# Nexus 9000 Cloud Scale ASIC NX-OS SPAN-to-CPU Procedure

## Contents

## Introduction

This document describes the steps used to perform a Switched Port Analyzer (SPAN)-to-CPU packet capture on a series of Cisco Nexus 9000 Cloud Scale ASIC modules. This document also describes common caveats encountered when using a SPAN-to-CPU packet capture to troubleshoot packet flow through a Cisco Nexus 9000 Cloud Scale series switch.

## Background Information

A SPAN-to-CPU packet capture allows network administrators to quickly and easily validate whether specific packets ingress and egress a Cisco Nexus 9000 Cloud Scale series switch. Similarly to a normal SPAN or Encapsulated Remote SPAN (ERSPAN) session, a SPAN-to-CPU monitor session involves the definition of one or more source interfaces and traffic directions. Any traffic that matches the direction (TX, RX, or both) defined on a source interface is replicated to the control plane of the Cisco Nexus 9000 device. This replicated traffic can be filtered and analyzed with the use of the Ethanalyzer control plane packet capture utility or saved to a local storage device for later review.

This feature is intended for temporary usage while troubleshooting packet flow through Cisco Nexus 9000 series switches. Cisco strongly recommends that SPAN-to-CPU monitor sessions are administratively shut down or removed when not actively used for troubleshooting a packet flow issue. Failure to do so might result in performance degradation for replicated traffic in the network and increased CPU utilization of the Cisco Nexus 9000 series switch.

### Applicable Hardware

The procedure covered in this document is applicable to this hardware only:

- **Nexus 9200/9300 Fixed Switches** N9K-C92160YC-XN9K-C92300YCN9K-C92304QCN9K-C92348GC-XN9K-C9236CN9K-C9272QN9K-C9332CN9K-C9364CN9K-C93108TC-EXN9K-C93108TC-EX-24N9K-C93180LC-EXN9K-C93180YC-EXN9K-C93180YC-EX-24N9K-C93108TC-FXN9K-C93108TC-FX-24N9K-C93180YC-FXN9K-C93180YC-FX-24N9K-C9348GC-FXPN9K-C93240YC-FX2N9K-C93216TC-FX2N9K-C9336C-FX2N9K-C9336C-FX2-EN9K-C93360YC-FX2N9K-C93180YC-FX3N9K-C93108TC-FX3PN9K-C93180YC-FX3SN9K-C9316D-GXN9K-C93600CD-GXN9K-C9364C-GXN9K-C9364D-GX2AN9K-C9332D-GX2B
- **Nexus 9500 Modular Switch Line Cards** N9K-X97160YC-EXN9K-X9732C-EXN9K-X9736C-EXN9K-X97284YC-FXN9K-X9732C-FXN9K-X9788TC-FXN9K-X9716D-GX

# Prerequisites

### Requirements

Cisco recommends that you understand the basics of the Ethernet Switched Port Analyzer (SPAN) feature on the Cisco Nexus 9000 series switches. For information about this feature, refer to the following documents:

- Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 9.3(x)
- Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 9.2(x)
- Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 7.0(3)I7(x)

### Components Used

The information in this document is based on Cisco Nexus 9000 series switches with the Cloud Scale ASIC running NX-OS software release 9.3(3).

The information in this document was created from devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

# Caveats and Limitations

SPAN-to-CPU monitor sessions have some caveats and limitations to be aware of when troubleshooting packet flows. This document will cover some commonly-encountered caveats. For a full list of guidelines and limitations, refer to the following documents:

- Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 9.3(x)

- Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 9.2(x)
- Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 7.0(3)I7(x)

## 50 kbps Default Hardware Rate Limiter

By default, Cisco Nexus 9000 series switches limit the rate of traffic replicated to the control plane through a SPAN-to-CPU monitor session to 50 kbps. This rate limiting is performed at the Cloud Scale ASIC/forwarding engine and is a self-protection mechanism to ensure the control plane of the device is not overwhelmed with replicated traffic.

The **show hardware rate-limiter span** command can be used to view the current setting of the SPAN-to-CPU monitor session rate limiter.

```
N9K# show hardware rate-limiter span

Units for Config: kilo bits per second Allowed, Dropped & Total: aggregated bytes since last
clear counters Module: 1 R-L Class Config              Allowed              Dropped
Total
 +----------------+----------+--------------------+--------------------+--------------------+
span                      50                    0 0 0
```

If replicated traffic is dropped by the hardware rate-limiter, then the Dropped column will be a non-zero value, as shown in the output below:

```
N9K# show hardware rate-limiter span

Units for Config: kilo bits per second Allowed, Dropped & Total: aggregated bytes since last
clear counters Module: 1 R-L Class Config Allowed Dropped              Total
 +----------------+----------+--------------------+--------------------+--------------------+
span                      50 0 499136              499136
```

The SPAN-to-CPU monitor session hardware rate limiter can be changed with the **hardware rate-limiter span {kbps}** global configuration command, as shown in the output below.

```
N9K# configure terminal
Enter configuration commands, one per line. End with CNTL/Z. N9K-1(config)# hardware rate-
limiter span 250
N9K-1(config)# end
N9K# show running-config | inc rate-limiter
hardware rate-limiter span 250 N9K# show hardware rate-limiter span

Units for Config: kilo bits per second Allowed, Dropped & Total: aggregated bytes since last
clear counters Module: 1 R-L Class Config              Allowed              Dropped
Total
 +----------------+----------+--------------------+--------------------+--------------------+
span                     250                    0 0 0
```

> **Caution**: Cisco does not recommend modifying the SPAN-to-CPU monitor session hardware rate limiter away from its default value of 50 kbps unless explicitly instructed to do so by Cisco TAC. Increasing this rate limiter to a high value can cause increased CPU utilization and control plane instability on the Cisco Nexus 9000 series switch, which could cause a significant impact on production traffic.

## SPAN-to-CPU Hardware Rate Limiter Allowed Counter is not Supported

The output of the **show hardware rate-limiter span** command contains an Allowed counter. On other hardware rate limiters, this counter indicates how many bytes successfully pass through the hardware rate limiter. However, the Allowed counter for the SPAN-to-CPU hardware rate limiter does not increment due to a software limitation. An example of this is shown in the output below:

```
N9K# show hardware rate-limiter span

Units for Config: kilo bits per second
Allowed, Dropped & Total: aggregated bytes since last clear counters


Module: 1
R-L Class Config Allowed              Dropped               Total
+----------------+----------+--------------------+--------------------+--------------------+
span 50 0               499136             499136
```

This software limitation affects all NX-OS software releases and is documented through CSCva37512.

In order to determine how much traffic has been replicated to the control plane of a Nexus 9000 device configured with an active SPAN-to-CPU monitor session, use the **show system internal access-list tcam ingress region span** command. An example of the filtered output of the aforementioned command that shows relevant packet and byte counters is shown below.

```
N9K# show system internal access-list tcam ingress region span | include pkts:
<snip>
pkts: 56582127, bytes: 4119668263
```

## Control Plane-Generated Packets do not Appear in TX SPAN-to-CPU Monitor Sessions

Packets created by the control plane and transmitted out of a source interface for a SPAN-to-CPU monitor session will not be captured by the SPAN-to-CPU monitor session. These packets will egress the interface correctly, but cannot be captured through a SPAN-to-CPU monitor session on the same device where the packet is generated.

For example, consider a Cisco Nexus 9000 series device where Ethernet1/1 is an L3/routed interface connected to another router. OSPF process 1 is activated on Ethernet1/1, which is the only OSPF-activated interface on the Cisco Nexus 9000 device.

```
N9K# show running-config ospf

!Command: show running-config ospf !Running configuration last done at: Wed Feb 26 16:16:30 2020
!Time: Wed Feb 26 16:16:37 2020 version 9.3(3) Bios:version 05.39 feature ospf router ospf 1
interface Ethernet1/1 ip router ospf 1 area 0.0.0.0 N9K# show ip ospf interface brief
 OSPF Process ID 1 VRF default Total number of interface: 1 Interface ID Area Cost State
Neighbors Status Eth1/1 1 0.0.0.0 4 DR 0 up
```

The Ethanalyer control plane packet capture utility shows that OSPF Hello messages are generated by the control plane of the device once every 10 seconds.

```
N9K# ethanalyzer local interface inband display-filter ospf limit-captured-frames 0
Capturing on inband 2020-02-26 16:19:13.041255 192.168.1.1 -> 224.0.0.5 OSPF Hello Packet
2020-02-26 16:19:22.334692 192.168.1.1 -> 224.0.0.5 OSPF Hello Packet
```

```
2020-02-26 16:19:31.568034 192.168.1.1 -> 224.0.0.5 OSPF Hello Packet
^C 3 packets captured
```

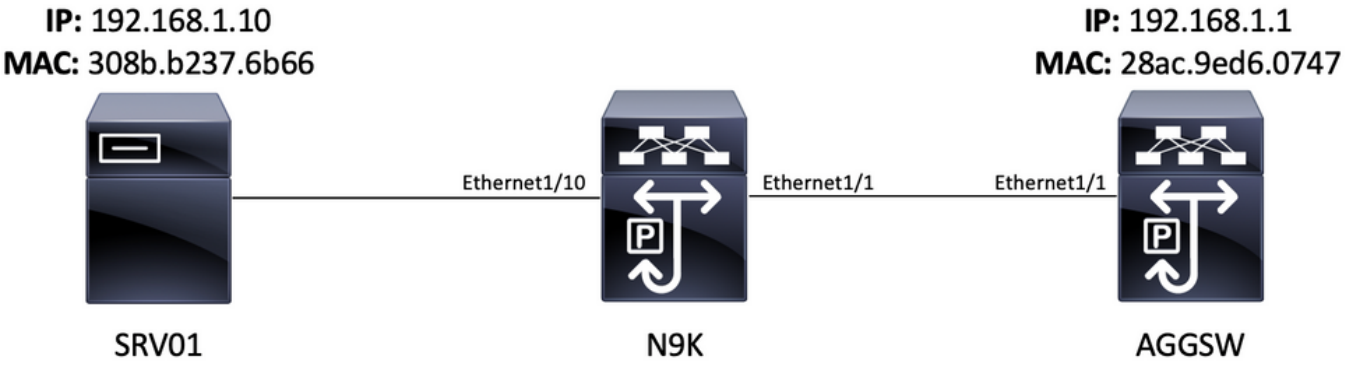
However, an egress/TX SPAN-to-CPU on the Ethernet1/1 interface does not show these Open Shortest Path First (OSPF) Hello packets transmitted on this interface after 60 seconds of time.

```
N9K# show running-config monitor

!Command: show running-configmonitor !Running configuration last done at: Wed Feb 26 16:20:48
2020 !Time: Wed Feb 26 16:20:51 2020 version 9.3(3) Bios:version 05.39 monitor session 1 source
interface Ethernet1/1 tx destination interface sup-eth0 no shut N9K# show monitor
Session  State        Reason                 Description
-------  -----------  ---------------------  --------------------------------
1        up           The session is up


N9K# ethanalyzer local interface inband mirror display-filter ospf autostop duration 60
Capturing on inband
0 packets captured
```

In order to verify whether packets generated by the control plane of a Cisco Nexus 9000 device are transmitted out of a specific interface, Cisco recommends using a packet capture utility on the remote device connected to the interface.

# Cisco Nexus 9000 Cloud Scale SPAN-to-CPU Procedure

Consider the following topology:



An Internet Control Message Protocol (ICMP) packet sourced from server SRV01 in VLAN 10 (192.168.10.10) is destined for the VLAN 10 gateway 192.168.10.1. A SPAN-to-CPU monitor session will be used to confirm that this ICMP packet traverses device N9K (a Cisco Nexus 93180YC-EX that runs NX-OS software release 9.3(3)), which acts as a Layer 2 switch that connects SRV01 to AGGSW in VLAN 10.

## Step 1. Confirm Sufficient Resources for the New SPAN Session

Cisco Nexus 9000 series switches with the Cloud Scale ASIC that run NX-OS software support a maximum of four active SPAN or ERSPAN sessions per ASIC/forwarding engine. Furthermore, if the first three SPAN or ERSPAN sessions are configured with bidirectional (TX and RX) source interfaces, the source interface of the fourth SPAN or ERSPAN session must be an ingress/RX source.

Before you configure a SPAN-to-CPU monitor session, verify the quantity of other SPAN or ERSPAN sessions currently configured on the device. This can be done with the **show running-config monitor** and **show monitor** commands. The example below shows the output of both commands when no other SPAN or ERSPAN sessions are configured on the device.

```
N9K# show running-config monitor

!Command: show running-configmonitor !Running configuration last done at: Tue Feb 25 20:34:04
2020 !Time: Tue Feb 25 20:34:06 2020 version 9.3(3) Bios:version 07.66 N9K# show monitor
Note: No sessions configured
```

> **Note**: Additional information about the maximum number of SPAN/ERSPAN sessions and other limitations can be found in the Cisco Nexus 9000 Series NX-OS Verified Scalability Guide for NX-OS Software Release 9.3(3).

## Step 2. Configure SPAN-to-CPU Monitor Session

The key configuration element that defines a SPAN-to-CPU monitor session is a destination interface of "sup-eth0", which is the supervisor's inband interface. The example below shows the configuration of a SPAN-to-CPU monitor session where the ingress/RX packets of Ethernet1/10 are replicated to the supervisor of the Cisco Nexus 9000 series switch.

```
N9K# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
N9K-1(config)# monitor session 1
N9K-1(config-monitor)# source interface Ethernet1/10 rx
N9K-1(config-monitor)# destination interface sup-eth0
N9K-1(config-monitor)# no shut
N9K-1(config-monitor)# end
N9K#
```

## Step 3. Verify SPAN-to-CPU Monitor Session is Up

Use the **show running-config monitor** and **show monitor** commands in order to verify that the SPAN-to-CPU monitor session is configured and operational. The configuration of the SPAN-to-CPU monitor session can be verified through the output of the **show running-config monitor** command, as shown in the example below.

```
N9K# show running-config monitor

!Command: show running-configmonitor !Running configuration last done at: Tue Feb 25 20:47:50
2020 !Time: Tue Feb 25 20:49:35 2020 version 9.3(3) Bios:version 07.66 monitor session 1 source
interface Ethernet1/10 rx destination interface sup-eth0 no shut
```

The operational state of the SPAN-to-CPU monitor session can be verified through the output of the **show monitor** command. The output should report that the state of the SPAN-to-CPU monitor session is "up" with a reason of "The session is up", as shown in the example below.

```
N9K# show monitor
Session State Reason Description - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - 1 up The session
is up
```

## Step 4. View Replicated Packets in the Control Plane

The Ethanalyzer control plane packet capture utility can be used to view traffic replicated to the control plane of the Cisco Nexus 9000 device. The **mirror** keyword in the Ethanalyzer command filters traffic such that only traffic replicated by a SPAN-to-CPU monitor session is shown. Ethanalyzer capture and display filters can be used to further limit the traffic displayed. Additional information about useful Ethanalyzer capture and display filters can be found in the Ethanalyzer on Nexus 7000 Troubleshooting Guide. Note that while this document was written for the Cisco Nexus 7000 platform, it is mostly applicable to the Cisco Nexus 9000 platform as well.

An example of the usage of the Ethanalyzer control plane packet capture utility to filter traffic replicated by a SPAN-to-CPU monitor session is shown below. Note that the **mirror** keyword is used, as well as a display filter defining ICMP packets sourced from or destined to 192.168.10.10 (the IP address of SRV01 in the aforementioned topology).

```
N9K# ethanalyzer local interface inband mirror display-filter "icmp && ip.addr==192.168.10.10"
limit-captured-frames 0
Capturing on inband
2020-02-25 21:01:07.592838 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.046682 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.047720 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.527646 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.528659 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.529500 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.530082 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.530659 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request 2020-02-25
21:01:08.531244 192.168.10.10 -> 192.168.10.1 ICMP Echo (ping) request ^C 9 packets captured
```

> **Note**: Use the Control-C key combination in order to exit the Ethanalyzer control plane packet capture utility.

One can view detailed information about this traffic by including the **detail** keyword in the Ethanalyzer command. An example of this for a single ICMP Echo Request packet is shown below.

```
N9K# ethanalyzer local interface inband mirror display-filter "icmp && ip.addr==192.168.10.10"
limit-captured-frames 0 detail
Capturing on inband Frame 2 (114 bytes on wire, 114 bytes captured) Arrival Time: Feb 25, 2020
21:56:40.497381000 [Time delta from previous captured frame: 1.874113000 seconds] [Time delta
from previous displayed frame: 1.874113000 seconds] [Time since reference or first frame:
1.874113000 seconds] Frame Number: 2 Frame Length: 114 bytes Capture Length: 114 bytes [Frame is
marked: False] [Protocols in frame: eth:ip:icmp:data] Ethernet II, Src: 30:8b:b2:37:6b:66
(30:8b:b2:37:6b:66), Dst: 28:ac:9e:d6:07:47 (28:ac:9e:d6:07:47) Destination: 28:ac:9e:d6:07:47
(28:ac:9e:d6:07:47) Address: 28:ac:9e:d6:07:47 (28:ac:9e:d6:07:47) .... ...0 .... .... .... ....
= IG bit: Individual address (unicast) .... ..0. .... .... .... .... = LG bit: Globally unique
address (factory default) Source: 30:8b:b2:37:6b:66 (30:8b:b2:37:6b:66) Address:
30:8b:b2:37:6b:66 (30:8b:b2:37:6b:66) .... ...0 .... .... .... .... = IG bit: Individual address
(unicast) .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default) Type
: IP (0x0800) Internet Protocol, Src: 192.168.10.10 (192.168.10.10), Dst: 192.168.10.1
(192.168.10.1) Version : 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP
0x00: Default; ECN: 0x00) 0000 00.. = Differentiated Services Codepoint: Default (0x00) ....
..0. = ECN-Capable Transport (ECT): 0 .... ...0 = ECN-CE: 0 Total Length: 100 Identification:
0x00e1 (225) Flags: 0x00 0.. = Reserved bit: Not Set .0. = Don't fragment: Not Set ..0 = More
fragments: Not Set Fragment offset: 0 Time to live: 254 Protocol: ICMP (0x01) Header checksum :
0x265c [correct] [Good: True] [Bad : False] Source: 192.168.10.10 (192.168.10.10) Destination:
192.168.10.1 (192.168.10.1) Internet Control Message Protocol Type : 8 (Echo (ping) request)
```

```
Code: 0 () Checksum : 0xf1ed [correct] Identifier: 0x0004 Sequence number: 0 (0x0000) Data (72
bytes) 0000 00 00 00 00 ed 9e 9e b9 ab cd ab cd ab cd ab cd ................ 0010 ab cd ab cd ab
cd ab cd ab cd ab cd ab cd ab cd ................ 0020 ab cd ab cd ab cd ab cd ab cd ab cd ab cd
ab cd ................ 0030 ab cd ab cd ab cd ab cd ab cd ab cd ab cd ab cd ................
0040 ab cd ab cd ab cd ab cd ........ Data: 00000000ED9E9EB9ABCDABCDABCDABCDABCDABCDABCDABCD...
[Length: 72] ^C 1 packet captured
```

### Step 5. Administratively Shut Down the SPAN-to-CPU Monitor Session

Use the **shut** configuration command within the context of the SPAN-to-CPU monitor session to gracefully shut down the SPAN-to-CPU monitor session and stop replicating traffic to the Cisco Nexus 9000 device's control plane.

```
N9K# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
N9K-1(config)# monitor session 1
N9K-1(config-monitor)# shut
N9K-1(config-monitor)# end
N9K#
```

Verify the operational state of the SPAN-to-CPU monitor session with the **show monitor** command. The operational state of the SPAN-to-CPU monitor session should show as "down" with a reason of "Session admin shut", as shown in the example below:

```
N9K# show monitor
Session State Reason Description - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - 1 down Session
admin shut
```

### Step 6. Remove SPAN-to-CPU Monitor Session Configuration (Optional)

If desired, remove the SPAN-to-CPU monitor session configuration with the **no monitor session {id}** configuration command. An example of this is shown in the output below.

```
N9K# configure terminal
Enter configuration commands, one per line . End with CNTL/Z. N9K-1(config)# no monitor session
1
N9K-1(config)# end
```

Verify that the SPAN-to-CPU monitor session configuration has been successfully removed with the **show running-config monitor** command, as shown in the example below.

```
N9K# show running-config monitor

!Command: show running-configmonitor !Running configuration last done at: Tue Feb 25 21:46:25
2020 !Time: Tue Feb 25 21:46:29 2020 version 9.3(3) Bios:version 07.66 N9K#
```

## Analyze the Results of a SPAN-to-CPU Packet Capture

The above example of this procedure shows that ICMP Echo Request packets sourced from 192.168.10.10 (SRV01) destined to 192.168.10.1 (AGGSW) ingress the Ethernet1/10 interface of the Cisco Nexus 9000 device with a hostname of N9K. This proves that SRV01 sends this traffic out of its network interface card. This also proves that the ICMP Echo Request packet progresses far enough into the Cisco Cloud Scale ASIC's forwarding pipeline for it to be replicated to the control plane of the device.

However, this does not prove that the Cisco Nexus 9000 device forwards the ICMP Echo Request packet out of Ethernet1/1 towards AGGSW. Further troubleshooting needs to be performed to validate whether the packet is forwarded out of Ethernet1/1 towards AGGSW. In order of trustworthiness:

1. If the remote device of the expected egress interface (Ethernet1/1 of N9K in the example) is a Cisco Nexus 9000 series device with a Cloud-Scale ASIC, you can perform an ingress/RX SPAN-to-CPU monitor session on the remote device (Eth1/1 of AGGSW in the example previously). If the remote device of the expected egress interface is not a Cisco Nexus 9000 series device with a Cloud-Scale ASIC, then a SPAN, port mirror, or other similar packet capture on the remote device is equivalent.

2. Perform an ingress/RX ELAM on the ingress interface (Ethernet1/10 of N9K in the example above) of the Cisco Nexus 9000 device. Additional information about this procedure can be found in the Nexus 9000 Cloud Scale ASIC NX-OS ELAM Troubleshooting TechNote.

3. Perform an egress/TX SPAN-to-CPU on the egress interface of the Cisco Nexus 9000 device (Ethernet1/1 of N9K in the example above).

## Related Information

- Cisco Nexus 9000 Series NX-OS Troubleshooting Guide, Release 9.3(x)
- Cisco Nexus 9000 Series NX-OS Troubleshooting Guide, Release 9.2(x)
- Cisco Nexus 9000 Series NX-OS Troubleshooting Guide, Release 7.0(3)I7(x)
- Ethanalyzer on Nexus 7000 Troubleshooting Guide
- Nexus 9000 Cloud Scale ASIC (Tahoe) NX-OS ELAM