

Topology-Independent In-Service Software Upgrades on the QFX5100

Juniper Innovation Brings ISSU to Data Center Top-of-Rack Switches

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Executive Summary

For a number of years, in-service software upgrades (ISSUs) have provided network administrators with a simpler, faster way to upgrade network system software. ISSU contributes to business continuity by ensuring network services and applications remain available even during system upgrades, so there's no impact on user productivity or customer satisfaction.

To date, however, ISSU has only been available on high-end, chassis-based networking devices, such as core routers and switches. And it has relied on redundant hardware—at a minimum, identically configured dual routing engines. Some vendors have claimed to offer ISSU through the use of completely redundant network devices, a truly expensive approach that takes half the network offline during an upgrade.

With the introduction of Juniper Networks® QFX5100 line of switches with its innovative software architecture, Juniper has delivered a new model for ISSU and an industry first—true ISSU for top-of-rack switches. Each QFX5100 features a Linux-based hypervisor supporting up to four virtual machines (VMs) running Juniper Networks Junos® operating system today and other services in the future. Juniper's Topology-Independent In-Service Software Upgrade (TISSU) technology leverages this VM-based architecture, eliminating the need for any redundant hardware and enabling network administrators to perform full system software upgrades in minutes, with no downtime.

TISSU dramatically reduces the time, cost, and complexity of system upgrades while contributing to hitless data center operation. It also eliminates the outages and costs that can result from failed device upgrades, further enhancing data center availability.

By making it easy to keep switches up to date with the latest features and security upgrades, TISSU ensures customers get the most from their networks while reducing risk. And by bringing technology to top-of-rack switch platforms that was previously only available for high-end systems, Juniper's TISSU now makes it possible to employ in-service upgrades across the network, end to end.

Introduction

The ability to perform ISSU has been a boon for network architects and administrators. This high availability feature for network devices lets administrators install new software versions without having to take network equipment offline.

Without ISSU, updating software on network devices is highly disruptive and time-consuming: It requires a significant amount of planning in advance, including e-mails notifying users of the impending update and attendant downtime, and the network is completely unavailable during the actual upgrade process. Manual software upgrades are also error prone, putting the enterprise at risk for greater disruption and downtime.

With ISSU, there's no need for network administrators to plan outages and block out the hours needed to complete an upgrade, significantly reducing the time it takes to perform software upgrades and dramatically lowering the associated costs. Likewise, network architects have more options and greater flexibility in how they design the network because there's no need to factor in the impact of software upgrades. Above all, ISSU contributes to business continuity by ensuring network services and applications remain available, so there's no impact on user productivity or customer satisfaction.

ISSU has a lot of advantages. To date, however, it has only been available on high-end, chassis-based networking devices such as core routers and switches, and it has been expensive to implement. Current ISSU implementations for modular routers and switches use an active-backup model based on two identically configured Routing Engines (REs), which allows the software upgrade to be done in a round-robin fashion, without bringing down the entire system.

Some vendors claim to support ISSU based on a redundant network topology, but this is not a true ISSU. This kind of "ISSU" implementation requires network administrators to install fully redundant, identically configured network gear in a topology-dependent design. During the upgrade process, half of the switches and routers are taken offline, new software loaded, and a failover performed to bring the updated devices back online. This process is then repeated for the remaining switches and routers. Besides being expensive, this method cuts available bandwidth in half, constraining business applications and services.

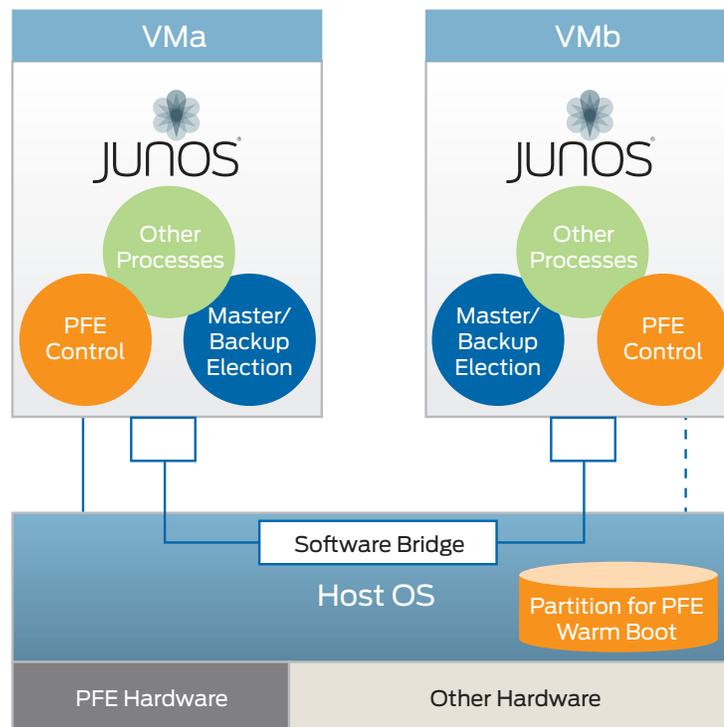


Figure 1: In-Service Software Upgrade (ISSU) architecture

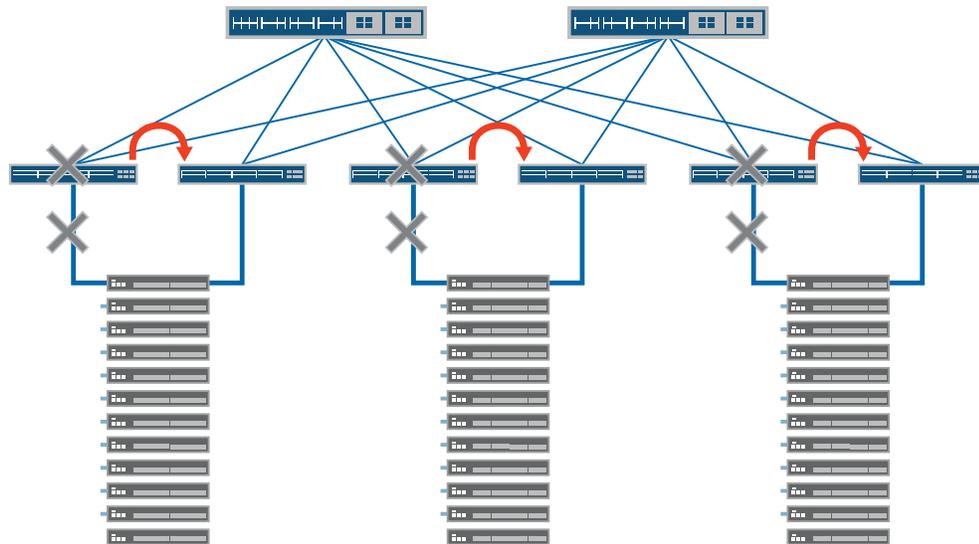
Juniper Networks knows there's a better way to upgrade network software. With the introduction of TISSU technology on the QFX5100 line of switches, Juniper is delivering a new model for ISSU and an industry first—true ISSU for top-of-rack switches.

TISSU extends the reach of ISSU to the heart of the data center, to a class—and price point—of switches not previously available. By leveraging VMs to host Junos OS on each switch, TISSU can perform entire operating system upgrades simply and quickly on a single QFX5100 switch. No redundant hardware is needed—no second supervisor module or routing engine, no second switch for a redundant topology—it's all integrated into TISSU. With this innovative technology, network administrators can upgrade software on data center access switches seamlessly, without disrupting servers, applications, or users.

Leveraging Junos OS Virtualization Technology—How TISSU Works

Juniper designed the QFX5100, its latest line of data center top-of-rack switches, as a universal building block for its fabric-based data center switching architectures. The QFX5100 features an innovative software architecture—a Linux-based hypervisor that supports up to four virtual machines (VMs) concurrently, on which the Junos OS (and other services in the future) run.

TISSU takes advantage of this virtualization technology. During normal switch operations, Junos OS only runs on one VM (called VMa for the purposes of this white paper). When TISSU is initiated, a second VM (VMb) is launched to load the new version of the software. Once VMb has loaded the new operating system, it synchronizes protocol states with VMa. When that synchronization process is complete, the Junos OS running on VMb seamlessly takes over switch operations and VMa shuts down.

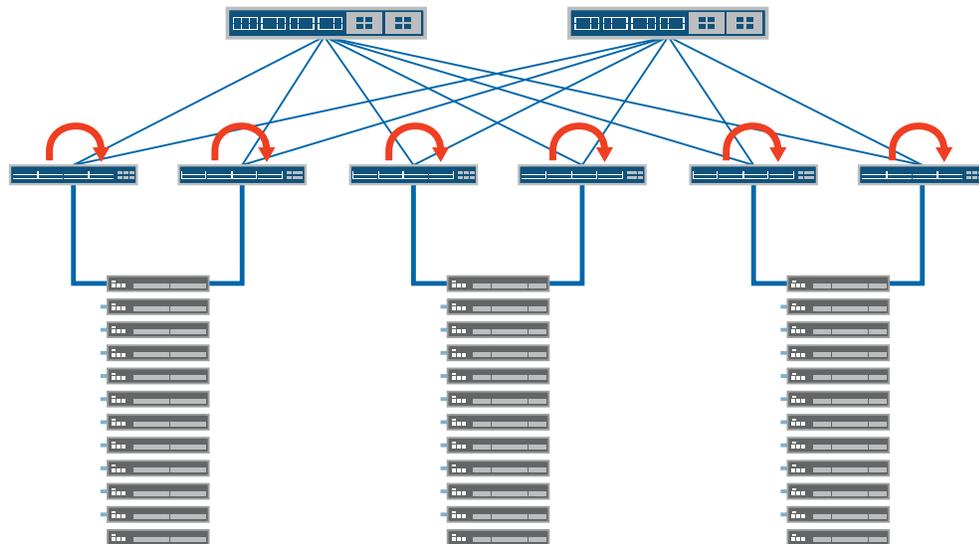


- Upgrade one switch at a time
- Applications run on half bandwidth
- Long maintenance window

Figure 2: Software updates without Topology-Independent In-Service Software Upgrades (TISSU)

TISSU is supported for all Layer 2 and Layer 3 protocols. This topology-independent design eliminates the need for a redundant switch topology to perform a software upgrade.

Note: TISSU is supported for standalone switches only. Devices operating in a Virtual Chassis or Virtual Chassis Fabric configuration should use the NSSU upgrade feature.



- Upgrade all switches at the same time
- Applications run on full bandwidth
- No application downtime

Figure 3: Software updates with TISSU

TISSU allows a complete operating system to be updated, not just individual subsystems. During upgrades, the switches seamlessly move to the newer software. There's no disruption to the control plane, and packet forwarding is continuous— so network operations are unaffected and applications run on full bandwidth.

To further streamline data center operations, Juniper plans to enable network administrators to upgrade multiple TISSU-capable switches at one time, with just a few clicks from Juniper Networks Junos Space Network Director software, which provides a single pane of glass for managing all Juniper switches.

Upgrade with Subsecond Convergence Time

With TISSU, upgrading data center access switch software is a simple, non-disruptive process with subsecond convergence time.

Network administrators begin the process with a few steps:

- Ensure that graceful Routing Engine switchover (GRES), nonstop active routing (NSR), and nonstop bridging (NSB) are enabled on target switches
- Copy the latest Junos OS release to the switch
- Initiate software upgrade using the switch CLI or (in the future) Junos Space Network Director management software

The switch then completes the process:

- TISSU launches *VMb*.
- *VMb* loads the newest software version and synchronizes all protocol state information from *VMa*.
- Once synchronized, *VMb* takes over control and *VMa* shuts down.
- Upgrade is complete.

To enable GRES, NSR, and NSB in TISSU, the network administrator must enter the following CLI commands:

```
set chassis redundancy graceful-switchover
set routing-options nonstop-routing
set protocols layer2-control nonstop-bridging
```

To commit the changes after configuration, enter these commands:

```
set system commit synchronize
commit synchronize
```

Implementing the actual TISSU capability requires a single command:

```
request system software in-service-upgrade <image location>
```

Extensive lab testing of TISSU reveals that network convergence time is in the millisecond range, even when a million packets per second are blasted into network interfaces on switches where TISSU has been performed.

To date, enterprises have had to schedule a maintenance window with a few hours of downtime to fully implement software upgrades. In contrast, TISSU operates in minutes, eliminating the hours of planning and execution previously needed to upgrade software on data center access switches.

TISSU Benefits

For a number of years, ISSU has provided IT with a simpler, faster way to upgrade network system software. By leveraging VMs, TISSU brings the high availability of ISSU to top-of-rack switches and extends this capability by delivering additional benefits, including the following:

- There is virtually no network downtime.
- Support for full system software upgrades is provided, not simply hot fixes or patches.
- There is no need for redundant REs.
- There is no need for redundant network topology.
- The VM architecture can support additional software services—for example, a service to collect network statistics for performance monitoring.
- Ease of use lets network administrators keep switches up to date with the latest features and security upgrades, ensuring customers get the most from their networks while reducing risk.
- It provides end-to-end ISSU, from data center core to the edge.

TISSU delivers upgrades with no downtime and eliminates the outages and costs that can result from failed device upgrades. With TISSU, network administrators can keep switches up to date while ensuring hitless data center operations.

Conclusion: Juniper Innovation

Data center uptime is crucial. By innovating in software, Juniper has delivered an industry first—the high-availability features of in-service software upgrades on top-of-rack data center switches. TISSU lets network administrators update switch software quickly and efficiently without affecting network—or server—operations.

Customers now have the flexibility to enable Topology-Independent In-Service Software Upgrade in Juniper Networks QFX5100 top-of-rack switch platforms—technology that was previously only available for modular, high-end dual-RE systems. In fact, TISSU makes it possible to employ in-service upgrades across the network, end to end. As a result, customers always have access to e-commerce sites, sale teams and suppliers can update order entry applications, and other business processes can continue uninterrupted.

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

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