

Understand the OpenFlow on Catalyst 9000 Series Switches

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Introduction

This document describes Software Defined Networking (SDN) as a new approach to networking, complementing traditional network architectures. The original definition of SDN is tied to OpenFlow.

OpenFlow SDN Goals

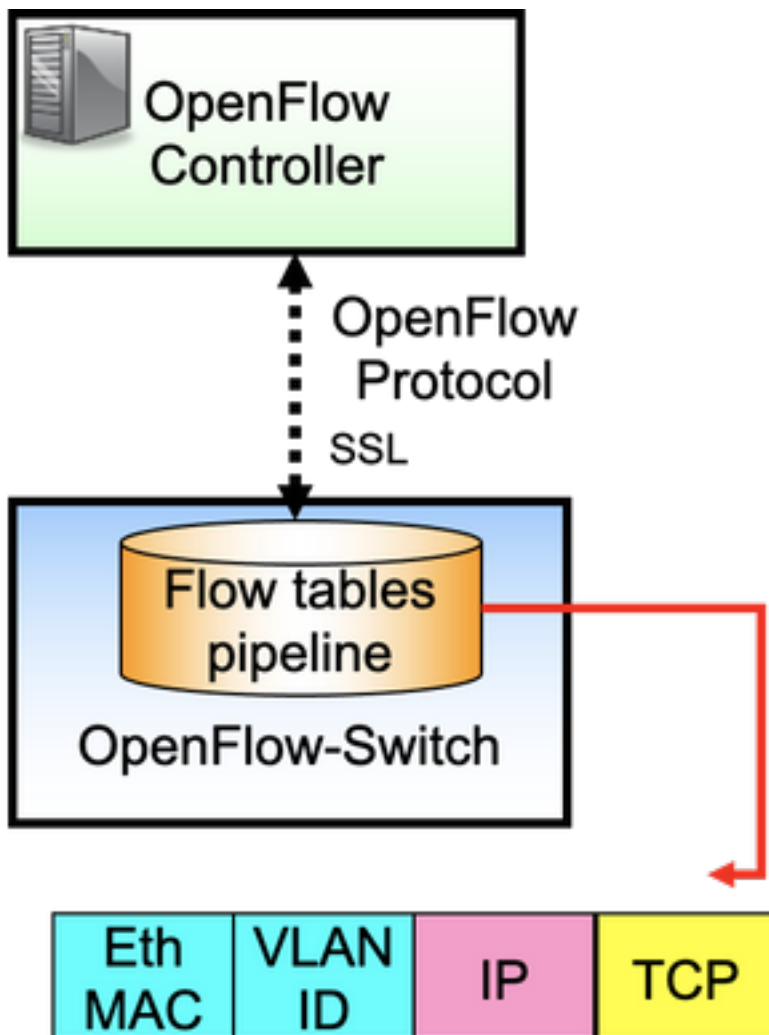
Here are the key goals for OpenFlow SDN.

- Increased network scalability.
- Reduced network complexity.
- Allow greater application control.
- Enable the feature independence.
- Achieved by separating the control and data planes, and **standardizing** the data plane. The control plane is implemented as omniscient, sophisticated, distributed software running on high-performance multi-core servers.
- OpenFlow is a specification from the Open Networking Foundation (ONF) that defines a flow-based forwarding infrastructure (**switch model**) and a standardized application programmatic interface (**protocol definition**).
- OpenFlow allows a controller to direct the forwarding functions of a switch through a secure channel. Local device configuration is out of the scope of the OpenFlow protocol.

Feature Summary

This is the Faucet OpenFlow controller:

- OpenFlow 1.3 switches (including TFM- Table Feature Message)
- Layer 2 switching, VLANs, ACLs, Layer 3 IPv4 and IPv6 routing, static and via BGP
- Deployed as a drop-in replacement for an L2/L3 switch in the network to enable extra SDN-based functionality.
- OpenFlow is a completely different forwarding paradigm, it uses the identical Catalyst 9000 hardware and software.
- The mode can be toggled between **OPENFLOW** and **NORMAL**, a reboot is required.

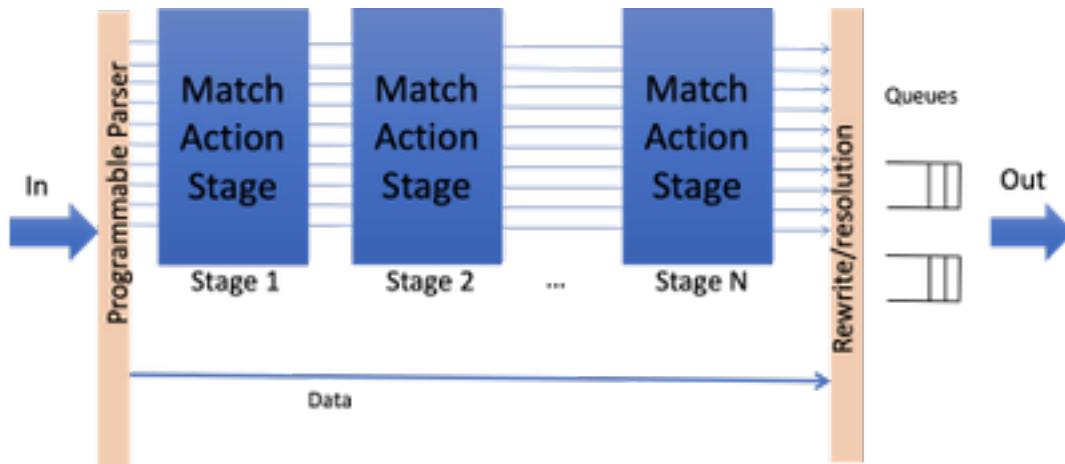


OpenFlow is the protocol between the controller (control plane) and the ethernet switch (data plane). The switch has flow tables arranged into a pipeline and the flows are rules to examine the packets.

A flow specifies:

- Match criteria
- Priority
- Actions to do on the packet
- Timeouts

Sample Pipeline:



Note: While there are no feature dependencies, the switch needs to be booted up in OpenFlow mode. Available Platforms in OpenFlow mode, Catalyst 9000 series switches - 9300/9400/9500/9500-H

Cisco Implementation (OpenFlow Mode on Cat9k)

The same image for normal and OpenFlow operation is used.

The switch should be in OpenFlow mode.

```
ott-of-c9k-210#show boot mode
System initialized in openflow forwarding mode
System configured to boot in openflow forwarding mode
All the front panel ports are openflow ports (no hybrid mode)
Changing the boot mode (reload mandatory)
ott-of-c9k-210(config)#boot mode openflow
Reload the switch.
```

Verify that the switch is in Openflow mode.

```
of-switch# show boot mode
System initialized in openflow forwarding mode
System configured to boot in openflow forwarding mode
"no boot mode openflow" followed by reboot reverts to normal mode.
```

```
CAT9300#show run openflow
feature openflow
openflow
switch 1 pipeline 1
 controller ipv4 10.104.99.42 port 6653 vrf Mgmt-vrf security none
 controller ipv4 10.104.99.42 port 6633 vrf Mgmt-vrf security tls
 controller ipv4 10.104.99.42 port 6637 vrf Mgmt-vrf security tls local-trustpoint tp-blue
```

There are a total of 8 controllers supported today!

IPV6 controller configuration and operation are also supported.

command options under OpenFlow

Purpose

switch 1 pipeline 1	Switch 1 and pipeline 1 is the only choice on C9k
controller ipv4 10.104.99.42 port 6653 vrf Mgmt-vrf security none	controller without security
controller ipv4 10.104.99.42 port 6633 vrf Mgmt-vrf security tls	controller with tls, uses global tls trustpoint configuration
controller ipv4 10.104.99.42 port 6637 vrf Mgmt-vrf security tls local-trustpoint tp-blue	controller with tls, uses local tlstrustpoint configuration but remote from global tlstrustpoint
max-backoff 10	Max time to retry OpenFlow connection when the controller connection goes down, the default value is 10 sec
probe-interval 10	Time interval to probe OpenFlow connection with controller, when connection becomes idle, the default value is 5 sec
rate-limit packet_in 2000 burst 3000	packet rate limit to controller, default values are 2000 packets per second and 3000 burst
statistics collection-interval 6	frequency to collect flow stats, the default value is 5sec
datapath-id 0x1	switch datapath unique-id, if unconfigured default value is ((1<<48) system-mac-addr)
default-miss controller	packet not matching any flow can be punted to the controller. default is to drop
logging flow-modify	dumps the flow-mod information as a log in show flow modify logging, not enabled by default
tls trustpoint local tp-local remote tp-remote	global tls trustpoint for a secure controller connection

Troubleshooting/Debugging

Controller-side debugging is out of the scope of this document.

Not all of your usual platform CLIs are supported on the Openflow switch. Choose and use only allowed CLIs for your debugging scenario.

Please refer to this config-guide for any other commands and references: https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/174/b_174_programmability_cg/openflow.html#id_76495

Show Commands - IOS®

Command	Purpose
show running-config openflow	Displays the OpenFlow running configuration information.
show openflow switch <i>number</i> controllers	Displays information about the OpenFlow agent connectivity to the controller.
show openflow switch <i>number</i> flows list	Displays information about the OpenFlow flows installed.
show openflow switch <i>number</i> ports	Displays information about the OpenFlow agent port status.
show openflow hardware capabilities	Displays the hardware capabilities such as the number of ports.

of tables, table size, supported match/action/miss

show openflow switch *number* groups

Displays information about Openflow groups.

show openflow switch *number* stats

Displays OpenFlow interface (rx/tx) stats, OpenFlow table stats (max flows per table, active flows per table, no. of lookups and matches).

show openflow switch *number* controller stats

Displays openflow controller(s) stats information.

Show commands - hardware:

Command

show platform software fed switch active openflow status

Purpose

Displays statistics on how many messages installed/successful/deleted.

show platform software fed switch active openflow flow *id*

Displays information in a particular flow.

show platform software fed switch active openflow group

Displays hardware information about flow groups.

show platform hardware fed switch active fwd-asic resource tcam utilization

Displays hardware information about TCAM usage.

show platform software fed <switch> active openflow error [brief | event | detail]

List all of the OpenFlow errors if any recorded.

show platform software fed <switch> active openflow table [<table-id> | mapping]

This command can provide the table id to feature capability/match capabilities and the sizes of the table.

show platform software fed switch active openflow event

Displays the list of the events on each table with the time taken on any action with respect to flow (addition, deletion, update).