CoA now support EAP and MAB 802.1x authentication.

Configuring the RADIUS accounting server and FortiGate RADIUS single sign-on

Use the following commands to set up RADIUS accounting and enable a FortiSwitch unit to receive CoA and disconnect messages from the RADIUS server:

```
config user radius
   edit <RADIUS_server_name>
      set acct-interim-interval <seconds>
      set secret <secret_key>
      set server <domain_ipv4_ipv6>
      set addr-mode {ipv4 | ipv6}
      set source-ip <ipv4_addr>
```

```
      set source-ip6 <ipv6_addr>
      config acct-server
         edit <entry_ID>
            set status {enable | disable}
            set server <accounting_server>
            set secret <secret_key>
            set port <port_number>
         next
      end
   next
end
```

Variable	Description
<RADIUS_server_name>	Enter the name of the RADIUS server that will be sending CoA and disconnect messages to the FortiSwitch unit. By default, the messages use port 3799.
acct-interim-interval <seconds>	Enter the number of seconds between each interim accounting message sent to the RADIUS server. The value range is 60-86400. The default is 600.
addr-mode {ipv4 | ipv6}	Select whether to connect to the RADIUS server with IPv4 or IPv6. The default is IPv4.
secret <secret_key>	Enter the shared secret key for authentication with the RADIUS server.
server <domain_ipv4_ipv6>	Enter the domain name, IPv4 address, or IPv6 address for the RADIUS server. There is no default.
source-ip <ipv4_addr>	If the `addr-mode` was set to `ipv4`, enter the IPv4 address of the server that will be sending accounting messages. The default is 0.0.0.0.
source-ip6 <ipv6_addr>	If the `addr-mode` was set to `ipv6`, enter the IPv6 address of the server that will be sending accounting messages. There is no default.
<entry_ID>	Enter the entry identifier. The value range is 0-20.
status {enable | disable}	Enable or disable RADIUS accounting. The default is disable.
server <accounting_server>	Enter the domain name, IPv4 address, or IPv6 address of the RADIUS server that will be receiving the accounting messages. There is no default value.
secret <secret_key>	Enter the shared secret key for the RADIUS accounting server.
port <port_number>	Enter the port number for the RADIUS accounting server to receive accounting messages from the FortiSwitch unit. The default is 1813.

Example: RADIUS accounting and single sign-on

Use the following commands to set up RADIUS accounting:

```
config user radius
```

```
   edit "local-RADIUS"
      set server 10.0.23.5
      set addr-mode ipv4
      set secret ENC
           LE8xetYYGiE0bkQpBDdH6acilwkYROCos7XK2q5cNPhu8sUDW9/fvkgE+fVURgZGEzTsndt41gb+K+zV9
           m+nXCnoUXqivzQdt1UNlMxgKXADnCpXuiY966aJsYigmW/AZ1IM5kweUxvuHK8eqJkkT0nl64c8DID/LM
           AcCTx6JMapRCBS
      set auth-type ms_chap_v2
      set acct-interim-interval 1200
      set source-ip 10.105.142.19
      config acct-server
         edit 1
            set status enable
            set server 10.0.23.5
            set secret ENC
                 LE8xetYYGiE0bkQpBDdH6acilwkYROCos7XK2q5cNPhu8sUDW9/fvkgE+fVURgZGEzTsndt41gb+
                 K+zV9m+nXCnoUXqivzQdt1UNlMxgKXADnCpXuiY966aJsYigmW/AZ1IM5kweUxvuHK8eqJkkT0nl
                 64c8DID/LMAcCTx6JMapRCBS
            set port 1813
         next
      end
   next
end
```

RADIUS change of authorization (CoA)

NOTE: For increased security, each subnet interface that will be receiving CoA requests must be configured with the `set allowaccess radius-acct` command.

NOTE: Starting in FortiSwitchOS 6.2.1, RADIUS accounting and CoA support EAP and MAB 802.1x authentication.

The FortiSwitch unit supports two types of RADIUS messages:

- CoA messages to change session authorization attributes (such as data filters and the session-timeout setting) during an active session. To change the session timeout for an authenticated session, the CoA-Request message needs to use the IEEE session-timeout attribute.
- Disconnect messages (DMs) to flush an existing session. For MAC-based authentication, all other sessions are unchanged, and the port stays up. For port-based authentication, only one session is deleted.

RADIUS CoA messages use the following Fortinet proprietary attribute:

```
Fortinet-Host-Port-AVPair 42 string
```

The format of the value is as follows:

Attribute	Value	Description
Fortinet-Host-Port-AVPair	action=bounce-port	The FortiSwitch unit disconnects all sessions on a port. The port goes down for 10 seconds and then up again.
Fortinet-Host-Port-AVPair	action=disable-port	The FortiSwitch unit disconnects all session on a port. The port goes down until the user resets it.

Attribute	Value	Description
Fortinet-Host-Port-AVPair	action=reauth-port	The FortiSwitch unit forces the reauthentication of the current session.

In addition, RADIUS CoA uses the session-timeout attribute:

Attribute	Value	Description
session-timeout	<session_timeout_value>	The FortiSwitch unit disconnects a session after the specified number of seconds of idleness. This value must be more than 60 seconds. **NOTE:** To use the session-timeout attribute, you must enable the `set radius-timeoutoverwrite` command first.

The FortiSwitch unit sends the following Error-Cause codes in RADIUS CoA-NAK and Disconnect-NAK messages:

Error Cause	Error Code	Description
Unsupported Attribute	401	This error is a fatal error, which is sent if a request contains an attribute that is not supported.
NAS Identification Mismatch	403	This error is a fatal error, which is sent if one or more NAS-Identifier Attributes do not match the identity of the NAS receiving the request.
Invalid Attribute Value	407	This error is a fatal error, which is sent if a CoA-Request or Disconnect-Request message contains an attribute with an unsupported value.
Session Context Not Found	503	This error is a fatal error if the session context identified in the CoA-Request or Disconnect-Request message does not exist on the NAS.

Configuring CoA and disconnect messages

Use the following commands to enable a FortiSwitch unit to receive CoA and disconnect messages from a RADIUS server:

```
config system interface
   edit "mgmt"
      set ip <address> <netmask>
      set allowaccess <access_types>
      set type physical
   next
config user radius
   edit <RADIUS_server_name>
      set radius-coa {enable | disable}
      set radius-port <port_number>
      set secret <secret_key>
      set server <server_name_ipv4_ipv6>
      set addr-mode {ipv4 | ipv6}
   end
```

Variable	Description
config system interface	
ip <address> <netmask>	Enter the interface IP address and netmask.
allowaccess <access_types>	Enter the types of management access permitted on this interface. Valid types are as follows: `http https ping snmp ssh telnet radius-acct`. Separate each type with a space. You must include `radius-acct` to receive CoA and disconnect messages.
<RADIUS_server_name>	Enter the name of the RADIUS server that will be sending CoA and disconnect messages to the FortiSwitch unit. By default, the messages use port 3799.
config user radius	
radius-coa {enable | disable}	Enable or disable whether the FortiSwitch unit will accept CoA and disconnect messages. The default is disable.
radius-port <port_number>	Enter the RADIUS port number. By default, the value is 1812.
secret <secret_key>	Enter the shared secret key for authentication with the RADIUS server.
server <server_name_ipv4_ipv6>	Enter the domain name, IPv4 address, or IPv6 address for the RADIUS server. There is no default.
addr-mode {ipv4 | ipv6}	Select whether to connect to the RADIUS server with IPv4 or IPv6.

Example: RADIUS CoA

The following example enables the FortiSwitch unit to receive CoA and disconnect messages from the specified RADIUS server:

```
config system interface
   edit "mgmt"
      set ip 10.105.4.14 255.255.255.0
      set allowaccess ping https http ssh snmp telnet radius-acct
      set type physical
   next
config user radius
   edit "Radius-188-200"
      set radius-coa enable
      set secret ENC
           +2NyBcp8JF3/OijWl/w5nOC++aDKQPWnlC8Ug2HKwn4RcmhqVYE+q07yI9eSDhtiIw63kR/oMBLGwFQoe
           ZfOQWengIlGTb+YQo/lYJn1V3Nwp9sdkcblfyayfc9gTeqe+mFltKl5IWNI7WRYiJC8sxaF9Iyr2/l4hp
           CiVUMiPOU6fSrj
      set server "10.105.188.200"
      set addr-mode ipv4
   next
end
```

Viewing the CoA configuration

Use the following command to check the CoA settings:

```
S524DF4K15000024 # diagnose user radius coa

90075.874 DAS: :radius_das_diag_handler:
RADIUS DAS Server List:
radius2:
Type: RADIUS_8021X, IP: 10.105.252.79,
Last CoA/DM Client IP Addr    : 10.105.252.79
Disc Reqs     : 2
Disc ACKs     : 1
Disc NAKs     : 1
CoA  Reqs     : 0
CoA  ACKs     : 0
CoA  NAKs     : 0
radius3:
Type: RADIUS_8021X, IP: 10.105.252.76,
Last CoA/DM Client IP Addr    :
Disc Reqs     : 0
Disc ACKs     : 0
Disc NAKs     : 0
CoA  Reqs     : 0
CoA  ACKs     : 0
CoA  NAKs     : 0
```

Use cases

Here are three use cases for 802.1x authentication.

Use case 1

In this use case, a Cisco phone uses MAB and uses LLDP-MED to assign the voice VLAN. A PC behind the Cisco phone uses 802.1x authentication with or without dynamic VLAN assignment.

The following is an example configuration:

```
config switch lldp profile
   edit "lldp-cisco-104"
      set 802.1-tlvs port-vlan-id
      set 802.3-tlvs power-negotiation
         config med-network-policy
            edit "voice"
               set assign-vlan enable
               set status enable
               set vlan 104
            next
         set med-tlvs inventory-management network-policy
      next
   end
```

```
config switch physical-port
   edit "port1"
      set lldp-profile "lldp-cisco-104"
   next
end

config switch interface
   edit "port1"
      set native-vlan 20
      set security-groups "CISEGRP"
      set snmp-index 1
         config port-security
            set mac-auth-bypass enable // Required. You need to enable MAB.
            set port-security-mode 802.1X-mac-based // Required
         end
      next
   end
```

Use case 2

In this use case, the Cisco phone uses 802.1x authentication and uses LLDP-MED to assign the voice VLAN. A PC behind the Cisco phone uses 802.1x authentication without dynamic VLAN assignment.

RADIUS dynamic VLAN assignment for the voice VLAN must match the voice VLAN configured in the LLDP-MED profile for Cisco phone 802.1x authentication.

The following is an example configuration:

```
config switch lldp profile
   edit "lldp-cisco-104"
      set 802.1-tlvs port-vlan-id
      set 802.3-tlvs power-negotiation
         config med-network-policy
            edit "voice"
               set assign-vlan enable
               set status enable
               set vlan 104
            next
         set med-tlvs inventory-management network-policy
      next
   end

config switch physical-port
   edit "port1"
      set lldp-profile "lldp-cisco-104"
   next
end

config switch interface
   edit "port1"
      set native-vlan 20
      set security-groups "CISEGRP"
      set snmp-index 1
         config port-security
            set mac-auth-bypass disable // Optional
```

```
            set eap-auto-untagged-vlans disable // Required. Needed to allow voice traffic
                 with voice VLAN tag at egress
            set port-security-mode 802.1X-mac-based // Required
         end
      next
   end
```

Use case 3

In this use case, the Cisco phone uses 802.1x authentication and uses LLDP-MED to assign the voice VLAN. The PC behind the Cisco phone uses 802.1x authentication with dynamic VLAN assignment.

RADIUS dynamic VLAN assignment for the voice VLAN has to match the voice VLAN configured in the LLDP-MED profile for Cisco phone 802.1x authentication.

The VLAN ID from the RADIUS dynamic VLAN assignment for the PC has to be added in the untagged VLAN list on the port.

The following is an example configuration:

```
config switch lldp profile
   edit "lldp-cisco-104"
      set 802.1-tlvs port-vlan-id
      set 802.3-tlvs power-negotiation
         config med-network-policy
            edit "voice"
               set assign-vlan enable
               set status enable
               set vlan 104
            next
         set med-tlvs inventory-management network-policy
      next
   end

config switch physical-port
   edit "port1"
      set lldp-profile "lldp-cisco-104"
   next
end

config switch interface
   edit "port1"
      set native-vlan 20
      set allowed-vlans 50 60 70 // Assume that VLANs 50, 60, and 70 are a part of the
           dynamic VLANs configured on RADIUS for PCs in different groups.
      set untagged-vlans 50 60 70
      set security-groups "CISEGRP"
      set snmp-index 1
         config port-security
            set mac-auth-bypass disable // Optional
            set eap-auto-untagged-vlans disable // Required. Needed to allow voice traffic
                 with voice VLAN tag at egress
            set port-security-mode 802.1X-mac-based // Required
         end
      next
   end
```

Detailed deployment notes

- Using more than one security group (with the `set security-groups` command) per security profile is not supported.
- CoA and single sign-on are supported only by the CLI in this release.
- RADIUS CoA is supported in standalone mode and in non-NAT FortiLink mode.
- The FortiSwitch unit supports using FortiAuthenticator, FortiConnect, Microsoft Network Policy Server (NPS), Aruba ClearPass, and Cisco Identity Services Engine (ISE) as the RADIUS server for CoA and RSSO.
- Each RADIUS CoA server can support only one accounting manager in this release.
- RADIUS accounting/CoA/VLAN-by-name features are supported only with `eap-passthru enable`.
- Fortinet recommends a unique secret key for each accounting server.
- For CoA to correctly function with FortiAuthenticator or FortiConnect, you must include the User-Name attribute (you can optionally include the Framed-IP-Address attribute) *or* the User-Name and Calling-Station-ID attributes in the CoA request.
- To obtain a valid Framed-IP-Address attribute value, you need to manually configure DHCP snooping in the 802.1x-authenticated ports of your VLAN network for both port and MAC modes.
- Port-based basic statistics for RADIUS accounting messages are supported in the Accounting Stop request.
- By default, the accounting server is disabled. You must enable the accounting server with the `set status enable` command.
- The default port for FortiAuthenticator single sign-on is 1813 for the FortiSwitch unit.
- In MAC-based authentication, the maximum number of client MAC addresses is 20. Each model has its own maximum limit.
- Static MAC addresses and sticky MAC addresses are mechanisms for manual/local authorization; 802.1x is a mechanism for protocol-based authorization. Do not mix them.
- Fortinet recommends an 802.1x setup rate of 5 to 10 sessions per second.
- Starting in FortiSwitch 6.2.0, when 802.1x authentication is configured, the EAP pass-through mode (`set eap-passthru`) is enabled by default.
- For information about RADIUS attributes supported by FortiSwitchOS, refer to the “Supported attributes for RADIUS CoA and RSSO” appendix.
- The authentication and accounting server configuration must be in the same address mode within the same member. The address mode is either IPv4 or IPv6, no matter what the address mode is in the FQDN or raw IP address. The address mode cannot be mixed.
- When a client is authorized with the RADIUS timeout VLAN enabled, the client is placed in the authorization VLAN. If the RADIUS server becomes unavailable afterward and the reauthentication timer expires for the session, the device keeps the client in the authorization VLAN but the state changes from AUTHENTICATED to SERVER_TIMEOUT.
- In general for 802.1x deployment, Fortinet suggests disabling STP in the 802.1x security ports. If STP is enabled on the ports, the ports must be assigned to STP instances that belong to a dynamic VLAN, guest VLAN, or auth-fail VLAN; otherwise, the network connectivity fails after the ports are authorized and assigned to a dynamic VLAN, guest VLAN, or auth-fail VLAN.

TACACS

This chapter contains information on using Terminal Access Controller Access-Control System (TACACS+) authentication with your FortiSwitch unit.

This chapter covers the following topics:

Administrative accounts

Administrative, or admin, accounts allow access to various aspects of the FortiSwitch configuration. The level of access is determined by the admin profile that is assigned to the admin account.

See Configuring administrator tasks on page 34 for the steps to create an admin profile.

Configuring a TACACS admin account

TACACS+ is a remote authentication protocol that provides access control for routers, network access servers, and other network computing devices using one or more centralized servers. If you have configured TACACS+ support and an administrator is required to authenticate using a TACACS+ server, the FortiSwitch unit contacts the TACACS+ server for authentication.

Using the GUI:

1. Go to *System* > *Admin* > *Administrators* and select *Add Administrator*.
2. Give the administrator account an appropriate name.
3. Select *Remote* for the administrator type.
4. Select a user group for remote users.
5. Enable *Wildcard*.
6. Select an administrator profile.
7. Select *Add*.

Using the CLI:

```
config system admin
   edit tacuser
      set remote-auth enable
      set wildcard enable
      set remote-group <group>
      set accprofile <profile>
   end
end
```

User accounts

User accounts identify a network user and determine what parts of the network the user is allowed to access.

Configuring a user account

```
config user tacacs+
   edit <tacserver>
      set authen-type {ascii | auto | chap | ms_chap | pap}
      set authorization enable
      set key <authorization_key>
      set server <server>
   end
end
```

Configuring a user group

```
config user group
   edit <tacgroup>
      set member <tacserver>
      config match
         edit 1
            set server-name <server>
            set group-name <group>
         end
      end
   end
end
```

Example configuration

The following is an example configuration of a TACACS+ user account, with the CLI syntax shown to create it:

1. Configuring a TACACS user account for login authentication:

```
config user tacacs+
   edit tacserver
   set authen-type ascii
   set authorization enable
   set key temporary
   set server tacacs_server
end
```

2. Configuring a TACACS+user group:

```
config user group
   edit tacgroup
      set member tacserver
      config match
```

```
        edit 1
           set server-name tacserver
           set group-name tacgroup
        end
     end
  end
end
```

3. Configuring a TACACS+ system admin user account:

```
config system admin
   edit tacuser
      set remote-auth enable
      set wildcard enable
      set remote-group tacgroup
      set accprofile noaccess
   end
end
```

Troubleshooting and support

The FortiSwitch unit provides various features for troubleshooting and support.

This chapter covers the following topics:

Dashboard

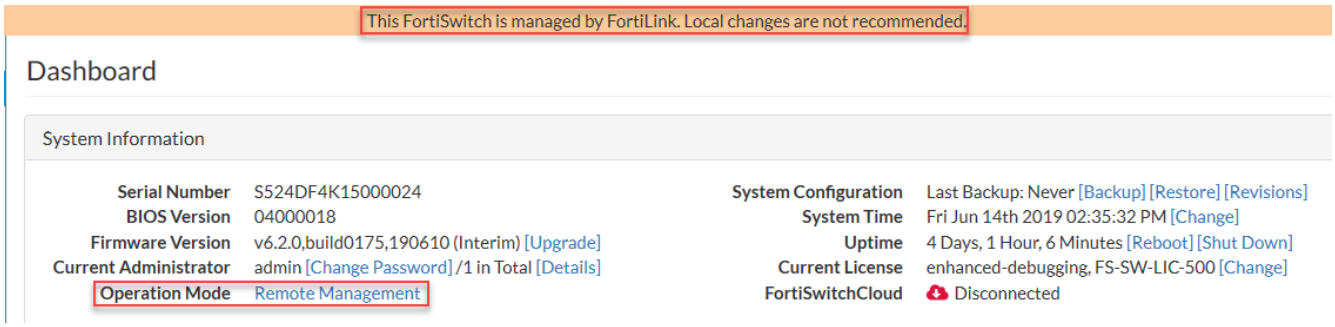
The dashboard displays your FortiSwitch management mode and shows the current values for the following:

- CPU
- RAM
- Temperature for FortiSwitch models that have temperature sensors
- PoE (on FortiSwitch PoE models)
- Bandwidth
- Losses

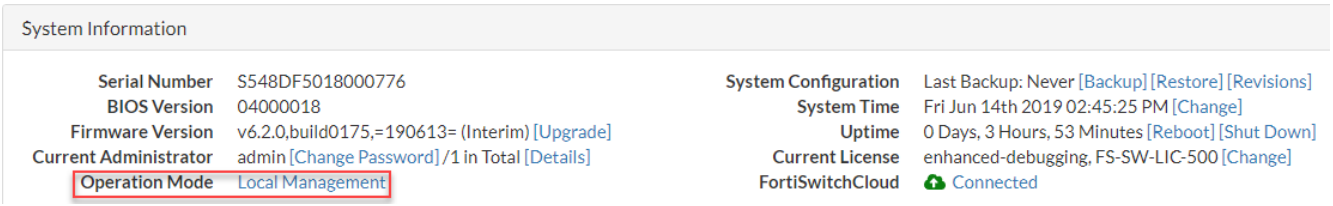
Operation mode

The Operation Mode field shows whether the FortiSwitch unit is managed by a FortiGate unit.

When the FortiSwitch unit is in FortiLink mode, a message is displayed above the dashboard, and the Operation Mode is “Remote Management.”



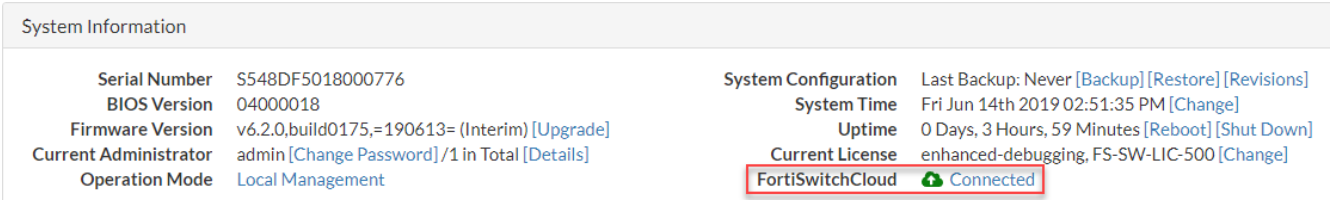
When the FortiSwitch unit is in standalone mode, the Operation Mode is “Local Management.”



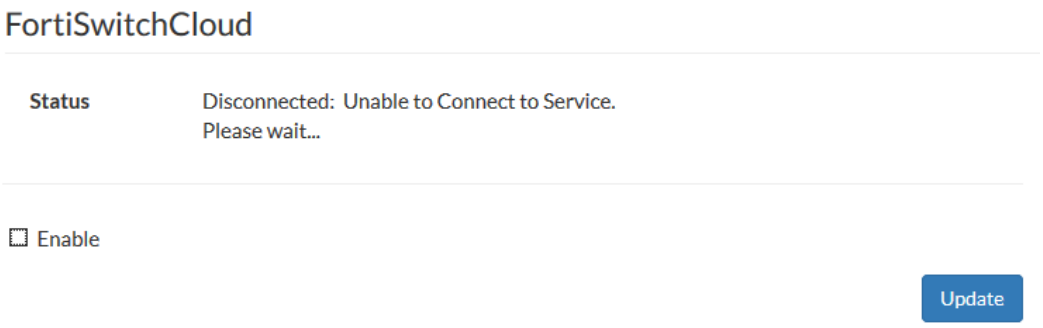
Select *Remote Management* or *Local Management* to go to the *Config* > *Management Mode* page, where you can switch between FortiLink mode and standalone mode.

FortiSwitch Cloud

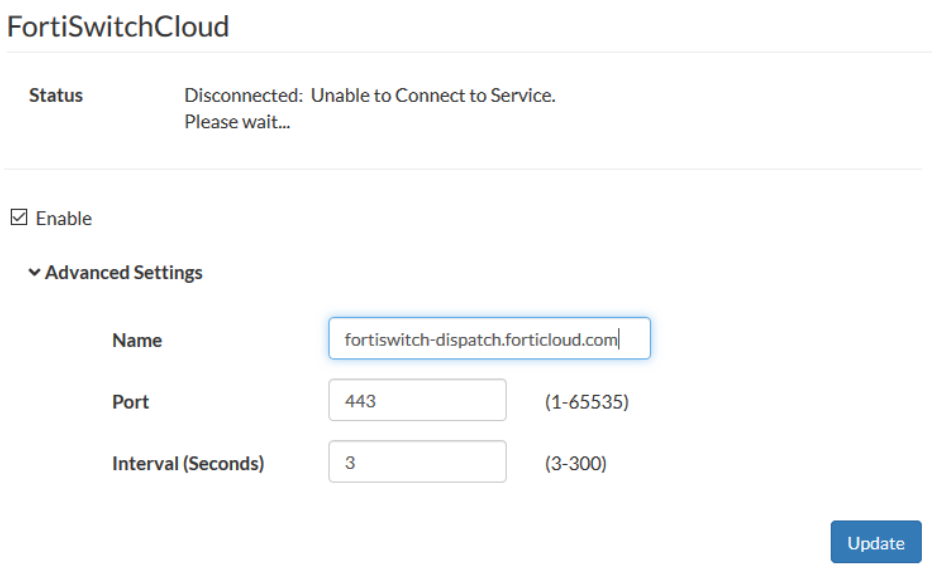
The FortiSwitchCloud field shows whether the FortiSwitch unit is managed by FortiSwitch Cloud. A FortiSwitch unit must be in standalone mode to be manged by FortiSwitch Cloud. For more details about using FortiSwitch Cloud, refer to the *FortiSwitch Cloud Administration Guide*.



Select *Connected* to go to the *System* > *FortiSwitchCloud* page.



Select *Enable* and then select *Advanced Settings* to configure your FortiSwitch unit to be managed by FortiSwitch Cloud.

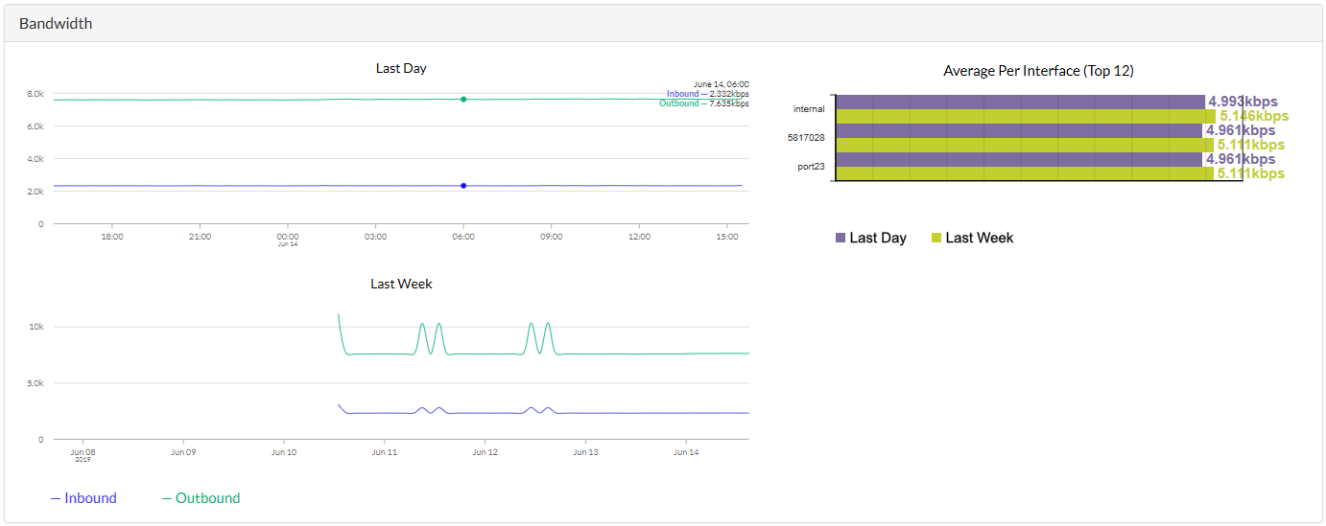


To switch to FortiSwitch Cloud management:

1. On the FortiSwitchCloud page, select *Enable* and then select *Advanced Settings*.
2. By default, the Name field is set to `fortiswitch-dispatch.forticloud.com`, the domain name for FortiSwitch Cloud. No change is needed.
3. By default, the Port field is set to 443, the port number used to connect to FortiSwitch Cloud. No change is needed.
4. In the Interval (Seconds) field, enter the time in seconds allowed for domain name system (DNS) resolution. The default is 15 seconds. The range of values is 3-300 seconds.
5. Select *Update* to save your changes.

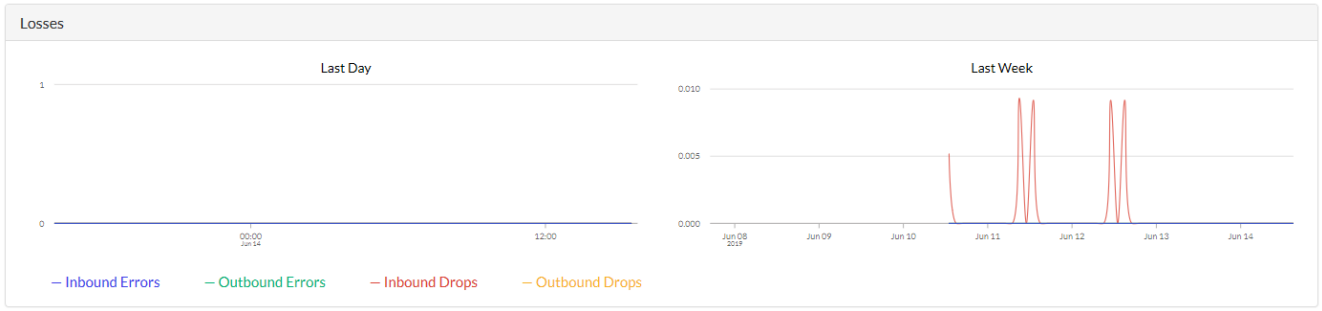
Bandwidth

The Bandwidth graphs show the inbound and outbound bandwidth for the entire FortiSwitch unit over a day and over a week. The Average Per Interface bar chart shows the average bandwidth (inbound bandwidth plus outbound bandwidth) for each interface over a day and over a week; only the interfaces with the highest bandwidth are displayed.



Losses

The Losses graphs show the inbound errors, outbound errors, inbound drops, and outbound drops for the entire FortiSwitch unit over a day and over a week.



Virtual wire

Some testing scenarios might require two ports to be wired 'back-to-back'. Instead of using a physical cable, you can configure a virtual wire between two ports. The virtual wire forwards traffic from one port to the other port with minimal filtering or modification of the packets.

Notes:

- ACL mirroring is not supported.
- You can select ports that are already ingress and egress mirror sources.

Using the GUI:

1. Go to *Switch* > *Virtual Wires*.
2. Select *Add Virtual Wire* to create a new virtual wire.

3. Enter a name and select the ports for first member and second member.
4. Select *Add* to save the changes.

Using the CLI:

Use the following commands to configure a virtual wire:

```
config switch virtual-wire
   edit <virtual-wire-name>
      set first-member <port-name>
      set second-member <port-name>
      set vlan <vlan-id>
   next
end
```

Virtual wire ports set a special Tag Protocol Identifier (TPID) in the VLAN header. The default value is 0xdee5, a value that real network traffic never uses.

Use the following commands to configure a value for the TPID:

```
config switch global
   set virtual-wire-tpid <hex value from 0x0001 to 0xFFFE>
end
```

Use the following command to display the virtual wire configuration:

```
diagnose switch physical-ports virtual-wire list


  port1(1) to port2(2) TPID: 0xdee5 VLAN: 4011
  port3(3) to port4(4) TPID: 0xdee5 VLAN: 4011
  port5(5) to port25(25) TPID: 0xdee5 VLAN: 4011
  port7(7) to port8(8) TPID: 0xdee5 VLAN: 4011
```

NOTE:

- Ports have ingress and egress VLAN filtering disabled. All traffic (including VLAN headers) is passed unchanged to the peer. All egress traffic is untagged.
- Ports have L2 learning disabled.
- Ports have their egress limited to their peer and do no allow egress from any other ports.
- The system uses TCAM to force forwarding from a port to its peer.
- The TCAM prevents any copy-to-cpu or packet drops.

TFTP network port

When you power on the FortiSwitch unit, the BIOS performs basic device initialization. When this activity is complete, and before the OS starts to boot, you can click any key to bring up the boot menu.

From the menu, click the "I" key to configure TFTP settings. With newer versions of the BIOS, you can specify the network port (where you have connected your network cable). If you are not prompted to specify the network port, you must connect your network cable to the default network port:

- If the switch model has a WAN port, the WAN port is the network port.
- If the switch has no WAN port, the highest port number is the network port.

Cable diagnostics

NOTE: There are some limitations for cable diagnostics on the FS-108E, FS-124E, FS-108E-POE, FS-108E-FPOE, FS-124E-POE, FS-124E-FPOE, FS-148E, and FS-148E-POE models:

- Crosstalk cannot be detected.
- There is a 5-second delay before results are displayed.
- The value for the cable length is inaccurate.
- The results are inaccurate for open and short cables.

You can check the state of cables connected to a specific port. The following pair states are supported:

- Open
- Short
- Ok
- Open_Short
- Unknown
- Crosstalk

If no cable is connected to the specific port, the state is Open, and the cable length is 0 meters.

For supported models, see Supported models on page 14.

Using the GUI:

1. Go to *Switch* > *Port* > *Physical*.
2. Select *Cable Diagnostic* for the appropriate port.
3. Select *Continue* to start the cable diagnostics.
   NOTE: Running cable diagnostics on a port that has the link up will interrupt the traffic for several seconds.
4. Select *Back to Physical Ports* to close the Cable Diagnostics window.

Using the CLI:

Use the following command to run a time domain reflectometry (TDR) diagnostic test on cables connected to a specific port:

```
diagnose switch physical-ports cable-diag <physical port name>
```

NOTE: Running cable diagnostics on a port that has the link up will interrupt the traffic for several seconds.

For example:

```
# diagnose switch physical-ports cable-diag port1

port1: cable (4 pairs, length +/- 10 meters)
pair A Open, length 0 meters
pair B Open, length 0 meters
pair C Open, length 0 meters
pair D Open, length 0 meters
```

Use the following command to check the medium dependent interface crossover (MDI-X) interface status for a specific port:

```
diagnose switch physical-ports mdix-status <physical port name>
```

For example:

```
# diagnose switch physical-ports mdix-status port1

port1: MDIX(Crossover)
```

Selective packet sampling

NOTE: This feature is not supported on FS-3032.

During debugging, you might want to see whether a particular type of packet was received on an interface on the switch.

1. Set up an access control list (ACL) on the switch with the interface that you want to monitor. See Access control lists on page 153. This ACL is the ingress interface.
2. Set up a mirror for the “internal” interface.

For example, if you want to monitor interface port17 for any IP packet (ether-type 0x800) with a destination subnet of 10.10.10/24 and a source subnet of 20.20.20/24, use the following commands.

```
# show switch acl ingress
config switch acl ingress
   edit 1
      config action
         set mirror "internal"
      end
      config classifier
         set dst-ip-prefix 10.10.10.0 255.255.255.0
         set ether-type 0x0800
         set src-ip-prefix 20.20.20.0 255.255.255.0
      end
      set ingress-interface "port17"
      set status active
   next
end
```

To examine the packets that have been sampled in the example, use the following command:

```
# diagnose sniffer packet sp17 none 6
```

Packet capture

When troubleshooting networks, it helps to look inside the header of the packets. This helps to determine if the packets, route, and destination are all what you expect. Packet capture is also called a network tap, packet sniffing, or logic analyzing.

To capture packets:

1. Create a packet-capture profile.
2. Start the packet capture.
3. Pause or stop the packet capture.
4. Display or upload the packet capture.
5. Delete the packet-capture file.

The maximum number of packet-capture profiles and the RAM disk size allotted for packet captures are different for the various platforms:

Platform	Maximum number of profiles	RAM disk size in MB
1xx	8	20
2xx	8	50
4xx	16	75
5xx	16	100
1xxx	16	100
3xxx	16	100

Create a packet-capture profile

To specify which packets to capture, define a filter and select a switch or system interface on which to capture the packets. You cannot select both a switch interface and a system interface.

The filter uses flexible logic. For example, if you want packets using UDP port 1812 between hosts named `forti1` and either `forti2` or `forti3`:

```
'udp and port 1812 and host forti1 and \( forti2 or forti3 \)'
```

You can specify the number of packets to capture and the maximum packet length to be captured. The maximum number of packets that can be captured depends on the RAM disk size.

Using the GUI:

1. Go to *System* > *Packet Capture*.
2. Select *Add Packet Capture*.
3. Enter a name for the packet-capture profile.
4. Select the switch or system interface that you want to capture packets on.
5. Enter how many packets to capture on the selected interface.
6. Enter the maximum packet length in bytes to capture on the interface.
7. If you want to use a filter to select which packets to capture, select the *Filter* checkbox.
   a. If you want to filter by hosts, enter the IP addresses, separated with commas.
   b. If you want to filter by ports, enter port numbers or ranges, separated with commas.
   c. If you want to filter by VLANs, enter VLAN numbers, separated with commas.
   d. If you want to filter by protocols, enter the numbers, separated with commas.

8. Select *Add*.

Using the CLI:

```
config system sniffer-profile
   edit <profile_name>
      set filter {<string> | none}
      set max-pkt-count <1-maximum>
      set max-pkt-len <64-1534>
      set switch-interface <switch_interface_name>
      set system-interface <system_interface_name>
   end
```

For example:

```
config system sniffer-profile
   edit profile1
      set filter none
      set max-pkt-count 100
      set max-pkt-len 100
      set system-interface mgmt
   end
```

Start the packet capture

After you create a packet-capture profile, you can start the packet capture.

Using the GUI:

1. Go to *System* > *Packet Capture*.
2. Select  .

Using the CLI:

```
execute system sniffer-profile start <profile-name>
```

For example:

```
execute system sniffer-profile start profile1
```

Pause or stop the packet capture

A packet capture continues to run until the `max-pkt-cnt` value is reached, or the packet capture is paused or stopped. You can restart a paused packet capture.

Using the GUI:

Go to *System* > *Packet Capture*.

- To pause a running packet capture, select  .
- To resume a paused packet capture, select  .

Using the CLI:

To pause a running packet capture:

```
execute system sniffer-profile pause <profile_name>
```

To restart a paused packet capture:

```
execute system sniffer-profile start <profile-name>
```

To stop a running packet capture:

```
execute system sniffer-profile stop <profile-name>
```

Display or upload the packet capture

You can display parsed information from the packet capture or upload the .pcap file to a TFTP or FTP server for further analysis.

Using the GUI:

1. Go to *System* > *Packet Capture*.
2. Select  .
   The `.pcap` file is saved in your Downloads folder.

Using the CLI:

To display the packet capture from a specific packet-capture profile:

```
get system sniffer-profile capture <profile_name>
```

To upload the `.pcap` file for a specific packet-capture profile to an FTP server:

```
execute system sniffer-profile upload ftp <profile_name> <packet_capture_file_name.pcap>
     <FTP_server_IP_address:<optional_port>>
```

To upload the `.pcap` file for a specific packet-capture profile to a TFTP server:

```
execute system sniffer-profile upload tftp <profile_name> <packet_capture_file_name.pcap>
     <TFTP_server_IP_address:<optional_port>>
```

Delete the packet-capture file

After you have examined the packet capture, you can manually delete the `.pcap` file. You can only delete the `.pcap` after the packet capture is stopped. You cannot delete the `.pcap` file if the packet capture is paused or running. All `.pcap` files are deleted when you power cycle the switch.

Using the GUI:

1. Go to *System* > *Packet Capture*.
2. Select  .

To delete all packet-capture files, select *Select All* and then select *Delete*.

Using the CLI:

```
execute system sniffer-profile delete-capture <profile_name>
```

For example:

```
execute system sniffer-profile delete-capture profile1
```

Network monitoring

You can monitor specific unicast MAC addresses in directed mode, monitor all detected MAC addresses on a FortiSwitch unit in survey mode, or do both. The FortiSwitch unit gives the directed mode a higher priority than survey mode. The directed mode and survey mode are disabled by default.

NOTE: Network monitoring is not available on FSR-112D-POE.

Directed mode

In directed mode, you select which unicast MAC addresses that you want examined. The FortiSwitch unit detects various fields of the packet—such as MAC address, IP address, VLAN, and user name—and stores the data in either of two databases.

NOTE: You cannot specify broadcast or multicast MAC addresses.

The maximum number of MAC addresses that can be monitored depends on the FortiSwitch model.

Platform Series	Maximum Number of MAC Addresses Monitored	Maximum Number of Hosts
1xx, 2xx	10	250
4xx, 5xx	20	1,024
10xx, 30xx	30	4,096

To find out how many network monitors are available, use the following command:

```
diagnose switch network-monitor cfg-stats

Network Monitor Configuration Statistics:
---------------------------------
Adds         : 0
Deletes      : 0
Free Entries : 20
```

To find out which network monitors are being used currently, use the following command:

```
diagnose switch network-monitor dump-monitors

Entry ID       Monitor Type       Monitor MAC      Packet-count
=============================================================
1               directed-mode   00:01:02:03:04:05       10
2               directed-mode   10:01:02:03:04:05       0
```

```
3               survey-mode     08:5b:0e:c1:07:65       419
4               survey-mode     08:5b:0e:4f:af:38       101
5               survey-mode     08:5b:0e:ce:59:40       2347
6               survey-mode     08:5b:0e:4f:af:44       0
7               survey-mode     08:5b:0e:c1:07:65       0
8               survey-mode     08:5b:0e:4f:af:38       80
9               survey-mode     08:5b:0e:ce:59:40       117
10              survey-mode     08:5b:0e:4f:af:44       0
```

To start network monitoring, use the following commands:

```
config switch network-monitor settings
   set status enable
end
```

To specify a single unicast MAC address (formatted like this: `xx:xx:xx:xx:xx:xx`) to be monitored, use the following commands:

```
config switch network-monitor directed
   edit <unused network monitor>
      set monitor-mac <MAC address>
   next
end
```

For example:

```
config switch network-monitor directed
   edit 1
      set monitor-mac 00:25:00:61:64:6d
   next
end
```

Survey mode

In survey mode, the FortiSwitch unit detects MAC addresses to monitor for a specified number of seconds. You can specify network monitoring for 120 to 3,600 seconds. The default time is 120 seconds. The FortiSwitch unit detects various fields of the packet—such as MAC address, IP address, VLAN, and user name—and stores the data in either of two databases.

To start network monitoring in survey mode, use the following commands:

```
config switch network-monitor settings
   set status enable
   set survey-mode enable
   set survey-mode-interval <120-3600 seconds>
end
```

For example:

```
config switch network-monitor settings
   set status enable
   set survey-mode enable
   set survey-mode-interval 480
end
```

Network monitoring statistics

After you have enabled network monitoring, you can view the statistics for the number and types of packets.

To see the type of packets going to and from monitored MAC addresses, use the following command:

```
diagnose switch network-monitor parser-stats

Network Monitor Parser Statistics:
----------------------------------
Arp         : 0
Ip          : 1
Udp         : 46
Tcp         : 353
Dhcp        : 0
Eapol       : 0
Unsupported : 352
```

To see the number of packets going to and from monitored MAC addresses, use the following command:

```
diagnose switch network-monitor dump-monitors

Entry ID       Monitor Type       Monitor MAC      Packet-count
=================================================================
1               directed-mode   00:01:02:03:04:05       10
2               directed-mode   10:01:02:03:04:05       0
3               survey-mode     08:5b:0e:c1:07:65       419
4               survey-mode     08:5b:0e:4f:af:38       101
5               survey-mode     08:5b:0e:ce:59:40       2347
6               survey-mode     08:5b:0e:4f:af:44       0
7               survey-mode     08:5b:0e:c1:07:65       0
8               survey-mode     08:5b:0e:4f:af:38       80
9               survey-mode     08:5b:0e:ce:59:40       117
10              survey-mode     08:5b:0e:4f:af:44       0
```

NOTE: The FortiSwitch unit creates an entry in the layer-3 database using the exact packet contents when they were parsed. If the MAC address is then assigned to a different VLAN, this change might not be detected immediately. If there is a discrepancy in the output for the `diagnose switch network-monitor dump-l2-db` and `diagnose switch network-monitor dump-l3-db` commands, use the output with the more recent time stamp.

To see all detected devices from the layer-2 database, use the following command:

```
diagnose switch network-monitor dump-l2-db

mac 00:01:02:03:04:05 vlan 1
created 19 secs ago, last seen 16 secs ago
user JoE sources: eapol
```

To see all detected devices from the IP address database, use the following command:

```
diagnose switch network-monitor dump-l3-db


mac 08:5b:0e:c1:07:65 ip 169.254.2.2 vlan 4094
created 63614 secs ago, last seen 2 secs ago
```

```
sources: arp ip
mac 00:10:20:30:40:50 ip 10.10.10.111 vlan 123
created 75 secs ago, last seen 45 secs ago
sources: arp ip
mac 00:11:22:33:44:55 ip 30.30.30.115 vlan 1
created 53 secs ago, last seen 53 secs ago
sources: dhcp arp ip
```

Flow tracking and export

NOTE:

- Flow export is supported on FortiSwitch models 2xx and higher.
- Layer-2 flows for NetFlow version 1 and NetFlow version 5 are not supported.
- For 2xxE models and higher, flow export uses psudorandom sampling (approximately 1 of *x* packets).

You can sample IP packets on a FortiSwitch unit and then export the data in NetFlow format or Internet Protocol Flow Information Export (IPFIX) format.

The maximum number of concurrent flows is defined by the FortiSwitch model. When this limit is exceeded, the oldest flow expires and is exported.

To use flow export, you need to enable packet sampling and then configure the flow export.

Enabling packet sampling

To use flow export, you must first enable packet sampling for each switch port and trunk:

```
config switch interface
   edit <interface>
      set packet-sampler enabled
      set packet-sample-rate <0-99999>
   end
```

Configuring flow export

Using the GUI:

1. Go to *System* > *Flow Export* > *Configure*.
2. Configure the collector.
   a. Required. In the IP Address field, enter the IP address for the collector. When the value is “0.0.0.0” or blank, the feature is disabled.
   b. In the Port field, enter the port number for the collector. The default port for NetFlow is 2055; the default port for IPFIX is 4739.
   c. In the Transport field, select *SCTP*, *TCP*, or *UDP* for the transport of exported packets.
3. Configure the flow export options.
   a. In the Format drop-down list, select the format of the exported flow data as NetFlow version 1, NetFlow version 5, NetFlow version 9, or IPFIX sampling.
   NOTE: When the export format is NetFlow version 5, the sample rate used in the exported packets is derived

from the lowest port number where sampling is enabled. Fortinet recommends that administrators using NetFlow version 5 set the sample rate consistently across all ports.

b. In the Identity field, enter a unique number to identify which FortiSwitch unit the data originates from. If the identity is not specified, the “Burn in MAC” value is used instead (from the `get system status` command output).

c. In the Level field, select the flow-tracking level from one of the following:
—When you select *IP*, the FortiSwitch unit collects the source IP address and destination IP address from the sample packet.
—When you select *MAC*, the FortiSwitch unit collects the source MAC address and destination MAC address from the sample packet.
—When you select *Port,* the FortiSwitch unit collects the source IP address, destination IP address, source port, destination port, and protocol from the sample packet.
—When you select *Protocol*, the FortiSwitch unit collects the source IP address, destination IP address, and protocol from the sample packet.
—When you select *VLAN*, the FortiSwitch unit collects the source IP address, destination IP address, source port, destination port, protocol, and VLAN from the sample packet.

d. In the Max Export Packet Size (Bytes) field, enter the maximum size of exported packets in the application level.

4. Configure the timeouts.
   a. In the General field, enter the general timeout in seconds for the flow session.
   b. In the ICMP field, enter the ICMP timeout for the flow session.
   c. In the Max field, enter the maximum number of seconds before the flow session times out.
   d. In the TCP field, enter the TCP timeout for the flow session.
   e. In the TCP FIN field, enter the TCP FIN flag timeout for the flow session.
   f. In the TCP RST field, enter the TCP RST flag timeout for the flow session.
   g. In the UDP field, enter the UDP timeout for the flow session.
5. Configure the aggregates.
   a. Select +.
   b. In the ID field, enter a number to identify the entry or use the default value.
   c. Required. In the IP/Netmask field, enter the IPv4 address and mask to match. All matching sessions are aggregated into the same flow.
   d. To add another entry, select +.
6. Select *Update*.

Using the CLI:

```
config system flow-export
   set collector-ip <IPv4_address>
   set collector-port <port_number>
   set format {netflow1 | netflow5 | netflow9 | ipfix}
   set identity <hexadecimal>
   set level {ip | mac | port | proto | vlan}
   set max-export-pkt-size <integer>
   set timeout-general <integer>
   set timeout-icmp <integer>
   set timeout-max <integer>
   set timeout-tcp <integer>
   set timeout-tcp-fin <integer>
   set timeout-tcp-rst <integer>
   set timeout-udp <integer>
   set transport {sctp | tcp | udp}
```

```
config aggregates
   edit <id>
      set ip <IPv4_address_mask>
   end
end
```

Viewing the flow-export data

Using the GUI:

Go to *System* > *Flow Export* > *Monitor*.

Using the CLI:

You can display the flow-export data or raw data for a specified number of records or for all records. You can also display statistics for flow-export data.

```
get system flow-export-data flows {all | <count>} {ip | subnet | mac | all} <switch_
     interface_name>
get system flow-export-data flows-raw {all | <count>} {ip | subnet | mac | all} <switch_
     interface_name>
get system flow-export-data statistics
```

NOTE: Layer-2 flows for netflow1 and netflow5 are not supported. For the output of the `get system flow-export-data statistics` command, the Incompatible Type field displays how many flows are not exported because they are not supported.

Deleting the flow-export data

Use the following commands to delete or expire all flow-export data:

```
diagnose sys flow-export delete-flows-all
diagnose sys flow-export expire-flows-all
```

Identifying a specific FortiSwitch unit

When you have multiple FortiSwitch units and need to locate a specific switch, use the following command to flash all port LEDs on and off for a specified number of minutes:

```
diagnose switch physical-ports led-flash <disable | time>
```

You can flash the port LEDs for 5, 15, 30, or 60 minutes. After you locate the FortiSwitch unit, you can use `disable` to stop the LEDs from flashing.

NOTE: For the FS-5xx switches, the `diagnose switch physical-ports led-flash` command flashes only the SFP port LEDs, instead of all the port LEDs.

Deployment scenario

Working configuration for PC and phone for 802.1x authentication using MAC

Summary

1. Configure all devices.
   - PC
   - Phone
   - FortiSwitch
   - FortiAuthenticator
   - DHCP server
2. Authenticate phone using MAB and using LLDP-MED.
3. Authenticate PC using EAP 802.1x.

A. Configure all devices

I. Configure the PC, phone, FortiSwitch, FortiAuthenticator [RADIUS server], and DHCP server)

Phone configuration (file: macmode_phone_pc_ping_work)

i. On the phone, enable the WAN port and leave the VLAN ID at the default to allow LLDP-Med (Policy) designate for voice VLAN assignment.
ii. On the phone, enable the LAN port and assign the VLAN ID for data matching the RADIUS VLAN assignment.

PC configuration

i. Install the supplicant software.
ii. Launch the supplicant software, type the user name and password, and enable DHCP on the interface.

FortiSwitch configuration

1. Configure the LLDP profile for voice.

```
# show switch lldp
config switch lldp profile

edit "pexa" <<<<<<<<<<<<<<<<
```

```
set 802.1-tlvs port-vlan-id
   config med-network-policy
      edit "voice"
         set status enable
         set vlan 21
      next
      edit "voice-signaling"
         set status enable
         set vlan 31
      next
      edit "guest-voice"
      next
      edit "quest-voice-signaling"
      next
      edit "softphone-voice"
         set status enable
         set vlan 41
      next
      edit "video-conferencing"
      next
      edit "streaming-video"
      next
      edit "video-signaling"
      next
   end
set med-tlvs inventory-management network-policy
```

2. Apply the LLDL profile on a dot1x port.

```
# show switch physical-port port4
config switch physical-port

   edit "pexa" <<<<<<<<<<<<<<<<
   set lldp-profile "pexa"
   set speed auto
   next
end
```

3. Configure a user group.

```
# show user group
config user group

   edit "Corp_Grp_10"
   set member "FAC_LAB"
   next
end
```

4. Configure the RADIUS server.

```
# show user radius
config user radius

   edit "FAC_LAB" <<<<<<<<
   set secret
```

```
      ENCW82jBg06XhKD/4Dugqm8QF2f7D1B4bfFdDSZaLUQPwZXv4F8zMc5sWHRl9suwmbmzNnAnyqPaarAYcSL
           uT8kVjFSRO0znx+TXVWTqdSeLCpbMv
           +HYFNOHMbYlfES8wTYYD40InCgrYr2johvr2vfa5KG4g8XMwKSIM0LurR//1WqT0fH
      set server
      next
   end
```

5. Configure port security on the dot1x port.

   a. Configure mac-mode port-security.
   b. Add voice VLAN on allowed list (for example, 21).
   c. Apply the security group.

   Interface port4 configuration:

```
   # show switch interface port4
   config switch interface

      edit "port4"
      set allowed-vlans 20-21,31,41
      set security-groups "Corp_Grp_10"
      set snmp-index 4
   configure port-security
      set auth-fail-vlan disable
      set guest-auth-delay 120
      set guest-vlan disable
      set mac-auth-bypass enable
      set port-security-mode 802.1X-mac-based
      set radius-timeout-overwrite disable
      set auth-fail-vlanid 40
      set guest-vlanid 30
   end
```

RADIUS configuration

MAB Authentication:

- Add phone MAC address to MAB list.

802.1X Authentication

1. Create a local user.
2. Create a user group with "Attributes" and enable PEAP and MSChapv2.

DHCP configuration

1. On the DHCP server, configure a pool for phone and a pool for the PC.

```
   !
   ip dhcp pool PC
   network 10.1.1.0 255.255.255.0
   default-router 10.1.1.1
   dns-server 10.1.1.1
   !
   ip dhcp pool PC
   network 20.1.1.0 255.255.255.0
```

```
default-router 20.1.1.1
dns-server 20.1.1.5
```

2. Configure exclude lists for pools for both gateway and DNS.

```
ip dhcp excluded-address 20.1.1.1 20.1.1.1.5
<<<<gateway and dns server
ip dhcp excluded-address 10.1.1.1 10.1.1.1.5
<<<<gateway and dns server
!
ip dhcp pool PC
network 20.1.1.0 255.255.255.0
default-router 20.1.1.1
dns-server 20.1.1.5
```

3. Configure the switch port VLAN interface as a gateway for the phone.

```
# show run
Building configuration

Current configuration
!
interface vlan21 <<<<<<
ip address 20.1.1.1
end
```

4. Configure the switch port VLAN interface as a gateway for the PC.

```
# show run
Building configuration

Current configuration
!
interface vlan10 <<<<<<
ip address 10.1.1.1
end

#
```

5. Configure the l2 port and associate the voice VLAN.

```
# show run
Building configuration

Current configuration
!
interface GigabitEthernet g1/0/1 <<<<<<
switchport access vlan 21
switchport trunk encapsulation dot1q
switchport trunk all
switchport mode trunk
end
```

6. Configure the l2 port and associate the data VLAN.

```
# show run
Building configuration
```

```
Current configuration
!
interface GigabitEthernet g1/0/2 <<<<<<
switchport access vlan 10
switchport trunk encapsulation dot1q
switchport trunk all
switchport mode trunk
end
```

II. Connect a link between the FortiSwitch unit and the DHCP server and assign matching VLAN for the phone for both ports

III. Connect a link between the FortiSwitch unit and the DHCP server and assign a matching VLAN for the PC for both ports

B. Authenticate phone using MAB

1. Connect the phone to the switch to authenticate with RADIUS through the MAB (mac-bypass).
2. Once authenticated:
   a. On the FortiSwitch unit, verify that the port is authorized and that the voice VLAN is on the allowed list.

```
# diagnose switch 8 status
Signal 10 received - config reload scheduled

wrdapd_hostapd_dump_state_console Hostapd own address 90:6c:ac:18:6f:2f
dump_diag:1:
receive dump diagnostic 802_1x/MAB sessions. ifname :port4: dump_diag:1:

port4 : Mode: mac-based (mac-by-pass enable)
        Link: Link up
        Port State: authorized ( ) <<<<<<
        Native Vlan : 1
        Allowed Vlan list: 1,10,20-21,31,41 <<<<<<
        Untagged Vlan list:
        Guest VLAN:

        Client MAC Type Vlan Dynamic-Vlan
        68:f7:28:fb:c0:0f 802.1x 1 10
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<phone

        Sessions info:
        68:f7:28:fb:c0:0f Type=802.1x,PEAP,state=AUTHENTICATED
        params:reAuth=3600
        00:a8:59:d8:f1:f6 Type=MAB,,state=AUTHENTICATED
        params: reAuth=3600

        edited on: 2016-11-29 17:25

        edited on: 2016-11-29 17:59
```

b. On the FortiSwitch unit, verify that the lldp neighbor detail accurately reflects the phone and voice VLAN designation.

```
        Neighbor learned on port4 by LLDP protocol
Last change 140 seconds ago
Last packet received 13 seconds ago

Chassis ID: 20.1.1.10 (ip) <<<<<<<<<<
System Name: FON-670i
System Description
V12.740.335.12.B

Time To Live: 60 seconds
System Capabilities: BT
Enabled Capabilities: BT
MED type: Communication Device Endpoint (Class III)
MED Capabilities: CP
Management IP Address: 20.1.1.10

Port ID: 00:a8:59:d8:f1:f6 (mac) <<<<<<<<<<<<<<
Port description: WAN Port 10M/100M/1000M
IEEE802.3, Power via MDI:
Power devicetype: PD
PSE MDI Power: Not Supported
PSE MDI Power Enabled: No
PSE Pair Selection: Can not be controlled
PSE power pairs: Signal
Power class: 1
Power type: 802.3at off
Power source: Unknown
Power priority: Unknown
Power requested: 0
Power allocated: 0
LLDP-MED, Network Policies:
voice: VLAN: 21 (tagged), Priority: 0 DSCP: 0 <<<<<<<<<<<<
voice-signaling: VLAN: 21 (tagged), Priority: 0 DSCP: 0
streaming-video: VLAN: 21 (tagged), Priority: 0 DSCP: 0

# Checking STA 00:a8:59:d8:f1:f6 inactivity:
Station has been active
```

c. On the phone, verify that the DHCP address is assigned.

d. On the DHCP server, check binding and ping from gateway to verify that the phone is reachable.

```
# show ip dhcp binding
IP address Client-ID/ Lease expiration Type
Hardware address
20.1.1.10 00a8.59d8.f1f6 Mar 20 1993 01:52 AM Automatic
#
#
#
# show ip dhcp binding
IP address Client-ID/ Lease expiration Type
Hardware address
10.1.1.7 0168.f728.fbc0.0f Mar 11 1993 01:54 AM Automatic <<<<<< pc
20.1.1.10 00a8.59d8.f1f6 Mar 20 1993 01:52 AM Automatic <<<<< phone
```

```
# ping 10.1.1.7

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.7, timeout is 2
!!!!!
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms
# ping 10.1.1.7

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.7, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms
# ping 10.1.1.7

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.7, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/9 ms
# ping 20.1.1.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.1.1.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms
#
```

C. Authenticate the PC using EAP dot1x

1. Connect the PC to the phone for EAP authentication and VLAN assignment (for data)
2. After authentication:
   a. On the FortiSwitch unit, verify that the port is authorized and that the data VLAN assigned to dynamic has been placed on the allowed list.

```
# diagnose switch 8 status
Signal 10 received - config reload scheduled

wrdapd_hostapd_dump_state_console Hostapd own address 90:6c:ac:18:6f:2f
dump_diag:1:
receive dump diagnostic 802_1x/MAB sessions. ifname :port4: dump_diag:1:

port4 : Mode: mac-based (mac-by-pass enable)
        Link: Link up
        Port State: authorized ( ) <<<<<<
        Native Vlan : 1
        Allowed Vlan list: 1,10,20-21,31,41
   <<<<<<
        Untagged Vlan list:
        Guest VLAN:

        Client MAC Type Vlan Dynamic-Vlan
        68:f7:28:fb:c0:0f 802.1x 1 10
<<<<<<<<<<<<<<<<<<<<<< PC
```

```
00:a8:59:d8:f1:f6 MAB 1 0

Sessions info:
68:f7:28:fb:c0:0f Type=802.1x,PEAP,state=AUTHENTICATED
params:reAuth=3600
00:a8:59:d8:f1:f6 Type=MAB,,state=AUTHENTICATED

params:reAuth=3600

edited on: 2016-11-29 17:25

edited on: 2016-11-29 17:59
```

b. On the PC, verify that the DHCP address is assigned.

c. From the DHCP server, check the binding and a ping from gateway to verify that the PC is reachable.

Appendix: FortiSwitch-supported RFCs

FortiSwitchOS supports the following RFCs:

BFD

- RFC 5880: Bidirectional Forwarding Detection (BFD)
- RFC 5881: Bidirectional Forwarding Detection (BFD) for IPv4 and IPv6 (Single Hop)
- RFC 5882: Generic Application of Bidirectional Forwarding Detection (BFD)

BGP

- RFC 1771: A Border Gateway Protocol 4 (BGP-4)
- RFC 1965: Autonomous System Confederations for BGP
- RFC 1997: BGP Communities Attribute
- RFC 2545: Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing
- RFC 2796: BGP Route Reflection - An Alternative to Full Mesh IBGP
- RFC 2842: Capabilities Advertisement with BGP-4
- RFC 2858: Multiprotocol Extensions for BGP-4
- RFC 4271: A Border Gateway Protocol 4 (BGP-4)
- RFC 6286: Autonomous-System-Wide Unique BGP Identifier for BGP-4
- RFC 6608: Subcodes for BGP Finite State Machine Error
- RFC 6793: BGP Support for Four-Octet Autonomous System (AS) Number Space
- RFC 7606: Revised Error Handling for BGP UPDATE Messages
- RFC 7607: Codification of AS 0 Processing

- RFC 7705: Autonomous System Migration Mechanisms and Their Effects on the BGP AS_PATH Attribute
- RFC 8212: Default External BGP (EBGP) Route Propagation Behavior without Policies
- RFC 8654: Extended Message Support for BGP

DHCP

- RFC 2131: Dynamic Host Configuration Protocol
- RFC 3046: DHCP Relay Agent Information Option
- RFC 7513: Source Address Validation Improvement (SAVI) Solution for DHCP

IP/IPv4

- RFC 3168: The Addition of Explicit Congestion Notification (ECN) to IP
- RFC 5227: IPv4 Address Conflict Detection
- RFC 5517: Cisco Systems' Private VLANs: Scalable Security in a Multi-Client Environment
- RFC 7039: Source Address Validation Improvement (SAVI) Framework

IP multicast

- RFC 2710: Multicast Listener Discovery (MLD) for IPv6 (MLDv1)
- RFC 4541: Considerations for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) Snooping Switches
- RFC 4605: Internet Group Management Protocol (IGMP)/Multicast Listener Discovery (MLD)-Based Multicast Forwarding (“IGMP/MLD Proxying”)
- RFC 4607: Source-Specific Multicast for IP

IPv6

- RFC 2464: Transmission of IPv6 Packets over Ethernet Networks: Transmission of IPv6 Packets over Ethernet Networks
- RFC 2474: Definition of the Differentiated Services Field (DS Field) in the and IPv6 Headers (DSCP)
- RFC 2893: Transition Mechanisms for IPv6 Hosts and Routers
- RFC 4213: Basic Transition Mechanisms for IPv6 Hosts and Router
- RFC 4291: IP Version 6 Addressing Architecture
- RFC 4443: Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification
- RFC 4861: Neighbor Discovery for IP version 6 (IPv6)
- RFC 4862: IPv6 Stateless Address Auto configuration
- RFC 5095: Deprecation of Type 0 Routing Headers in IPv6

- RFC 6724: Default Address Selection for Internet Protocol Version 6 (IPv6)
- RFC 7113: Implementation Advice for IPv6 Router Advertisement Guard (RA-Guard)
- RFC 8200: Internet Protocol, Version 6 (IPv6) Specification
- RFC 8201: Path MTU Discovery for IP version 6

IS-IS

- RFC 1195: Use of OSI IS-IS for Routing in TCP/IP and Dual Environments
- RFC 5308: Routing IPv6 with IS-IS

MIB

- RFC 1213: Management Information Base for Network Management of TCP/IP-based internets: MIB-II
- RFC 1354: IP Forwarding Table MIB
- RFC 1493: Definitions of Managed Objects for Bridges
- RFC 1573: Evolution of the Interfaces Group of MIB-II
- RFC 1643: Definitions of Managed Objects for the Ethernet-like Interface Types
- RFC 1724: RIP Version 2 MIB Extension
- RFC 1850: OSPF Version 2 Management Information Base
- RFC 2233: The Interfaces Group MIB using SMIv2
- RFC 2618: RADIUS Authentication Client MIB
- RFC 2620: RADIUS Accounting Client MIB
- RFC 2674: Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions
- RFC 2787: Definitions of Managed Objects for the Virtual Router Redundancy Protocol
- RFC 2819: Remote Network Monitoring Management Information Base
- RFC 2932: IPv4 Multicast Routing MIB
- RFC 2934: Protocol Independent Multicast MIB for IPv4
- RFC 3289: Management Information Base for the Differentiated Services Architecture
- RFC 3433: Entity Sensor Management Information Base
- RFC 3621: Power Ethernet MIB
- RFC 6933: Entity MIB (Version 4)

OSPF

- RFC 1583: OSPF Version 2
- RFC 1765: OSPF Database Overflow
- RFC 2328: OSPF Version 2
- RFC 2370: The OSPF Opaque LSA Option
- RFC 2740: OSPF for IPv6

- RFC 3101: The OSPF Not-So-Stubby Area (NSSA) Option
- RFC 3137: OSPF Stub Router Advertisement
- RFC 3623: Graceful OSPF Restart
- RFC 5340: OSPF for IPv6
- RFC 5709: OSPFv2 HMAC-SHA Cryptographic Authentication
- RFC 6549: OSPFv2 Multi-Instance Extensions
- RFC 6845: OSPF Hybrid Broadcast and Point-to-Multipoint Interface Type
- RFC 6860: Hiding Transit-Only Networks in OSPF
- RFC 7474: Security Extension for OSPFv2 When Using Manual Key Management
- RFC 7503: OSPFv3 Autoconfiguration
- RFC 8042: OSPF Two-Part Metric
- RFC 8362: OSPFv3 Link State Advertisement (LSA) Extensibility

Other protocols

- RFC 854: Telnet Protocol Specification
- RFC 2030: Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI
- RFC 2362: Protocol Independent Multicast-Sparse Mode (PIM-SM): Protocol Specification
- RFC 3176: InMon Corporation's sFlow: A Method for Monitoring Traffic in Switched and Routed Networks
- RFC 3768: Virtual Router Redundancy Protocol (VRRP)
- RFC 3954: Cisco Systems NetFlow Services Export Version 9
- RFC 5101: Specification of the IP Flow Information Export (IPFIX) Protocol for the Exchange of IP Traffic Flow Information
- RFC 5798: Virtual Router Redundancy Protocol (VRRP) Version 3 for IPv4 and IPv6

RADIUS

- RFC 2865: Remote Authentication Dial In User Service (RADIUS)
- RFC 2866: RADIUS Accounting
- RFC 5176: Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS)

RIP

- RFC 1058: Routing Information Protocol
- RFC 2080: RIPng for IPv6
- RFC 2082: RIP-2 MD5 Authentication
- RFC 2453: RIP Version 2
- RFC 4822: RIPv2 Cryptographic Authentication

SNMP

- RFC 1157: A Simple Network Management Protocol (SNMP)
- RFC 2571: An Architecture for Describing SNMP Management Frameworks
- RFC 2572: Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)
- RFC 2573: SNMP Applications
- RFC 2576: Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework

Appendix: Supported attributes for RADIUS CoA and RSSO

Attributes sent from the FortiSwitch unit to the RADIUS server during 802.1x authentication (Access-Request)

Attribute	AVP Type	Type	Description
NAS-Identifier	32	text	Host name of switch
User-Name	1	alphanumeric	User name of supplicant or MAC address
EAP-Message	79	concat	Include EAP content
Framed-MTU	12	integer	Configurable (size of bytes). The range of values is 600-1500. The default value is 1500.
NAS-Port-Id	87	text	Port connected to supplicant
NAS-Port	5	integer	Value of port ID; for example, 12 means port12
NAS-Port-Type	61	enum	Ethernet (15)
Calling-Station-ID	31	text	MAC address of supplicant
Message-Authenticator	80	string	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.
Service-Type	6	enum	Optional. The following settings are available: - administrative—The user granted access to the administrative interface. - authenticate-only—Authentication is requested, and no authentication information needs to be returned. - call-check—This setting is used by the NAS in an Access-Request packet or Access-Accept packet to answer the call. - callback-administrative—The user disconnected, called back, and granted access to the administrative interface.

Attribute	AVP Type	Type	Description
			- callback-framed—The user disconnected and called back and then used a Framed-Protocol attribute. - callback-login—The user disconnected and called back. - callback-nas-prompt—The user disconnected and called back and then provided a command prompt. - framed—The user used a Framed-Protocol attribute. - login—The user should be connected to a host. - nas-prompt—The user provided a command prompt on the NAS. - none—Disable the Service-Type AVP. - outbound—The user granted access to outgoing devices. The default is `none` for 802.1x authentication. MAC Authentication Bypass (MAB) always uses the `call-check` setting, no matter what is configured.

Attributes sent from the RADIUS server to the FortiSwitch unit during 802.1x authentication (Access-Accept)

Attribute	AVP Type	Type	Description
User-Name	1	alphanumeric	User name of supplicant (MAC address of host in MAB)
Class	25	string	Whatever the server returns
Tunnel-Type	64	enum	Optional. Set to 13 for VLAN.
Tunnel-Medium-Type	65	vsa	Optional. Set to 6 for IEEE-802.
Tunnel-Private-Group-ID	81	text	VLAN number or VLAN name
Vendor-Specific	26	vsa	Fortinet-Group-Name

Attribute	AVP Type	Type	Description
Filter-Id	11	text	Relayed from the server
Session-Timeout	27	integer	How many seconds before the session times out

RADIUS attributes in the Accounting Start message

Attribute	AVP Type	Description
Acct-Status-Type	40	1 for Start
Acct-Session-Id	44	802.1x or MAB session ID generated by the switch. For example: 0000004b
User-Name	1	Host login name or MAC address. For example: host01
Acct-Multi-Session-Id	50	For example, e81cba8e8146 in MAC mode. This attribute cannot be used in port mode. The minimum value is 1; the maximum value is 1.
NAS-Identifier	32	For example, S148EP591900009 for the host name of the switch.
Framed-IP-Address	8	This value is the host IP address if is found in the switch; otherwise, the switch does not send this attribute. For example: 100.1.0.3
NAS-Port-Id	87	This value is a text string that identifies the port of the NAS connected to the host. For example: port48
NAS-Port	5	This value indicates the physical port number of the NAS. For example: 48
NAS-Port-Type	61	0 for asynchronous
Called-Station-Id	30	MAC address of the 802.1x port. For example: E8-1C-BA-8E-81-46

Attribute	AVP Type	Description
Calling-Station-Id	31	MAC address of host. For example: 00-12-01-00-00-01
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Filter-Id	11	Relayed from the server
Vendor-Specific	26	Fortinet-Group-Name. Authentication fails if this value does not match.
Class	25	Whatever the server returns

RADIUS attributes in the Accounting Interim Update message

Attribute	AVP Type	Description
Acct-Status-Type	40	3 for Interim-Update
Acct-Session-Id	44	802.1x or MAB session ID generated by the switch. For example: 0000004b
User-Name	1	Host login name or MAC address. For example: host01
Acct-Multi-Session-Id	50	For example, e81cba8e8146 in MAC mode. This attribute cannot be used in port mode.
Acct-Link-Count	51	2 for two sessions on the port. This attribute is only valid for MAC mode.
NAS-Identifier	32	For example, S148EP591900009 for the host name of the switch.
Framed-IP-Address	8	This value is the host IP address if is found in the switch; otherwise, the switch does not send this attribute. For example: 100.1.0.3
NAS-Port-Id	87	This value is a text string that identifies the port of the NAS connected to the host. For example: port48

Attribute	AVP Type	Description
NAS-Port	5	This value indicates the physical port number of the NAS. For example: 48
NAS-Port-Type	61	15 for Ethernet
Called-Station-Id	30	MAC address of the 802.1x port. For example: E8-1C-BA-8E-81-46
Calling-Station-Id	31	MAC address of host. For example: 00-12-01-00-00-01
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Filter-Id	11	Eng-Group. If Filter-Id is received during authentication, it is included in accounting.
Class	25	Whatever the server returns
Vendor-Specific	26	Fortinet-Group-Name. Authentication fails if this value does not match.

RADIUS attributes in the Accounting Stop message

Attribute	AVP Type	Description
Acct-Status-Type	40	2 for Stop
Acct-Session-Id	44	802.1x or MAB session ID generated by the switch. For example: 0000004b
User-Name	1	Host login name or MAC address. For example: host01
Acct-Multi-Session-Id	50	For example, e81cba8e8146 in MAC mode. This attribute cannot be used in port mode.
Acct-Link-Count	51	2 for two sessions on the port
NAS-Identifier	32	For example, S148EP591900009 for the host name of the switch.
Framed-IP-Address	8	This value is the host IP address if is found in the switch; otherwise, the switch does not send this attribute. For example: 100.1.0.3
NAS-Port-Id	87	This value is a text string that identifies the port of the NAS connected to the host. For example: port48

Attribute	AVP Type	Description
NAS-Port	5	This value indicates the physical port number of the NAS. For example: 48
NAS-Port-Type	61	15 for Ethernet
Called-Station-Id	30	MAC address of the 802.1x port. For example: E8-1C-BA-8E-81-46
Calling-Station-Id	31	MAC address of host. For example: 00-12-01-00-00-01
Acct-Input-Octets	42	3200
Acct-Output-Octets	43	16050448
Acct-Input-Packets	47	20
Acct-Output-Packets	48	93606
Acct-Terminate-Cause	49	6 for Admin-Reset
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Filter-Id	11	Eng-Group. If Filter-Id is received during authentication, it is included in accounting.
Class	25	Whatever the server returns
Vendor-Specific	26	Fortinet-Group-Name. Authentication fails if this value does not match.

RADIUS attributes in the Disconnect-Request message

Attribute	AVP Type	Description
Calling-Station-ID	31	MAC address of host
Framed-IP-Address	8	IP address of host
User-Name	1	Host login name
NAS-IP-Address	4	NAS IP address
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time

RADIUS attributes in the Disconnect-ACK message

Attribute	AVP Type	Description
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.

RADIUS attributes in the Disconnect-NAK message

Attribute	AVP Type	Description
Calling-Station-ID	31	MAC address of host
NAS-Port	5	Port that the host is connected to
Acct-Session-Id	44	802.1x or MAB session identifier generated by the switch
Framed-IP-Address	8	IP address of host
User-Name	1	Host login name
Error-Cause	101	Refer to the “Error-Cause codes in RADIUS CoA-NAK and Disconnect-NAK messages” table in this appendix for a listing of error causes, error codes, and descriptions.

RADIUS attributes in the CoA-Request message (reauth-port)

Attribute	AVP Type	Description
Calling-Station-ID	31	MAC address of host

Attribute	AVP Type	Description
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.
Vendor-Specific	26	Fortinet-Group-Name
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
User-Name	1	Host login name

RADIUS attributes in the CoA-Request message (disable-port)

Attribute	AVP Type	Description
Calling-Station-ID	31	MAC address of host
User-Name	1	Host login name
NAS-IP-Address	4	NAS IP address
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.
Vendor-Specific	26	Fortinet-Group-Name
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Class	25	Whatever the server returns
Filter-Id	11	Relayed from the server

RADIUS attributes in the CoA-Request message (bounce-port)

Attribute	AVP Type	Description
Calling-Station-ID	31	MAC address of host
User-Name	1	Host login name
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.
Vendor-Specific	26	Fortinet-Group-Name
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Class	25	Whatever the server returns
Filter-Id	11	Relayed from the server

RADIUS attributes in the CoA-Request message (session-timeout)

Attribute	AVP Type	Description
Calling-Station-ID	31	MAC address of host
NAS-Port	5	Port that the host is connected to
Acct-Session-Id	44	802.1x or MAB session identifier generated by the switch
Framed-IP-Address	8	IP address of host
User-Name	1	Host login name

RADIUS attributes in the CoA-ACK message

Attribute	AVP Type	Description
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.

RADIUS attributes in the CoA-NAK message

Attribute	AVP Type	Description
Error-Cause	101	Refer to the “Error-Cause codes in RADIUS CoA-NAK and Disconnect-NAK messages” table in this appendix for a listing of error causes, error codes, and descriptions.
Event-Timestamp	55	Time when the event occurred. For example: May 31, 2019 12:25:03.00000000 Pacific Daylight Time
Message-Authenticator	80	The Message-Authenticator attribute is a checksum of the entire Access-Request packet, containing the Type, ID, Length, and Authenticator field; the shared secret is used as the key.

Error-Cause codes in RADIUS CoA-NAK and Disconnect-NAK messages

Error Cause	Error Code	Description
Unsupported Attribute	401	This error is a fatal error, which is sent if a request contains an attribute that is not supported.

Error Cause	Error Code	Description
NAS Identification Mismatch	403	This error is a fatal error, which is sent if one or more NAS-Identifier Attributes do not match the identity of the NAS receiving the request.
Invalid Attribute Value	407	This error is a fatal error, which is sent if a CoA-Request or Disconnect-Request message contains an attribute with an unsupported value.
Session Context Not Found	503	This error is a fatal error if the session context identified in the CoA-Request or Disconnect-Request message does not exist on the NAS.

Stop error codes for RADIUS accounting

Error Message	Error Code	Description
ACCT_TERM_CAUSE_IDLE_TIMEOUT	4	The system has been idle for too long.
ACCT_TERM_CAUSE_USER_REQUEST	1	The user requested the service to be stopped.
ACCT_TERM_CAUSE_SESSION_TIMEOUT	5	The session has timed out.
ACCT_TERM_CAUSE_ADMIN_RESET	6	The administrator has reset the session or port.