

## Nexus 9300 ISSU Impact on Control Plane & Data Plane

The Cisco Nexus platform can perform In-Service Software Upgrade (ISSU) whereby Software images are upgraded in a non-disruptive manner and data plane forwarding is not impacted. The significant advantage of such a capability is continuous network availability in data center environments.

When a standard ISSU is performed on a Nexus switch with a single supervisor (e.g. N9K-C93180YC-EX), the supervisor CPU will be reset to load the new software version. When the new software is loaded, the control plane activities are restored. During this process, the data plane is not impacted (i.e. no disruption in traffic). According to Cisco's **"Upgrading or Downgrading the Cisco Nexus 9000 Series NX-OS Software"** guide, the control plane's downtime is approximately less than 120 seconds.

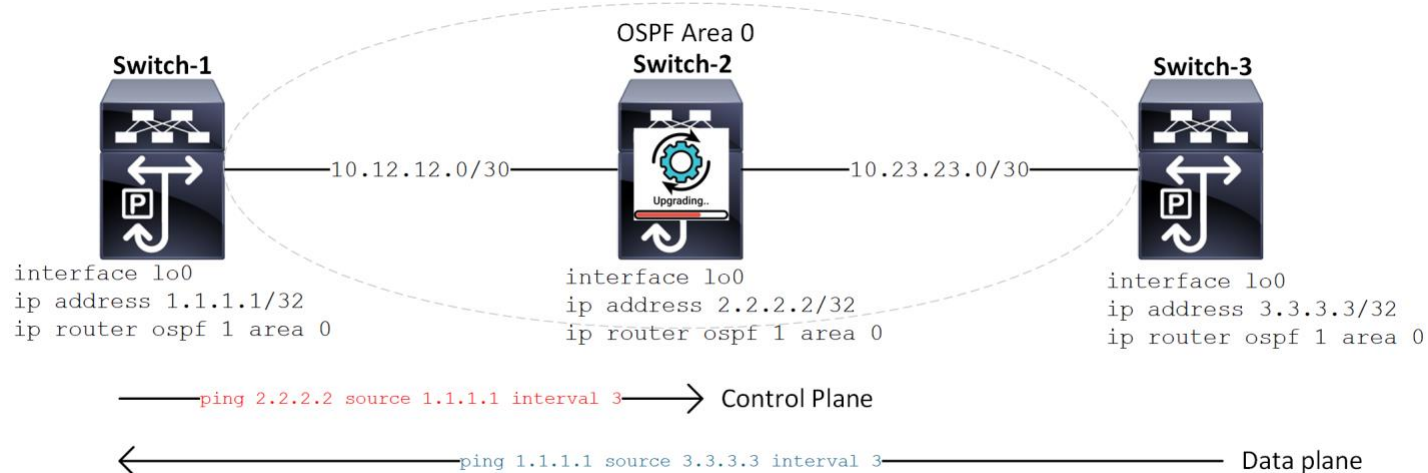
This lab examines the impact of a standard ISSU on the control and data planes. The testing was conducted in a controlled environment.

### Note

Production network software upgrades should be performed during a designated maintenance window to minimize potential disruptions.

## Lab Overview

The following test topology was used to conduct this lab.



The devices that were used are as follows:

- **Switch-1:** N9K-C93180YC-FX3 (Software: 10.3(6))
- **Switch-2:** N9K-C93180YC-EX (Software: 9.3(12))
- **Switch-3:** N9K-C93180YC-EX (Software: 10.3(6))

To evaluate the impact of an ISSU, ICMP traffic was tested in 2 scenarios:

1. ICMP traffic was sourced from Switch-1 to Switch-2 (control plane) to validate the control plane behaviour
2. ICMP traffic was sourced from Switch-3 to Switch-1 (data plane traffic transiting through Switch-2).

The upgrade was then triggered on Switch-2, and the continuity of both traffic flows was monitored throughout the process. Additionally, the impact on OSPF adjacencies was tested to ensure routing stability during the upgrade. The results confirmed minimal control plane downtime (less than 120 seconds) and uninterrupted data plane forwarding, consistent with Cisco's ISSU documentation. OSPF Graceful Restart ensured that OSPF adjacencies were maintained throughout the upgrade process and restarted momentarily when the CPU was restoring the control plane services.

**To trigger the non-disruptive upgrade the following command is issued:**

```
Switch-2# install all nxos bootflash:nxos64-cs.10.3.6.M.bin non-disruptive
```

The "non-disruptive" keyword is required to trigger in-service software upgrade which causes zero-downtime on the data traffic.

#### Note

The default software upgrade is disruptive; hence this keyword is required.

The specific command syntax and options may vary depending on the Nexus model and NX-OS version, and it is advisable to always refer to the latest Cisco documentation for your specific hardware and software combination.

```
Switch-2# install all nxos bootflash:nxos64-cs.10.3.6.M.bin non-disruptive
Installer will perform compatibility check first. Please wait.

Verifying image bootflash:/nxos64-cs.10.3.6.M.bin for boot variable "nxos".
[#####] 100% -- SUCCESS

Verifying image type.
[#####] 100% -- SUCCESS

Preparing "nxos" version info using image bootflash:/nxos64-cs.10.3.6.M.bin.
[#####] 100% -- SUCCESS

Preparing "bios" version info using image bootflash:/nxos64-cs.10.3.6.M.bin.
[#####] 100% -- SUCCESS

Performing module support checks.
[#####] 100% -- SUCCESS

Notifying services about system upgrade.
[#####] 100% -- SUCCESS

Compatibility check is done:
Module  bootable      Impact  Install-type  Reason
-----
1       yes          non-disruptive  reset

Images will be upgraded according to following table:
Module  Image              Running-Version(pri:alt)  New-Version  Upg-Required
-----
1       nxos                9.3(12)                  10.3(6)      yes
1       bios                v07.69(04/07/2021):v07.56(06/08/2016)  v07.69(04/07/2021)      no

Do you want to continue with the installation (y/n)? [n] y

Install is in progress, please wait.
```

```

Performing runtime checks.
[#####] 100% -- SUCCESS

Notifying services about the upgrade.
[#####] 100% -- SUCCESS

Setting boot variables.
[#####] 100% -- SUCCESS

Performing configuration copy.
[#####] 100% -- SUCCESS

Module 1: Refreshing compact flash and upgrading bios/loader/bootrom.
Warning: please do not remove or power off the module at this time.
[#####] 100% -- SUCCESS

Upgrade can no longer be aborted, any failure will result in a disruptive upgrade.

Freeing memory in the file system.
[#####] 100% -- SUCCESS

Loading images into memory.
[#####] 100% -- SUCCESS

Saving linecard runtime state.
[#####] 100% -- SUCCESS

Saving supervisor runtime state.

```

## Impact on Control Plane and Data Plane - Observations

During the supervisor CPU reload interval the ICMP traffic that was transiting through Switch-2 towards Switch-1 was not impacted:

```

Switch-3#
Switch-3# ping 1.1.1.1 source 3.3.3.3 interval 3 count unlimited
PING 1.1.1.1 (1.1.1.1) from 3.3.3.3: 56 data bytes
64 bytes from 1.1.1.1: icmp_seq=0 ttl=253 time=1.174 ms
64 bytes from 1.1.1.1: icmp_seq=1 ttl=253 time=1.343 ms
64 bytes from 1.1.1.1: icmp_seq=2 ttl=253 time=1.252 ms
64 bytes from 1.1.1.1: icmp_seq=3 ttl=253 time=1.251 ms

```

There was zero packet loss as follows:

```

--- 1.1.1.1 ping statistics ---
131 packets transmitted, 131 packets received, 0.00% packet loss
round-trip min/avg/max = 1.033/1.26/1.453 ms
Switch-3#
Switch-3#

```

Conversely, the ICMP traffic that was sourced from Switch-1 towards Switch-2 (control plane traffic) experienced some downtime for less than 120 seconds as expected:

## Before CPU reload

Prior to the CPU reload, traffic between Switch-1 and Switch-2 was uninterrupted.

```
Switch-1#  
Switch-1# ping 2.2.2.2 source 1.1.1.1 interval 3 count unlimited  
PING 2.2.2.2 (2.2.2.2) from 1.1.1.1: 56 data bytes  
64 bytes from 2.2.2.2: icmp_seq=0 ttl=254 time=1.084 ms  
64 bytes from 2.2.2.2: icmp_seq=1 ttl=254 time=1.262 ms
```

### During CPU reload:

During the supervisor CPU reload interval the ICMP traffic from Switch-1 to Switch-2 was interrupted.

```
64 bytes from 2.2.2.2: icmp_seq=84 ttl=254 time=1.107 ms  
64 bytes from 2.2.2.2: icmp_seq=85 ttl=254 time=1.157 ms  
Request 86 timed out  
Request 87 timed out  
Request 88 timed out  
Request 89 timed out  
Request 90 timed out  
Request 91 timed out  
Request 92 timed out  
Request 93 timed out  
Request 94 timed out  
Request 95 timed out  
Request 96 timed out  
Request 97 timed out  
Request 98 timed out  
Request 99 timed out  
Request 100 timed out  
Request 101 timed out  
Request 102 timed out  
Request 103 timed out  
Request 104 timed out  
Request 105 timed out  
Request 106 timed out  
Request 107 timed out  
Request 108 timed out  
Request 109 timed out  
Request 110 timed out  
Request 111 timed out  
Request 112 timed out  
Request 113 timed out  
Request 114 timed out  
Request 115 timed out  
Request 116 timed out  
Request 117 timed out  
Request 118 timed out  
64 bytes from 2.2.2.2: icmp_seq=119 ttl=254 time=1.348 ms  
64 bytes from 2.2.2.2: icmp_seq=120 ttl=254 time=1.298 ms  
64 bytes from 2.2.2.2: icmp_seq=121 ttl=254 time=1.288 ms
```

The downtime was approximately 99 seconds with a packet loss of ~25%.

```

--- 2.2.2.2 ping statistics ---
131 packets transmitted, 98 packets received, 25.19% packet loss
round-trip min/avg/max = 0.99/1.172/1.444 ms
Switch-1#
Switch-1#

```

## OSPF perspective:

The CPU reload, leads to an OSPF restart since OSPF is a routing protocol and is impacted during the supervisor CPU reload. During the OSPF restarting process on Switch-2, the OSPF adjacencies are maintained through Graceful restart helper mode. The GR helper mode is critical to maintaining the OSPF adjacency, routing table and forwarding table states, hence traffic from Switch-3 to Switch-1 is uninterrupted.

Switch-2 sends a Graceful LSA to its OSPF neighbors (Switch-1 and Switch-3) 2 before it starts the CPU reload.

### Switch-2 sends a Graceful Restart LSA:

```

ospf: 1 [28295] (default) GR Sending LSA with period 840
ospf: 1 [28295] (default) PSS entry for LSA 1.0.0.0(0x9) 1.1.1.1 (0x80000001) (0x209b) (0)(0) area 0.0.0.0 (Ethernet1/3) updated

```

Switch-1 & Switch-3 receive the GR LSA, so they can transition into helper mode which enables the continuous forwarding of traffic when the Switch-2 control plane processes are restarting.

```

ospf: 1 [11148] Received grace LSA on interface Ethernet1/3
ospf: 1 [11148] (default) Enabling flooding on all the active physical interfaces.
ospf: 1 [11148] (default) Transition nbr 10.12.12.2 into helper mode(Reason: 2, GP: 839)
ospf: 1 [11148] (default) Transition nbr 10.12.12.2 into helper mode(Reason: 2, GP: 839)

```

During the OSPF graceful restart, the OSPF adjacency is maintained using the forwarding information that is programmed into hardware before the CPU reloads. Switch-2 makes use of the routes that have been programmed in hardware to forward data plane traffic.

```
Switch-2# show forwarding route
```

```
slot 1
=====
```

```
IPv4 routes for table default/base
```

Prefix	Next-hop	Interface
0.0.0.0/32	Drop	Null0
127.0.0.0/8	Drop	Null0
255.255.255.255/32	Receive	sup-eth1
1.1.1.1/32	10.12.12.1	Ethernet1/3
2.2.2.2/32	Receive	sup-eth1
3.3.3.3/32	10.23.23.2	Ethernet1/2
10.12.12.0/24	Attached	Ethernet1/3
10.12.12.0/32	Drop	Null0
10.12.12.1/32	10.12.12.1	Ethernet1/3
10.12.12.2/32	Receive	sup-eth1
10.12.12.3/32	Attached	Ethernet1/3
10.23.23.0/24	Attached	Ethernet1/2
10.23.23.0/32	Drop	Null0
10.23.23.1/32	Receive	sup-eth1
10.23.23.2/32	10.23.23.2	Ethernet1/2
10.23.23.3/32	Attached	Ethernet1/2

Switch-1 or Switch-3 maintains neighborship with Switch-2 using the Graceful restart helper mode.

```
02:33:19.095784 ospf: 1 [11148] (default) Kept nbr 10.12.12.3 alive during GR helper mode
02:33:25.905452 ospf: 1 [11148] (default) aging slot 225
02:33:26.680341 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:33:26.680396 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:33:35.905579 ospf: 1 [11148] (default) aging slot 226
02:33:36.014022 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:33:36.014071 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:33:45.577117 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:33:45.577183 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:33:45.905716 ospf: 1 [11148] (default) aging slot 227
02:33:53.620758 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:33:53.620814 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:33:55.905853 ospf: 1 [11148] (default) aging slot 228
02:34:00.007029 ospf: 1 [11148] (default) Kept nbr 10.12.12.3 alive during GR helper mode
02:34:02.465340 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:34:02.465397 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:34:05.905980 ospf: 1 [11148] (default) aging slot 229
02:34:09.995825 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:34:09.995881 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:34:15.906108 ospf: 1 [11148] (default) aging slot 230
02:34:19.078514 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:34:19.078575 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
02:34:25.906263 ospf: 1 [11148] (default) aging slot 231
02:34:28.314856 ospf: 1 [11148] (default) P2P hello out, ivl 10/40, options 0x02, mask /30 nbrs 1 on Ethernet1/3 (area 0.0.0.0)
02:34:28.314924 ospf: 1 [11148] (default) sent: prty:6 HELLO to 224.0.0.5/Ethernet1/3
```

After the software upgrade the CPU restores control plane services, which results in OSPF adjacencies to be re-established between Switch-2 and it's OSPF neighbors.

```
ospf: 1 [11148] (default) sent: prty:5 DDESC to 10.12.12.2/Ethernet1/3
ospf: 1 [11148] (default) rcvd: prty:0 ver:2 t:DDESC len:32 rid:1.2.3.3 area:0.0.0.0 crc:0xa8dd aut:0 aukid:0 from 10.12.12.2/Ethernet1/3
ospf: 1 [11148] (default) Got DBD from 10.12.12.2 with 0 entries
ospf: 1 [11148] (default) seqnr 0x6a069f18, dbdbits 0x1, mda 1500, options 0x42
ospf: 1 [11148] (default) Pin in list, 229 -> 229, 'first area lsa in next dbd'
ospf: 1 [11148] (default) Pin in list, 4 -> 4, 'first as lsa in next dbd'
ospf: 1 [11148] (default) Got DBD from 10.12.12.2 with 0 entries
ospf: 1 [11148] (default) seqnr 0x6a069f18, dbdbits 0x1, mda 1500, options 0x42
ospf: 1 [11148] (default) Removed pin, 1 -> 0, 'next area lsa to request'
ospf: 1 [11148] (default) Removed pin, 1 -> 0, 'next as lsa to request'
ospf: 1 [11148] (default) PSS entry for nbr 10.12.12.2/Ethernet1/3 updated
ospf: 1 [11148] (default) Nbr 10.12.12.2: EXCHANGE -> FULL, event EXCHDONE
```

The Grace LSA is flushed and Switch-1/3 terminated the “GR helper mode state”

```
ospf: 1 [11148] (default) LSA 1.2.3.3 (0x9) 1.2.3.3 (0x80000002) (0x1e9c) (3600) inserted at lsager slot 233
ospf: 1 [11148] (default) Received grace LSA on interface Ethernet1/3
ospf: 1 [11148] (default) Enabling flooding on all the active physical interfaces.
ospf: 1 [11148] (default) Maxage Grace LSA rcvd 1.2.3.3 (0x9) 1.2.3.3 (0x80000002) (0x1e9c) (3600), adding nbr 10.12.12.3 to helper term list
ospf: 1 [11148] (default) Start LSU delay timer with initial wait 5.000 on intf Ethernet1/3
ospf: 1 [11148] (default) Terminating hitless helper mode for nbr 10.12.12.3
```

OSPF Adjacencies are fully restored:

```
Switch-2#
Switch-2# sh ip ospf neig
OSPF Process ID 1 VRF default
Total number of neighbors: 2
Neighbor ID      Pri State           Up Time    Address      Interface
3.3.3.3          1 FULL/ -         00:00:13   10.23.23.2   Eth1/2
1.1.1.1          1 FULL/ -         00:00:13   10.12.12.1   Eth1/3
Switch-2#
```

Software version upgrade post checks/verification on Switch-2:

The software upgrade on Switch-2 was successful as show by the Figure below.

```

Switch-2# show install all status
This is the log of last installation.

Continuing with installation process, please wait.
The login will be disabled until the installation is completed.

<Tue Jan 28 17:41:05>
Status for linecard upgrade.
-- SUCCESS <Tue Jan 28 17:41:06>

<Tue Jan 28 17:41:06>
Performing supervisor state verification.
-- SUCCESS <Tue Jan 28 17:41:08>

<Tue Jan 28 17:41:08>
Supervisor non-disruptive upgrade successful.

<Tue Jan 28 17:41:08> Install has been successful.
Switch-2#

```

```

Switch-2# show module

```

Mod	Ports	Module-Type	Model	Status
1	54	48x10/25G + 6x40/100G Ethernet Module	N9K-C93180YC-EX	active *

```

Switch-2# show version

```

Mod	Sw	Hw	Slot
1	10.3(6)	2.0	NA

## References

<https://www.cisco.com/c/en/us/td/docs/dcn/nx-os/nexus9000/103x/upgrade/cisco-nexus-9000-nx-os-software-upgrade-downgrade-guide-103x/m-upgrading-or-downgrading-the-cisco-nexus-9000-series-nx-os-software.html>

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