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.

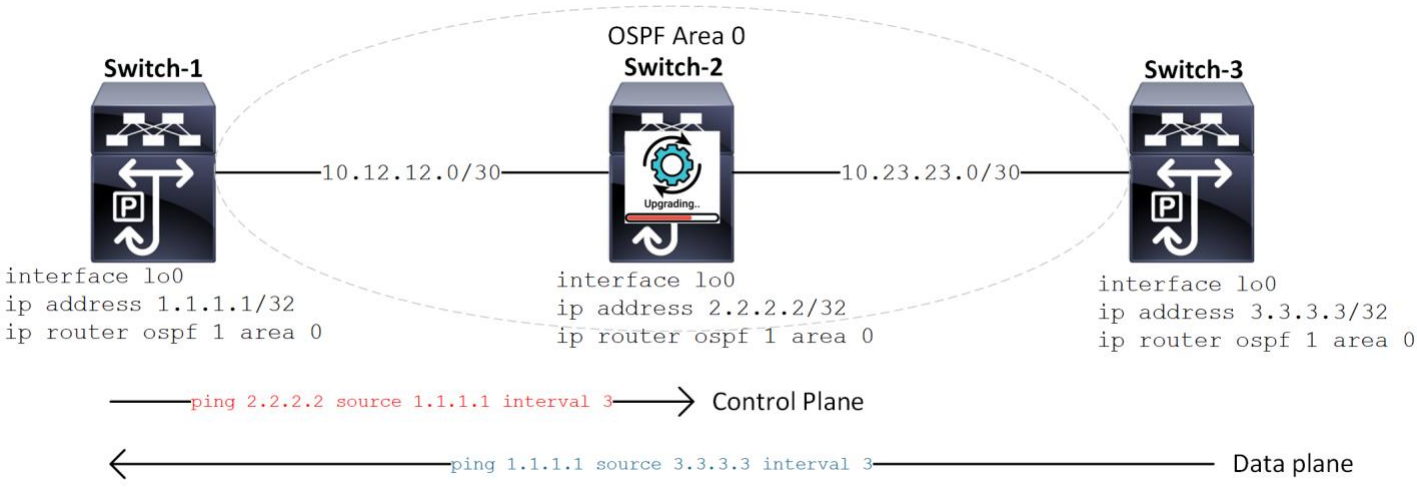
When a standard ISSU is performed on a Nexus switch with a single supervisor (e.g. N9K-C93180YC-EX), the supervisor CPU will be reset to load the new software version. When the new software is loaded, the control plane activities are restored. During this process, the data plane is not impacted (i.e. 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.

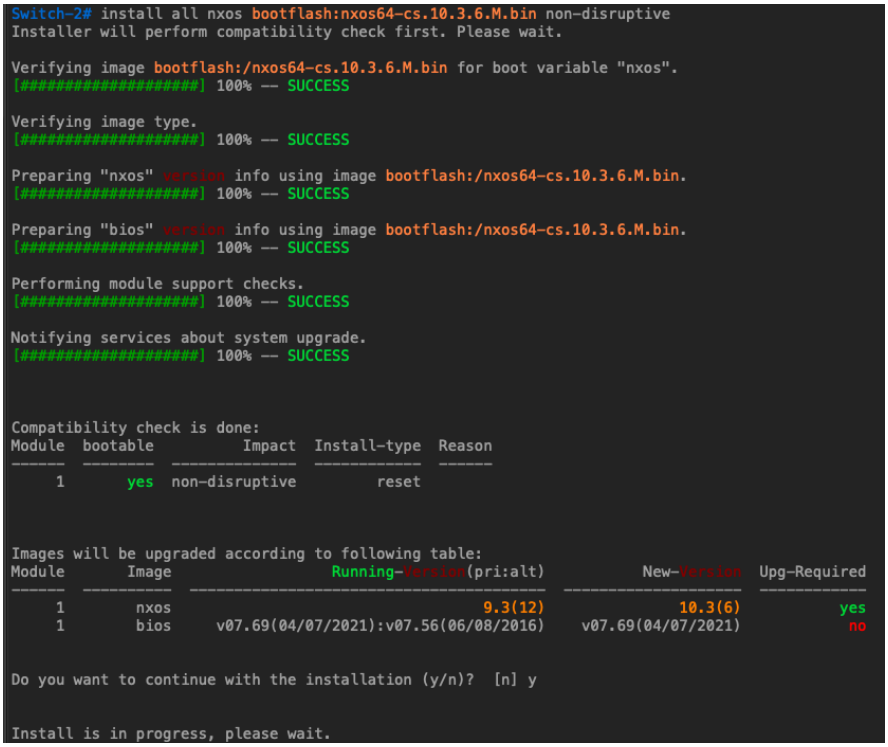
To trigger the non-disruptive upgrade the following command is issued:

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

The "`non-disruptive`" keyword id 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.



```
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 3.0.0.0(0x9) 2.2.2.2 (0x80000001) (0x209b) (0)(0) area 0.0.0.0 (Ethernet1/3) updated
```

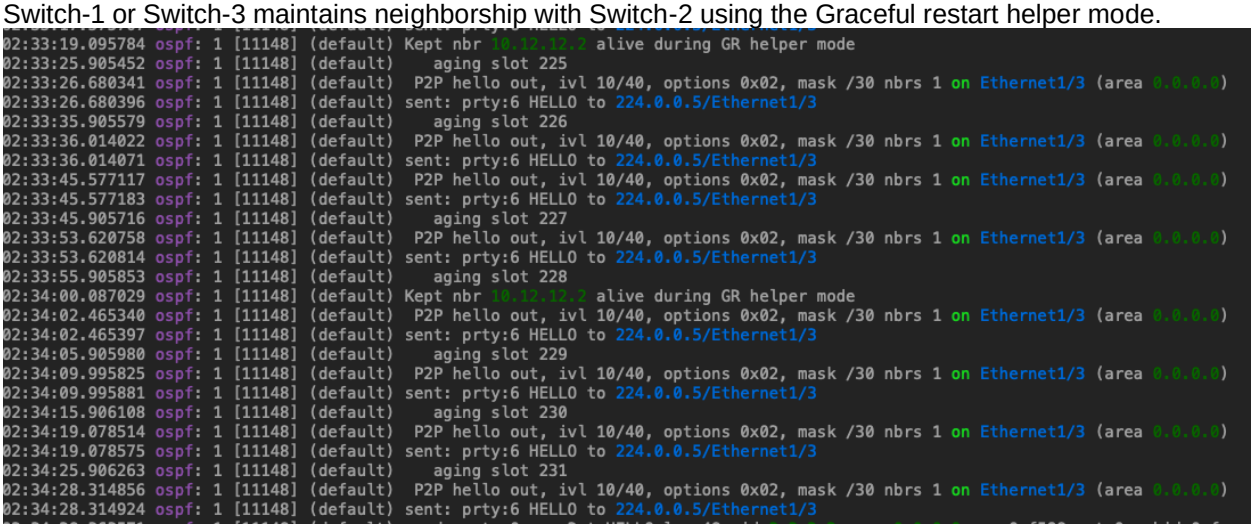
Switch-1 & Switch-3 receive the GR LSA, so they can transition into helper mode which enables the continuous forwarding of traffic when the Switch-2 control plane processes are restarting.

```
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)
```

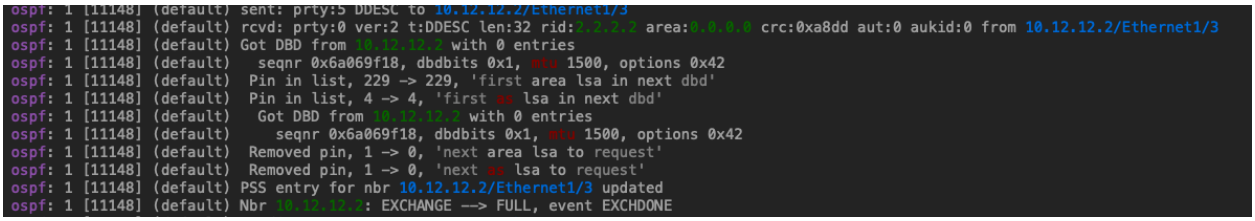
During the OSPF graceful restart, the OSPF adjacency is maintained using the forwarding information that is programmed into hardware before the CPU reloads. Switch-2 makes use of the routes that have been programmed in hardware to forward data plane traffic.

```
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
10.12.12.0/30       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
10.23.23.0/30       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
```

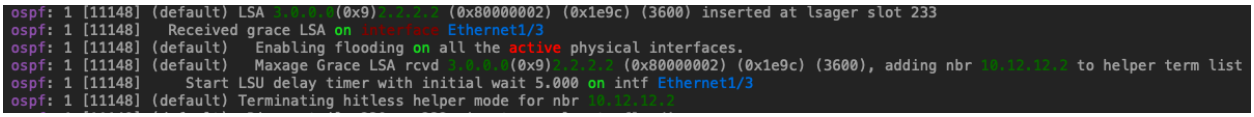
Switch-1 or Switch-3 maintains neighborship with Switch-2 using the Graceful restart helper mode.



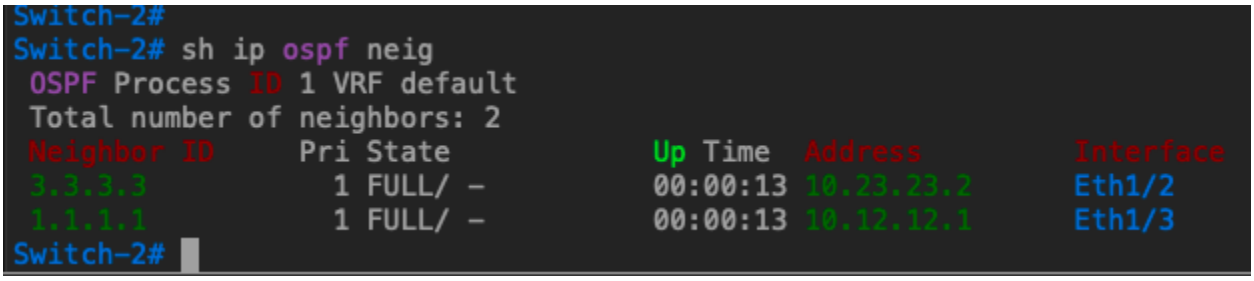
After the software upgrade the CPU restores control plane services, which results in OSPF adjacencies to be re-established between Switch-2 and it's OSPF neighbors.



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



OSPF Adjacencies are fully restored:



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 *

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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