3-Stage EVPN/VXLAN Fabric with Juniper Apstra—Juniper Validated Design (JVD)

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Juniper Networks Validated Designs provide you with a comprehensive, end-to-end blueprint for deploying Juniper solutions in your network. These designs are created by Juniper's expert engineers and tested to ensure they meet your requirements.

Using a validated design, you can reduce the risk of costly mistakes, save time and money, and ensure that your network is optimized for maximum performance.

About this Document

This document details a Juniper Validated Design (JVD) to provision a 3-stage EVPN/VXLAN fabric with Juniper Apstra using Apstra's Data Center Architecture design feature, consisting of two spines, three server leaf switches, and two border leaf switches. The validation was done using several combinations of device models, which are listed in the document. This document is intended for an audience familiar with Juniper technologies such as the Junos OS, QFX switches, and Juniper Apstra.

NOTE: Nomenclature Note: Edge-routed bridging (ERB) is the Juniper terminology for a network architecture that is referred to elsewhere in the industry as distributed VXLAN routing with EVPN or the distributed gateways model.

Solution Benefits

IN THIS SECTION

This document offers comprehensive guidance on deploying a modern 3-stage fabric with EVPN-VXLAN. The 3-Stage Fabric with Juniper Apstra is designed to meet the needs of most of Juniper's customers, has been extensively tested by Juniper, and is deployed by customers across the globe. Advanced JVD testing by Juniper combined with widespread adoption simplifies troubleshooting and shortens the support cycle, leading to a more stable data center fabric, reducing operational costs.

The 3-Stage Fabric with Juniper Apstra is Juniper's "standard candle" data center network architecture. Like all Juniper data center JVDs it is based on best practices as determined by Juniper's subject matter experts, and Juniper support teams have extensive training and resources necessary to support networks based on JVDs.

Juniper Validated Design Benefits

JVDs are a prescriptive blueprint for building a data center fabric with well-documented capabilities and appropriate product selection. JVDs must pass rigorous testing with real-world workloads to achieve validation, verifying that all products in the Building Blocks JVD work together as expected and mitigating the risk faced while deploying a network. The core benefits of JVDs are:

- Repeatability—Unlock value with repeatable network designs. Because JVDs are prescriptive designs used by multiple customers, all JVD customers benefit from lessons learned through lab testing and real-world deployments.
- Reliability—Layered testing with real traffic. JVDs are quantified and integrated best practice designs based on carefully chosen hardware platforms and software versions and tested with real-world traffic.
- Accelerated Deployment—Ease installation with step-by-step guidance. Simplify deployment with guidance, automation, and prebuilt integrations.
- Accelerated Decision-Making—Leave behind costly bespoke networks. Bridge business and technology in designs that meet the needs of most customers and consider how features behave and operate in real-world applications and conditions.
- Best Practice Networks—Better outcomes for a better experience. Juniper Validated Designs have known characteristics and performance profiles to help you make informed decisions about your network.

Juniper Apstra

Apstra is a multi-vendor, intent-based network fabric management solution that provides closed-loop automation and assurance. Apstra translates business intent and technical objectives to essential policy and device-specific configuration. Apstra continuously self-validates and resolves issues to assure compliance. The core benefits of Apstra are:

- Intent-based networking—Automates configuration generation and continuously validates operating state versus intent.
- Network Automation—Apstra is a multi-vendor network automation platform that is continuously updated to work with the latest hardware and exhaustively tested using modern DevOps practices.
- Recoverability—Built-in rollback capability restores known-working configuration in a fraction of the time.
- Day 2+ Management—Apstra's rich analytics capabilities, including Flow Data, reduce Mean Time to Resolution (MTTR).
- Simplicity—Apstra simplifies network management. For example, by reducing the complexity of data center interconnection (DCI), making it easy to unify multiple data centers while isolating failure domains for high availability and resilience.

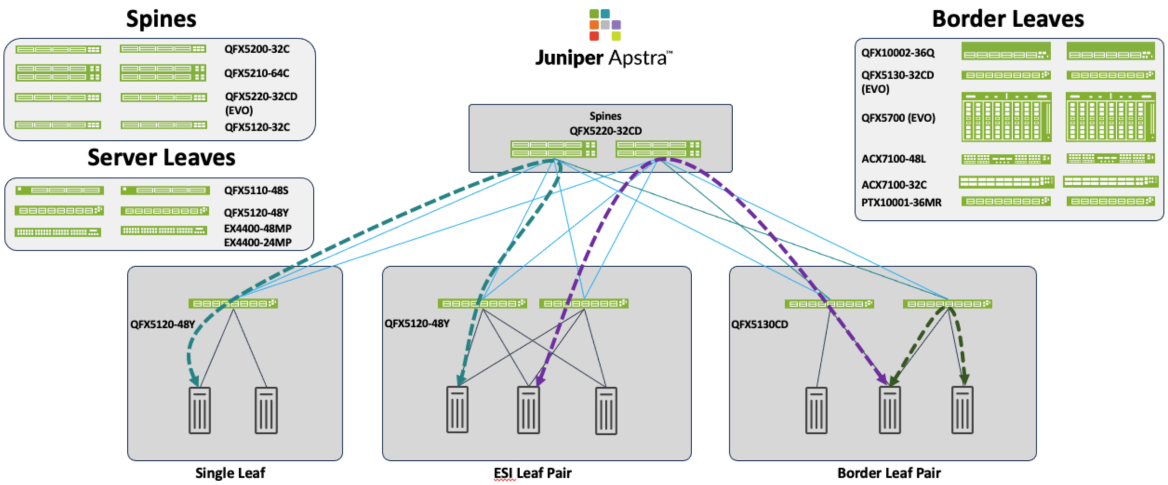
Use Case and Reference Architecture

Traditional data center designs required chassis-based switches, which were complex to manage. As business demands change, data centers are changing. Today's data centers need to support virtualization, span multiple geographies, incorporate hybrid cloud elements, and provide infrastructure for AI workloads. With each new class of workload, managing and supporting these data centers is getting ever more complex. The Edge-Routed Bridging (ERB) network architecture at the heart of the 3-Stage Fabric with Juniper Apstra simplifies data center design by distributing the traditional network chassis into a switching fabric that is far more resilient and flexible.

ERB is a distributed network architecture that can meet nearly any network requirement. As a result, ERB underlies all Juniper data center-validated designs. With Juniper data center switches running Junos OS and Juniper Apstra as an orchestration platform to manage these switches, customers can now provision, manage, and monitor data centers using Juniper Apstra software, as shown in Figure 1 on page 4 and DCI capable Border . The ERB design is flexible, and with Juniper Apstra adding or removing leaf switches is easier.

Juniper Apstra is a multi-vendor Intent-Based Network System (IBNS). Apstra orchestrates data center deployments and manages small to large-scale data centers through Day-0 to Day-2 operations. It is an ideal tool for building data centers for AI clusters, providing invaluable Day-2 insights through monitoring and telemetry services. It supports provisioning 3-stage or 5-stage data center designs, including collapsed fabric for even smaller data center designs.

Figure 1: 3-Stage Architecture: Lean Spines, Server leaf Switches and DCI Capable Border Leaf Switches



Solution Architecture

IN THIS SECTION

The 3-Stage Fabric with Juniper Apstra is an EVPN/VXLAN-based validated design based upon the ERB network architecture. Using an ERB network architecture provides the design increased resilience by assigning specific functions to each device role and ensuring that each device role can be scaled independently of the others. Each network switch participating in the design must occupy one of three roles:

- Server Leaf Switches

The leaf switch focuses on learning and advertising the local MAC Addresses to other remote switches through the BGP EVPN control plane. This means leaf switches can discover all the “remote” hosts without flooding the overlay with ARP/ND requests.

- **Border Leaf Switches**

Although a border leaf can function as a server leaf switch, it can also act as a gateway to external networks and hence require DCI features. DCI features include connecting to network overlays such as VMware NSX-T, MACSEC, deep buffers, and so on.

- **Spine Switches**

The spine switch only performs IP forwarding and relaying of routes to all server and border leaf switches. As a result, spine switches in ERB network architectures are referred to as lean spines.

The use of an ERB network architecture and the associated switch roles not only simplifies the data center design but also provides flexibility at the leaf layer so that new leaf switches can be introduced as traffic throughput increases. Another aspect of this design is the use of non-modular switches, such as the 1U QFX5130-32CD, which can perform high throughput functions at the leaf layer.

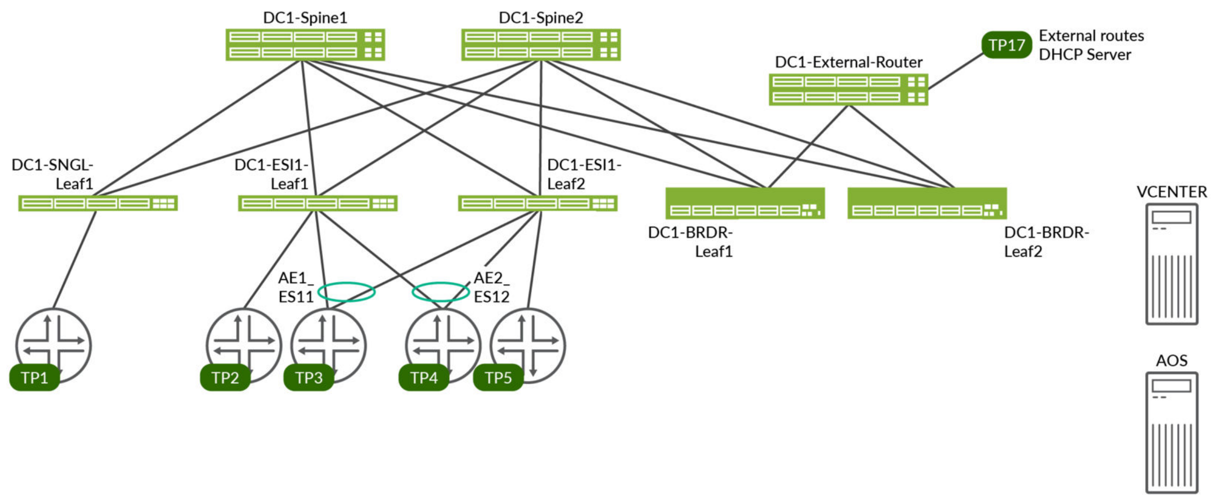
To summarize, the ERB network architecture, which underlies the 3-stage fabric with Juniper Apstra, can be thought of as a distributed chassis. In an ERB network, leaf switches are roughly analogous to a “line card” in a traditional modular chassis, while the lean spine means the network fabric is more flexible and resilient than a single modular chassis switch. This creates a network more capable and flexible than a traditional modular chassis-based switch, without requiring the purchase or maintenance of a modular chassis-based switch for most enterprise data center scenarios.

For those data centers looking for scale that can only be achieved with chassis-based switches, the Juniper Validation process does take this into account, validating modular chassis switch combinations in ERB network roles. The result is validated network fabrics that can scale from the needs of individual racks up to serving entire data centers and beyond.

Figure 1 on page 4 depicts the hardware in various roles such as spine, leaf, and border leaf. This JVD will walk through the high-level steps required to configure a 3-stage Data center, with QFX5220-32CD switches in the spine role, QFX5130-32CD switches in the border leaf role, and QFX5120-48Y switches in the server leaf role. These switches in these roles are considered the baseline design of this JVD, though other switches are qualified for these roles, as documented below.

Below is the reference architecture of 3-Stage Fabric with Juniper Apstra.

Figure 2: 3-Stage Reference Design with Baseline Devices



VRF Characteristics

RED VRF

- VLANs 400–649 with IRB v4/v6
  - on DC1-SNGL-LEAF1 single access port
  - on DC1-ESI-LEAF1 single access port, AE1 and AE2
  - on DC1-ESI1-LEAF2 single access port, AE1 and AE2
  - on DC1-BRDR-LEAF1 to distribute routes to external-router
  - on DC1-BRDR-LEAF2 to distribute routes to external-router
- VLANs 400–649 on each test port with 10 unique MAC/IP per VLAN
- DHCP client on TP3
- External DHCP server on TP17

Blue VRF

- VLANs 3500–3749 with IRB v4/v6
  - on DC1-SNGL-LEAF1 single access port
  - on DC1-ESI-LEAF1 single access port, AE1 and AE2

    - on DC1-ESI1-LEAF2 single access port, AE1 and AE2
    - on DC1-BRDR-LEAF1 to distribute routes to external-router
    - on DC1-BRDR-LEAF2 to distribute routes to external-router
- VLANs 3500–3749 on each test port with 10 unique MAC/IP per VLAN
- DHCP client on TP3, TP4, TP5
- External DHCP server on TP2

Juniper Hardware and Software Components

For this solution, the Juniper products and software versions are as below.

The design documented in this JVD is considered the baseline representation for the validated solution. As part of a complete solutions suite, we routinely swap hardware devices with other models during iterative use case testing. Each switch platform validated in this document goes through the same rigorous role-based testing using specified versions of Junos OS and Apstra management software.

Juniper Hardware Components

The following switches are tested and validated to work with the 3-Stage Fabric with Juniper Apstra JVD in the following roles:

Table 1: Supported Devices and Positioning

Supported Devices and Positioning			
Solution	Server Leaf Switches	Border Leaf Switches	Spine
3-stage EVPN/VXLAN (ERB)	QFX5120-48Y-8C*	QFX5130-32CD*	QFX5220-32CD*
	QFX5110-48S	QFX5700	QFX5120-32C
	EX4400-24MP#	ACX7100-48L	QFX5210-64CD
		ACX7100-32C	QFX5200-32C
		PTX10001-36MR	

Table 1: Supported Devices and Positioning *(Continued)*

Supported Devices and Positioning			
Solution	Server Leaf Switches	Border Leaf Switches	Spine
		QFX10002-36Q	

* marked are baseline devices

NOTE: There is a scale limitation on EX4400 switches that affects the whole fabric. Refer to the Multi-dimensional Scale Numbers Tested Table 5 on page 84 for scale numbers with EX4400. The version used for validation for EX4400 was 22.4R3.25 as this version supports MAC-VRF feature. Please contact Juniper account representative for more information about EX4400 setup and scale.

For more information on validated devices refer to Devices Under Test(Validated Devices) No Link Title.

For the purposes of this JVD document, the following switches are used for the configuration walkthrough:

Table 2: Hardware for 3-Stage Data Center JVD Reference Design

Juniper Hardware for 3-Stage Design			
Juniper Products	Role	Hostname	Software or Image Version
QFX5220-32CD	Spine	dc1-spine1 & dc1-spine2	Junos OS Evolved Release 23.4R2-S3
QFX5120-48Y	Server Leaf	dc1-single-leaf1 dc1-esi-001-leaf1 dc1-esi-001-leaf2	Junos OS Release 23.4R2-S3
QFX5130-32CD	Border Leaf	dc1-border-leaf1 dc1-border-leaf2	Junos OS Evolved Release 23.4R2-S3

NOTE: All devices listed in Supported Devices and Positioning Table 1 on page 7 are validated against Junos OS Release 23.4R2-S3 release. The validated Junos OS release for PTX10001-36MR is Junos OS Evolved Release 23.4R2-S3, for ACX7100-32C and ACX7100-48L is Junos OS Evolved Release 23.4R2-S3.

Table 3: Juniper Software and Version

Juniper Software	
Juniper Products	**Software or Image Version**
Juniper Apstra	4.2.1-207

Validated Functionality

The 3-Stage Fabric with Juniper Apstra was validated using the following parameters in its configuration:

- This JVD consists of a 3-stage CLOS with an ERB network architecture using EVPN-VXLAN.
- Servers will be connected and tested both in single-homed and multi-homed configurations.
- In the case of multihomed ESI servers, LACP is enabled between the servers and the leaf switches.
- Configure ESI on aggregated ethernet interfaces for multi-homed devices.
- ECMP is configured across the fabric to minimize traffic loss.
- Both the overlay and underlay of the fabric are built using eBGP.
- Learn and advertise EVPN Type 2 and Type 5 routes.
- BFD is enabled for both underlay eBGP and overlay eBGP.
- Asymmetric IRB is enabled with anycast IP address on L3-enabled leaf switches for inter-VLAN routing. For more information on the IRB model for inter-subnet forwarding in EVPN, refer to the EVPN VXLAN Guide.
- Both IPv4 and IPv6 are enabled; however, IPv6 is only used for loopback.

- Inter-VRF connectivity is configured using external router to allow route leaking between VRFs, however, to achieve this configuration Apstra Connectivity templates were used to connect to the external router.

Additional Functionality

The below features are not considered part of, nor are described in, this JVD; however, they are validated:

- DCI between data centers.
- Interoperability with NSX-T Edge Gateway.
- Host connectivity between fabric-connected hosts created by Apstra towards NSX-managed hosts.

Configuration Walkthrough

IN THIS SECTION

This walkthrough summarizes the steps required to configure the 3-Stage Fabric with Juniper Apstra JVD. For more detailed step-by-step configuration information, refer to the Juniper Apstra User Guide. Additional guidance in this walkthrough is provided in the form of Notes.

This walkthrough details the configuration of the baseline design, as used during validation in the Juniper data center validation test lab. The baseline design consists of QFX5220-32CD switches in the spine role, QFX5130-32CD switches in the border leaf role, and QFX5120-48Y switches in the server leaf role. The goal of JVD is to provide options so that any of these switch platforms can be replaced with a validated switch platform for that role, as described in Supported Devices and Positioning Table 1 on page 7. In order to keep this walkthrough a manageable length, only the baseline design platforms will be used for the purposes of this document.

Apstra: Configure Apstra Server and Apstra ZTP Server

This document does not cover the installation of Apstra. For more information about installation, refer to the Juniper Apstra User Guide.

The first step is to configuration of the Apstra server. A configuration wizard launches upon connecting to the Apstra server VM for the first time. At this point, passwords for the Apstra server, Apstra UI, and network configuration can be configured.

Apstra: Management of Junos OS Device

There are two methods of adding Juniper devices into Apstra: manually or in bulk using ZTP:

To add devices manually (recommended):

In the Apstra UI navigate to **Devices** > **Agents** > **Create Offbox Agents**.

This requires minimum configuration of root password and management IP to be configured on the devices.

To add devices through ZTP:

From the Apstra ZTP server, to add devices, refer to the Juniper Apstra User Guide for more information on the ZTP of Juniper devices.

For this setup, a root password and management IPs were already configured on all switches prior to adding the devices to Apstra. To add switches to Apstra, first log into the Apstra Web UI, choose a method of device addition as per above, and provide the appropriate username and password preconfigured for those devices.

NOTE: Apstra pulls the configuration from Juniper devices called a pristine configuration. The Junos configuration ‘groups’ stanza is ignored when importing the pristine configuration, and Apstra will not validate any group configuration listed in the inheritance model, refer to the Use Configuration Groups to Quickly Configure Devices. However, it’s best practice to avoid setting loopbacks, interfaces (except management interface), routing-instances (except management-instance). Apstra will set the protocols LLDP and RSTP when device is successfully Acknowledged.

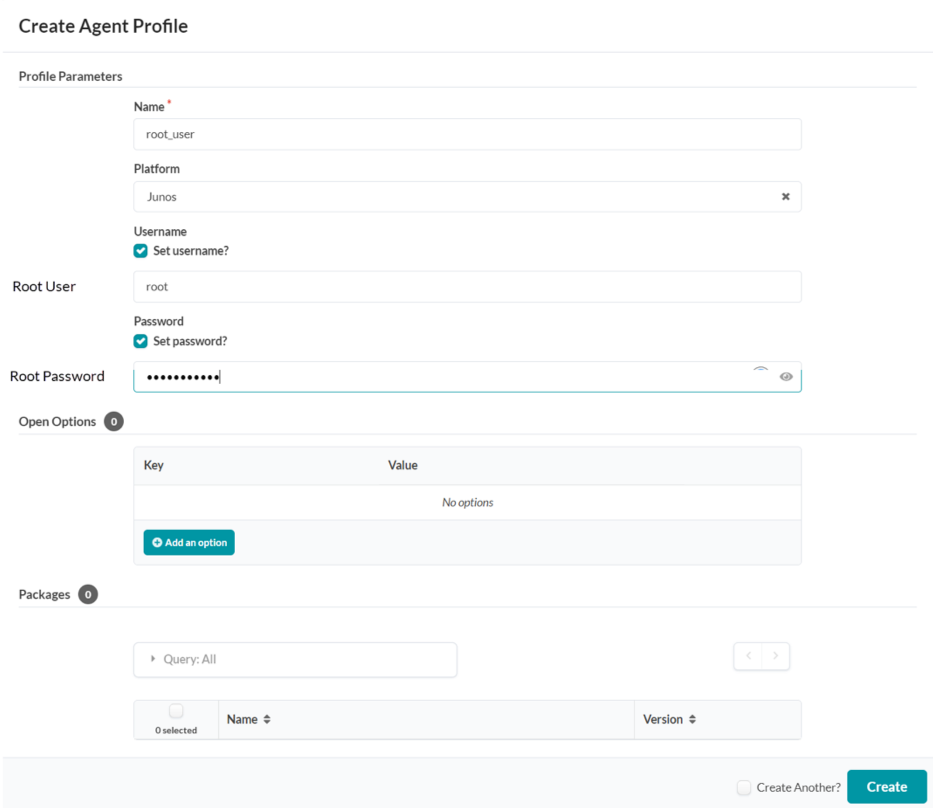
Apstra Web UI: Create Agent Profile

For the purposes of this JVD lab, the root user and password are the same across all devices. Hence, an agent profile is created as below. Note that this also obscures the password, which keeps it secure.

1. Navigate to **Devices** > **Agent Profiles.**

2. Click **Create Agent Profile**.

Figure 3: Create Agent Profile in Apstra



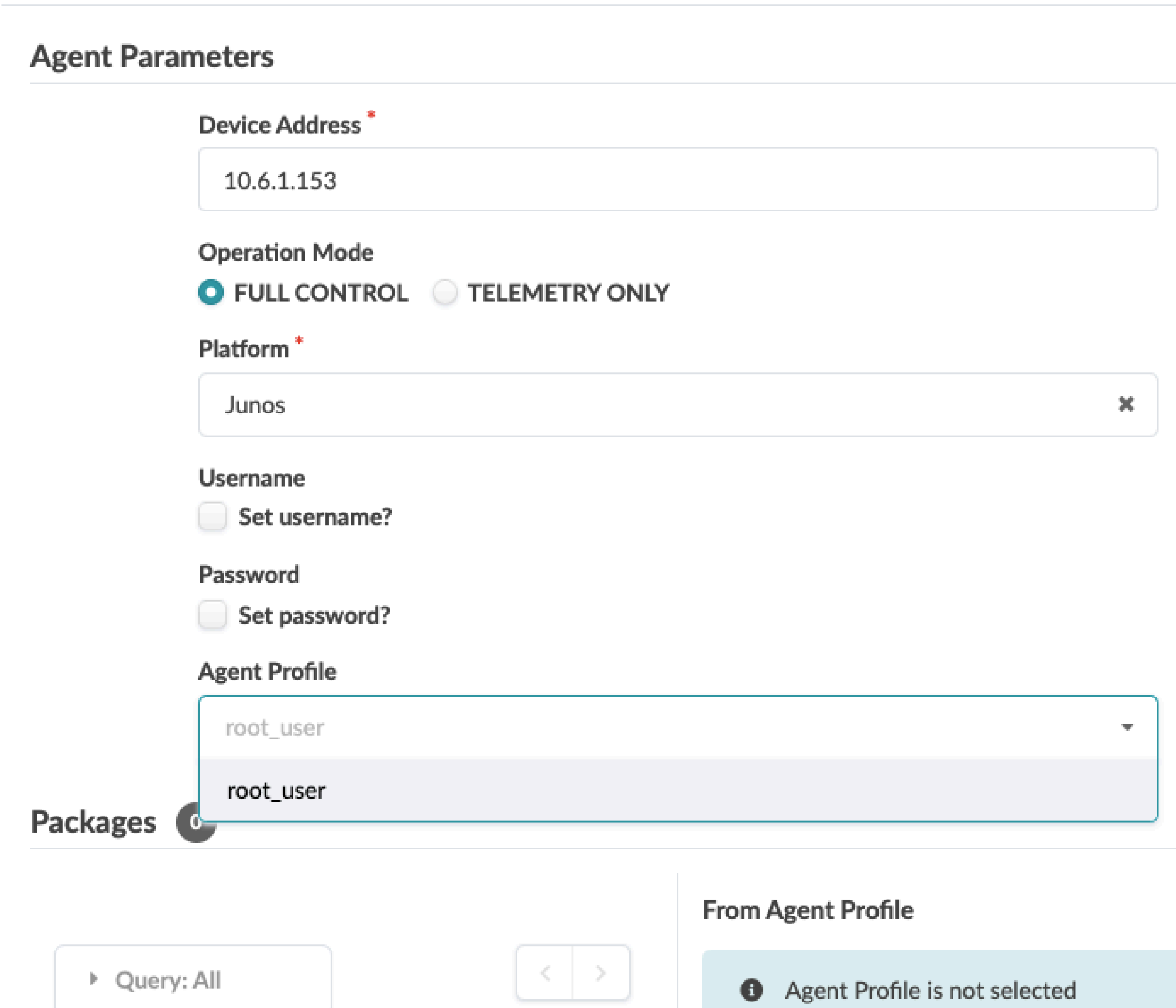
Apstra Web UI: Enter IP Address or IP Address Range for Bulk Discovery of Devices

An IP address range can be provided to bulk-add devices into Apstra.

1. Navigate to **Devices** > **Agents**.

2. Click **Create Offbox Agents**.

Figure 4: Create Offbox Agent



Apstra Web UI: Add Pristine Configuration and Upgrade Junos OS

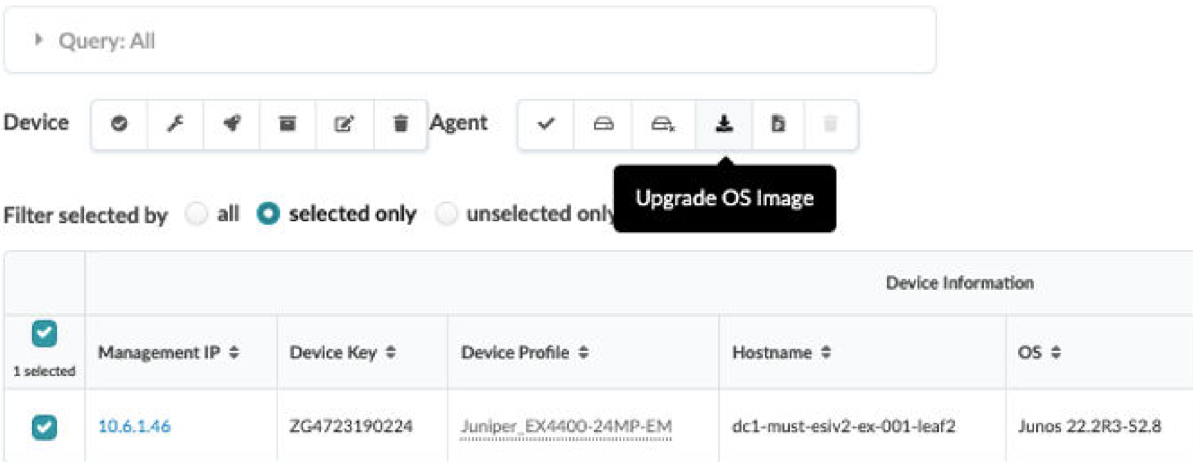
From **Devices > Managed Devices**, add the pristine configuration by collecting from the device or pushing from Apstra. The configuration applied as part of the pristine configuration should be the base configuration or minimal configuration required to reach the devices with the addition of any users, static routes to the management switch, and so on. This creates a backup of the base configuration in Apstra and allows devices to be reverted to the pristine configuration in case of any issues.

Figure 5: Add Pristine Configuration

NOTE: If pristine configuration is updated using Apstra as shown in above Figure 5 on page 15 then ensure to run **Revert to Pristine.**Important: A maintenance window is required to perform any device upgrade as upgrades can be disruptive.Best practice recommendations for Upgrade:Upgrade devices using the Junos OS CLI as outlined in the Junos OS Software Installation and Upgrade Guide, along with the Junos OS version release notes, as Apstra currently only performs basic upgrade checks. However, this JVD summarizes Upgrade steps if Apstra is intended to be used for upgrades.In case if a device is added to Blueprint, then set the device to “undeploy” and unassign its serial number from blueprint and commit the changes, which reverts it back to pristine Configuration. Then proceed to upgrade. Once upgrade is complete, add the device back to Blueprint.

Apstra allows the upgrade of devices. However, Apstra performs basic checks and issues the upgrade command. To upgrade the device from Apstra, refer to the following figure.

Figure 6: Upgrade Device from Apstra



To register a Junos OS image on Apstra, either provide a link to the repository where all OS images are stored or upload the OS image as shown below. In the Apstra UI, navigate to **Devices > OS Images** and click **Register OS Images**.

Figure 7: Upload OS Image

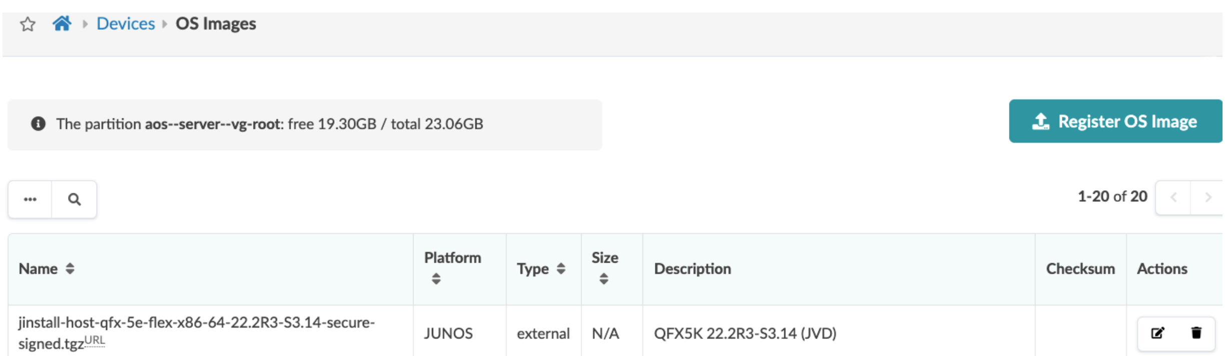
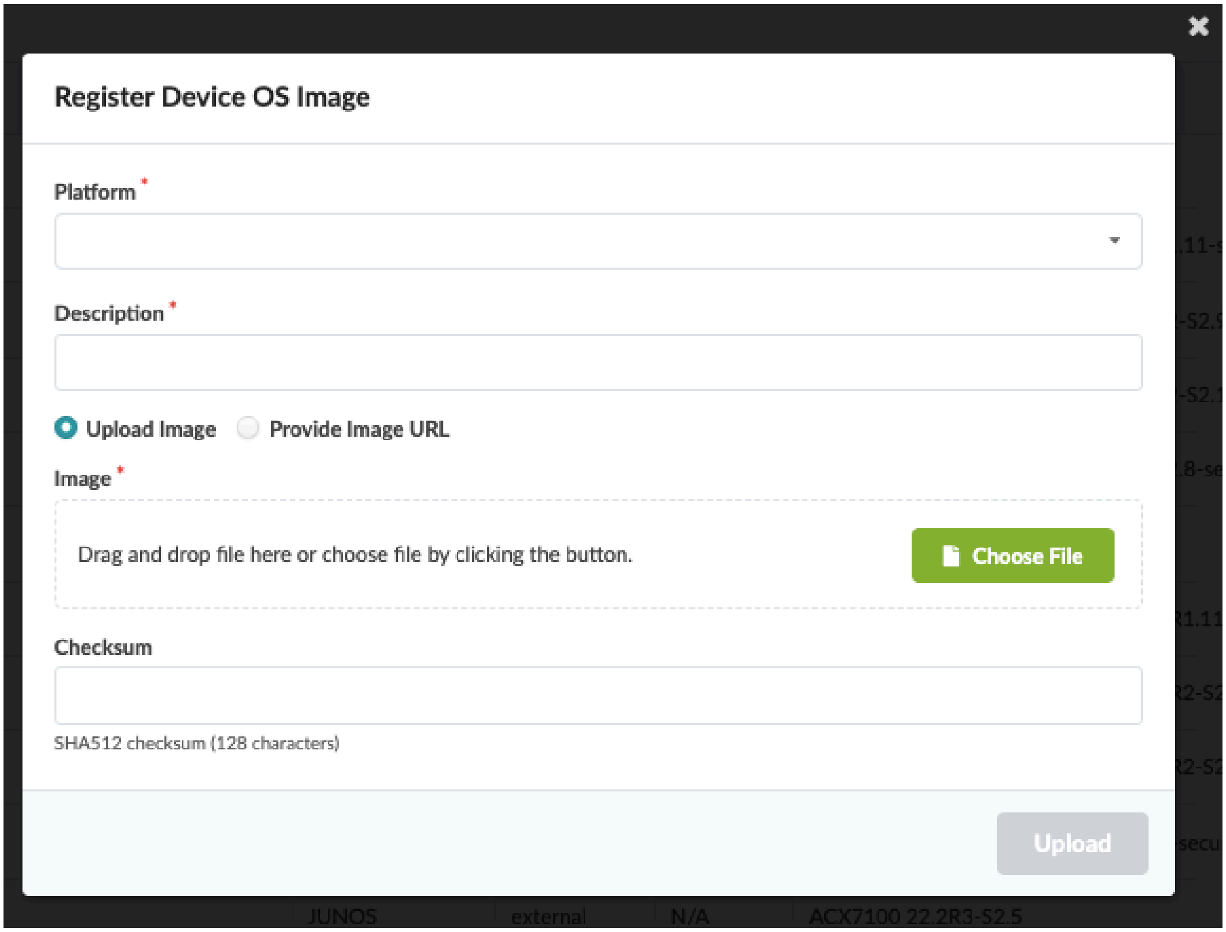


Figure 8: Register OS Image by Uploading or Provide Image URL



Apstra Fabric Provisioning

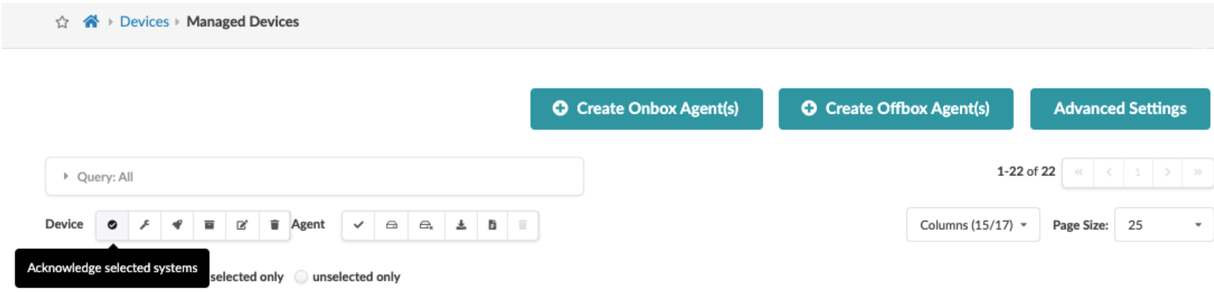
Check Discovered Devices and Acknowledge the Devices.

Devices > Managed Devices

Once the offbox agent has been added and the device information has been collected, click the checkbox interface to select all the devices and then click acknowledge. This places the switch under the management of the Apstra server.

Finally, ensure that the pristine configuration is collected once again as Apstra adds the configurations for LLDP and RSTP.

Figure 9: Acknowledge Devices to Manage in Apstra



Once a switch is acknowledged, the status icon under the "Acknowledged?" table header changes from a red X to a green checkmark. Verify this change for all switches. If there are no changes, repeat the procedure to acknowledge the switches again.

Figure 10: Devices Managed by Apstra

Device Information							Agent Information		
Management IP	Device Key	Device Profile	OS	State	Comms	Acknowledged?	Type	Agent Profile	Apstra Version
10.92.72.128	XC3623120013	Juniper_QFX5220-32CD	Junos 22.2R3-S3.13-EVO	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207
10.92.72.37	XC3622260031	Juniper_QFX5220-32CD	Junos 22.2R3-S3.13-EVO	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207
10.92.76.31	YR3622410026	Juniper_QFX5130-32CD	Junos 22.2R3-S3.13-EVO	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207
10.6.1.150	XH3719030120	Juniper_QFX5120-48Y	Junos 22.2R3-S3.18	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207
10.92.76.30	YR3622410005	Juniper_QFX5130-32CD	Junos 22.2R3-S3.13-EVO	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207
10.6.1.58	XH3719090097	Juniper_QFX5120-48Y	Junos 22.2R3-S3.18	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207
10.6.1.57	XH3719090062	Juniper_QFX5120-48Y	Junos 22.2R3-S3.18	IS-ACTIVE			OFFBOX	root_user	AOS_4.2.1_OB.207

NOTE: After a device is managed by Apstra, all device configuration changes should be performed using Apstra. Do not perform configuration changes on devices outside of Apstra, as Apstra may revert those changes.

Apstra Web UI: Identify and Create Logical Devices, Interface Maps with Device Profiles

In the following steps, we define the 3-stage fabric with the Juniper Apstra baseline architecture and devices. Before provisioning a blueprint, a replica of the topology is created. In the following steps, we define the ERB data center reference architecture and devices:

- This involves selecting logical devices for spine, leaf, and border leaf switches. Logical devices are abstractions of physical devices that specify common device form factors such as the amount, speed, and roles of ports. Vendor-specific information is not included, which permits building the network definition before selecting vendors and hardware device models. The Apstra software installation includes many predefined logical devices that can be used to create any variation of the logical device.
- Logical devices are then mapped to device profiles using interface maps. The ports mapped on the interface maps match the device profile and the physical device connections. Again, the Apstra software installation includes many predefined interface maps and device profiles.
- Finally, the racks and templates are defined using the configured logical devices and device profiles, which are then used to create a blueprint.

The Juniper Apstra User Guide explains the device lifecycle, which must be understood when working with Apstra blueprints and devices.

NOTE: The 3-stage design provisioning steps use the Apstra Data Center Reference design.

Navigate to **Design** > **Logical Devices**, then review the devices listed based on the number of ports and speed of ports. Select the device that most closely resembles the device that should be added, then clone the logical device.

NOTE: System added or default logical devices cannot be changed.

The following table shows the device roles, logical device types, ports, and connections created for the 3-Stage Fabric with Juniper Apstra JVD lab in this document. The Port Groups column depicts the minimum connections required for this lab. This will vary from the actual port groups these switches can provide.

Table 4: Logical Device Port Speeds and Connection for Each Fabric Device

Device Role	Port Group Connections1	Port Groups2	Connected To
Spine	Superspine/Spine/Leaf/Access/ Generic	5 x 100 Gbps (each spine)	2 Border Leaf switches 3 Server Leaf switches

Table 4: Logical Device Port Speeds and Connection for Each Fabric Device *(Continued)*

Device Role	Port Group Connections1	Port Groups2	Connected To
Server Leaf (single)	Superspine/Spine/Leaf/Access/ Generic	2 X 100 Gbps 5 x 10 Gbps	2 Spine 2 Servers (Generic)
Server Leaf switches (2 ESI leaf switches)	Superspine/Spine/Leaf/Access/ Generic	4 X 100 Gbps (both leaf switches) 5 X 10 Gbps	2 Spine 4 Servers (Generic)
Border Leaf switches	Superspine/Spine/Leaf/Access/ Generic	6 X 10 Gbps 4 X 100 Gbps (both leaf switches)	6 Servers 2 Spine

1 For port group connections, these can vary depending on the role and devices connected.

2 For port groups, the number of ports can vary depending on connections and speed.

Device Profiles

For all devices covered in this document the device profiles (defined in Apstra found under **Devices > Device Profiles**) were exactly matched by Apstra while adding devices into Apstra, as covered in "Apstra: Management of Junos OS Device" on page 12. During the validation of the supported devices, there are instances where device profiles had to be custom-made to suit the line card setup on the device, for instance, QFX5700. For more information on device profiles, refer to the Apstra User Guide for Device Profiles.

NOTE: The device profiles covered in this JVD document are not modular chassis-based. For modular chassis-based devices such as QFX5700, the line card Profiles and Chassis Profile are available in Apstra and linked to the device profile. These cannot be edited; however, they can be cloned, and custom profiles can be created for line card, Chassis, and Device profile as shown below in Figure 11 on page 21 and Figure 12 on page 21.

Figure 11: QFX5700 Device Profile Linked to Chassis Profile and Linecard Profile

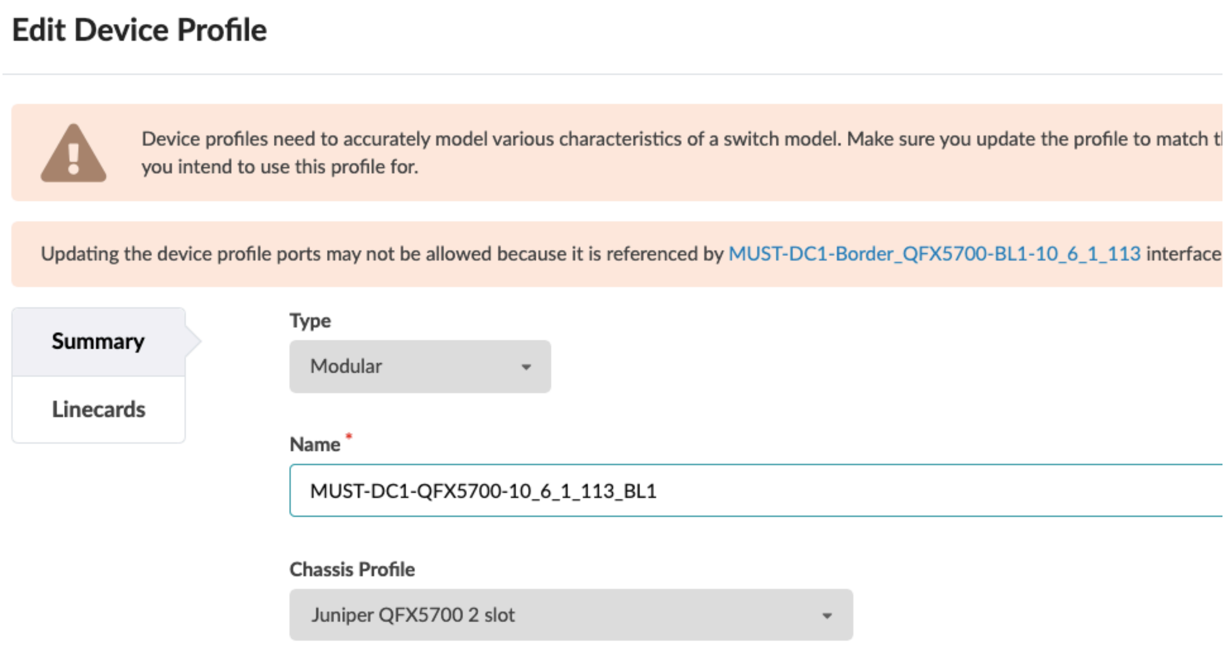
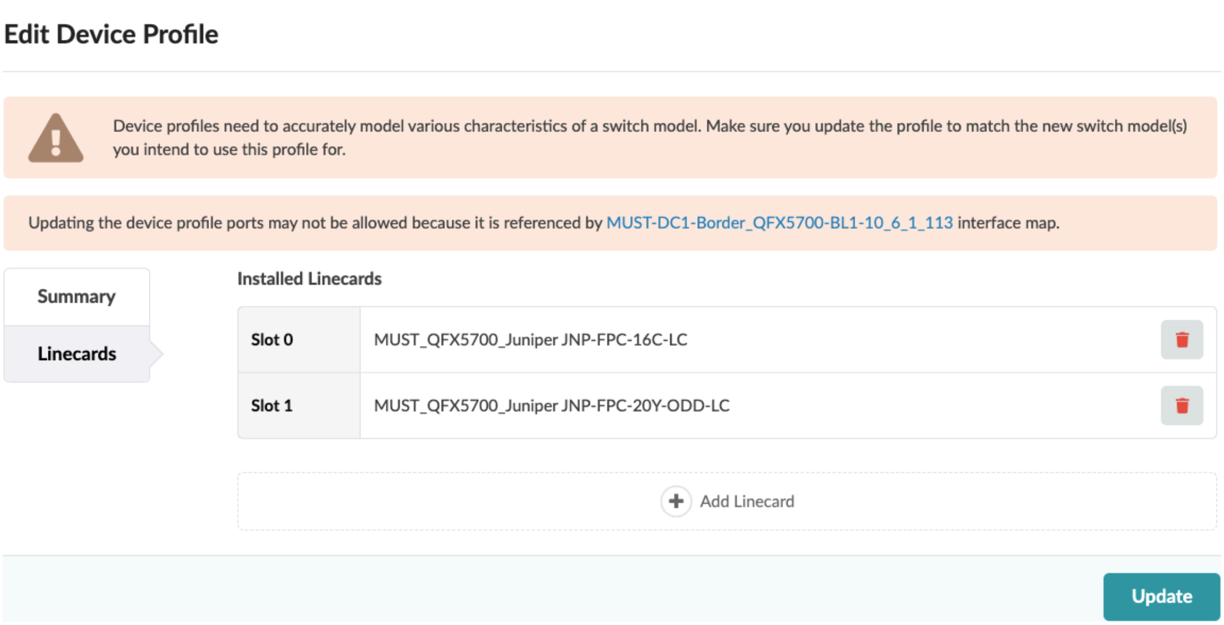


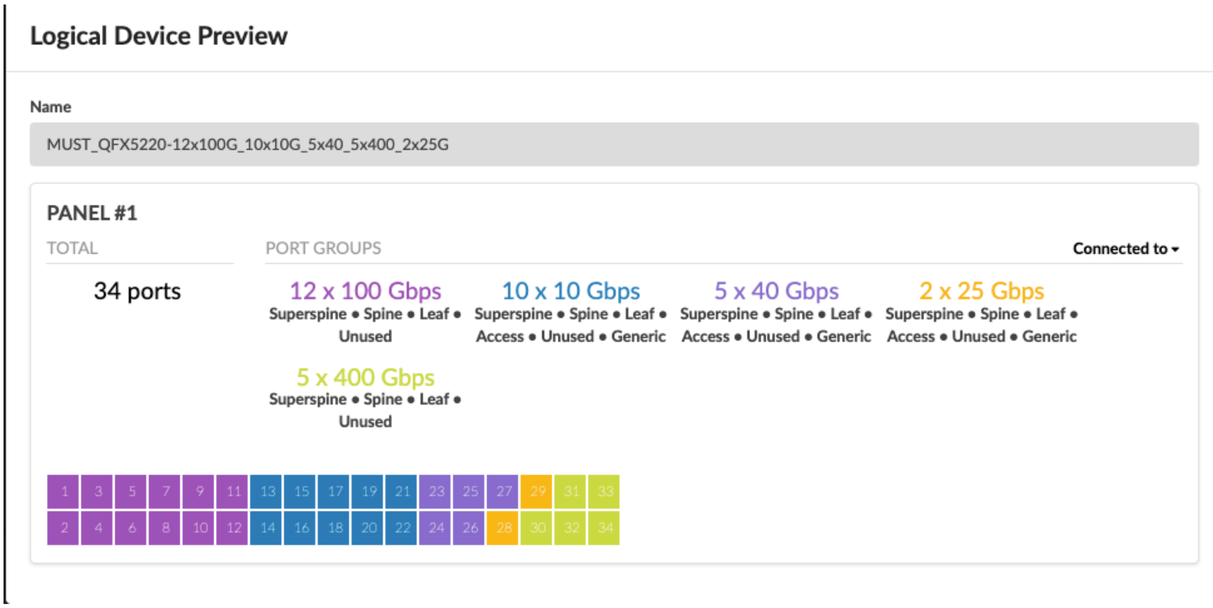
Figure 12: QFX5700 Device profile linked to Linecard Profile



Spine Logical Device and Corresponding Interface Maps

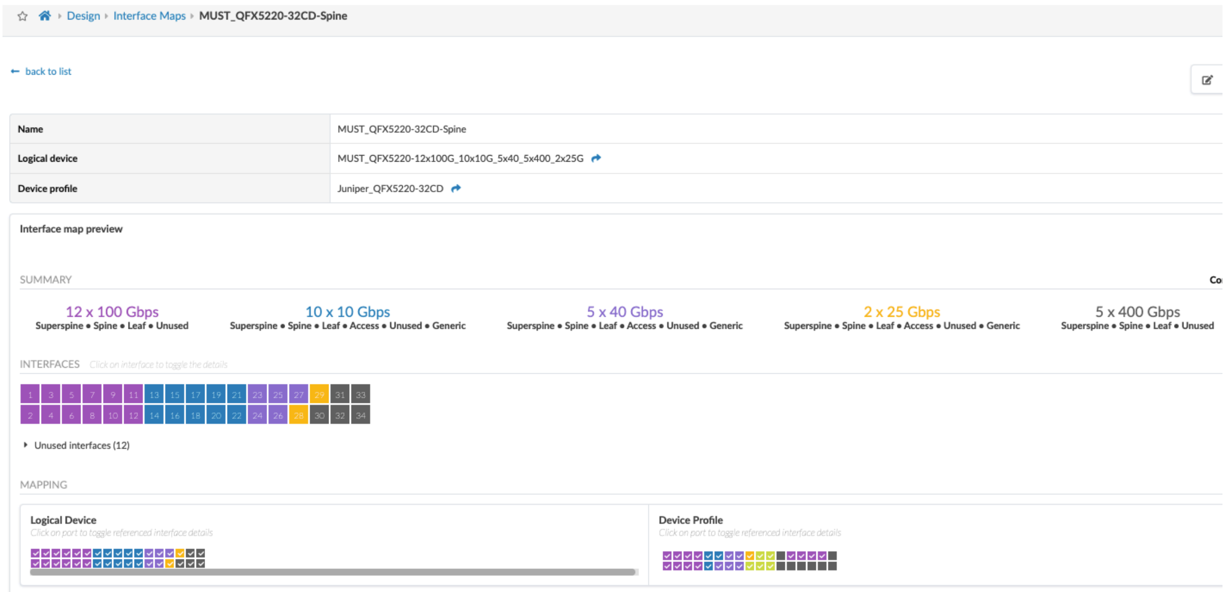
The spine logical device is based on QFX5220-32CD (Junos OS). For the purposes of this solution, seven 100G links are used to connect to leaf switches. As shown in Figure 13 on page 22 12 ports of 100 Gbps are enough for five spine to leaf connections.

Figure 13: Apstra Logical Device Spine Configuration



The spine logical device ports are mapped to the Device Profiles using the Interface map as shown below. The ports mapped on the interface maps match the device profile and the physical device connections.

Figure 14: Spine Interface Map

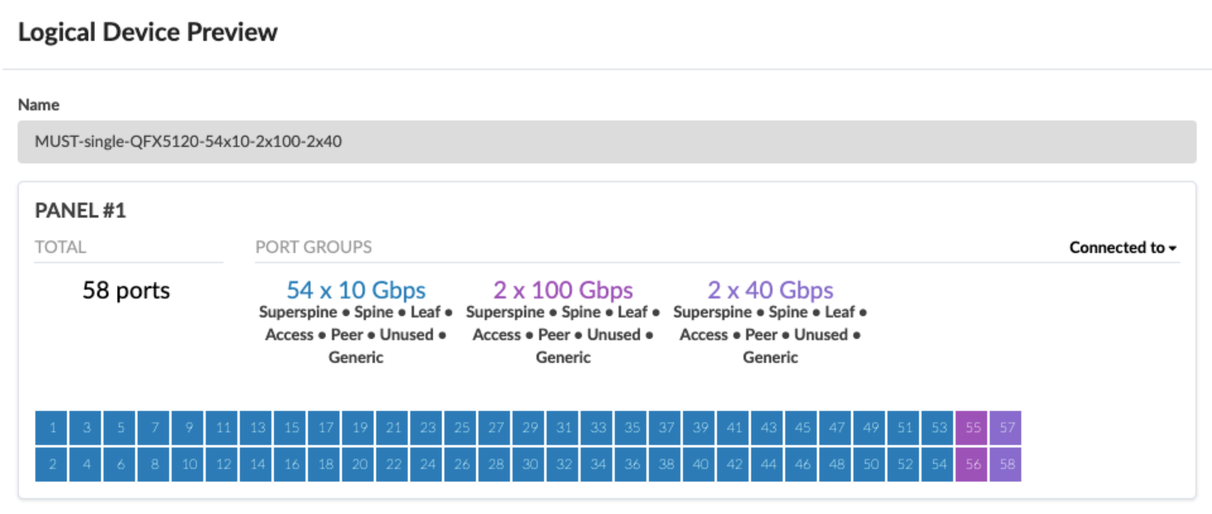


Server Leaf switches Logical Device and Interface Maps

For the purposes of this JVD, there are three QFX5120-48Y server leaf switches. Two of them are ESI-supporting switches, and one of them is a non-ESI LAG switch. All three server leaf switches are connected to each spine using 100 GB interfaces, and the 10 GB interfaces connect to the generic servers.

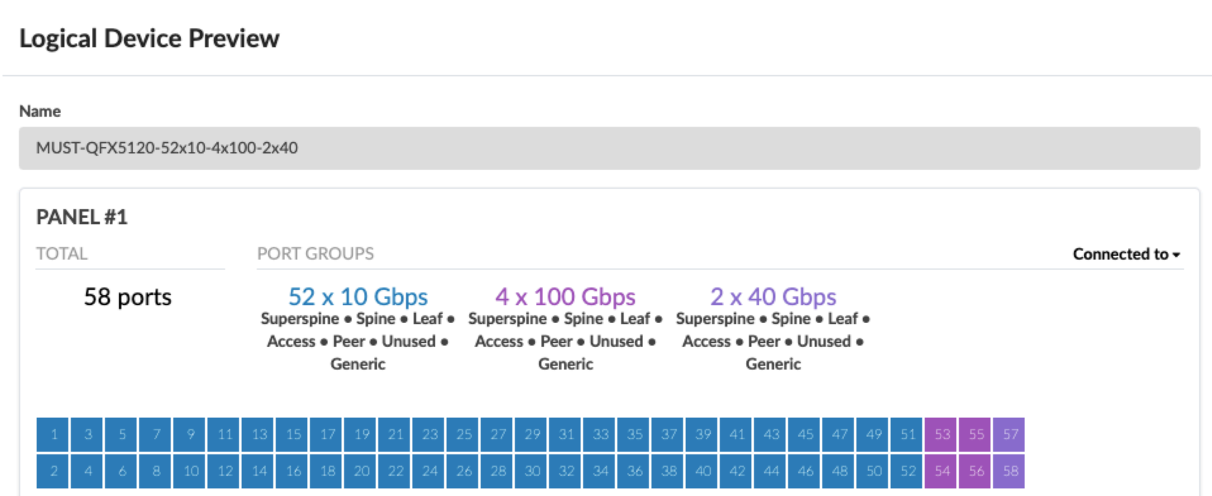
For a single (non-redundant) leaf switch, no ESI is used, and only LACP (Active) is configured.

Figure 15: Apstra Single Leaf Logical Device



For ESI (redundant) leaf switches, ESI Lag is used for multi-homing. ESI lag is configured under the Rack in **Design** > **Rack Types**.

Figure 16: Apstra Server Leaf Switches Logical Device



The server leaf logical device is mapped to the device profile as below.

Figure 17: Single Server Leaf Switches Interface Map

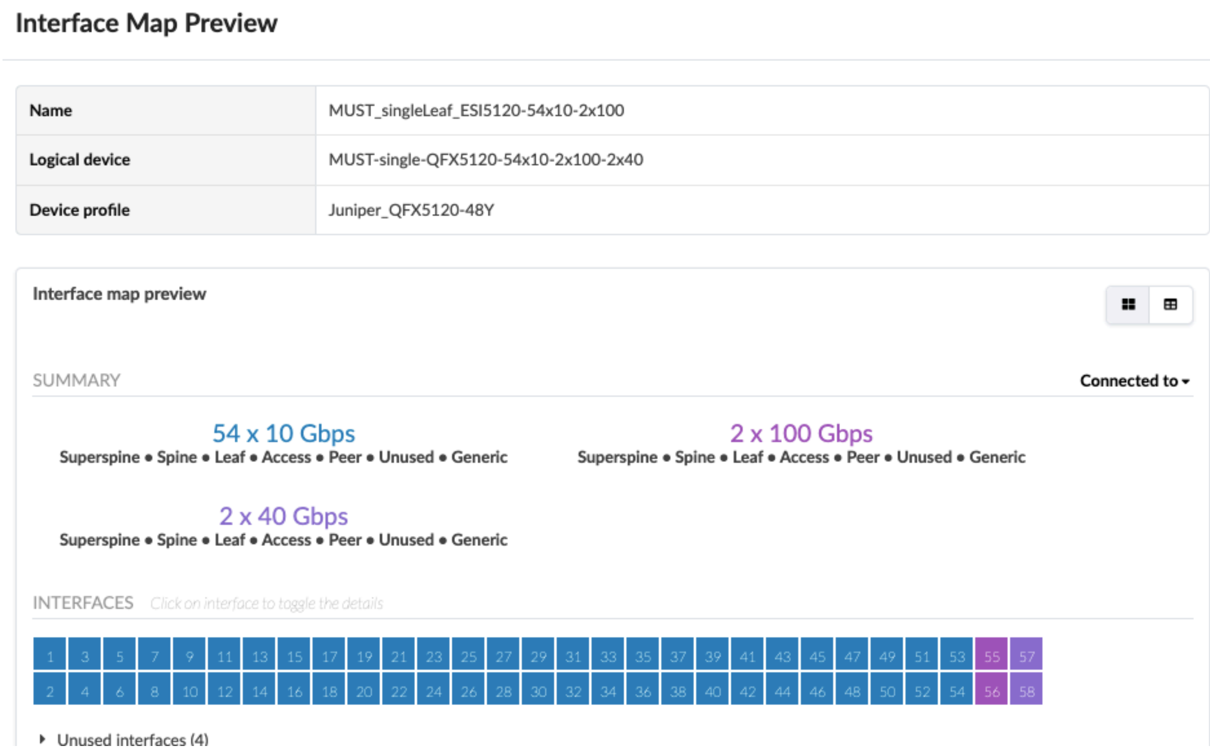
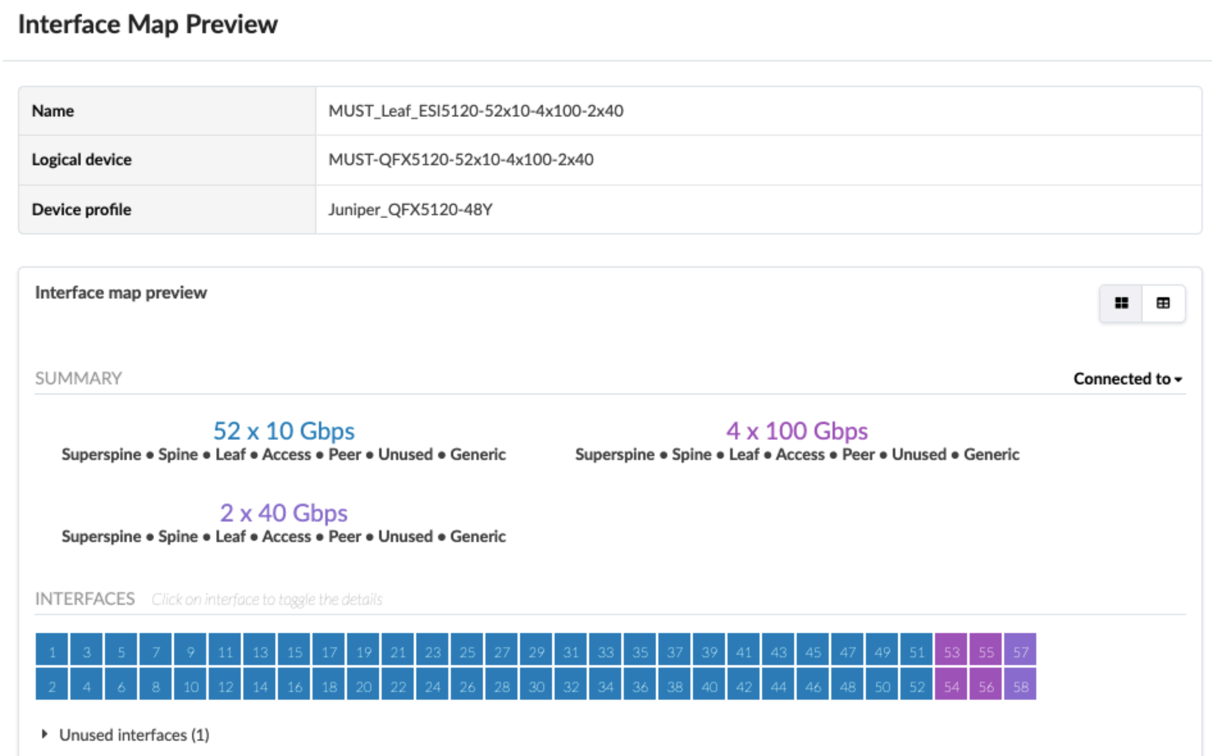


Figure 18: Server Leaf Switches Interface Map for ESI Leaf Switches



NOTE: In this case, the single leaf and ESI server leaf pairs both have the same device profile, but due to differences in how the physical ports on the switches are connected towards the servers and the spine, two different logical devices were designed.

Border Leaf Switches Logical Device and Interface Maps

The border leaf logical device is a representation of the QFX5130-32CD switches used in this design. The physical cabling determines the ports allocated for the interface Maps.

Figure 19: Border Leaf Switches Logical Device

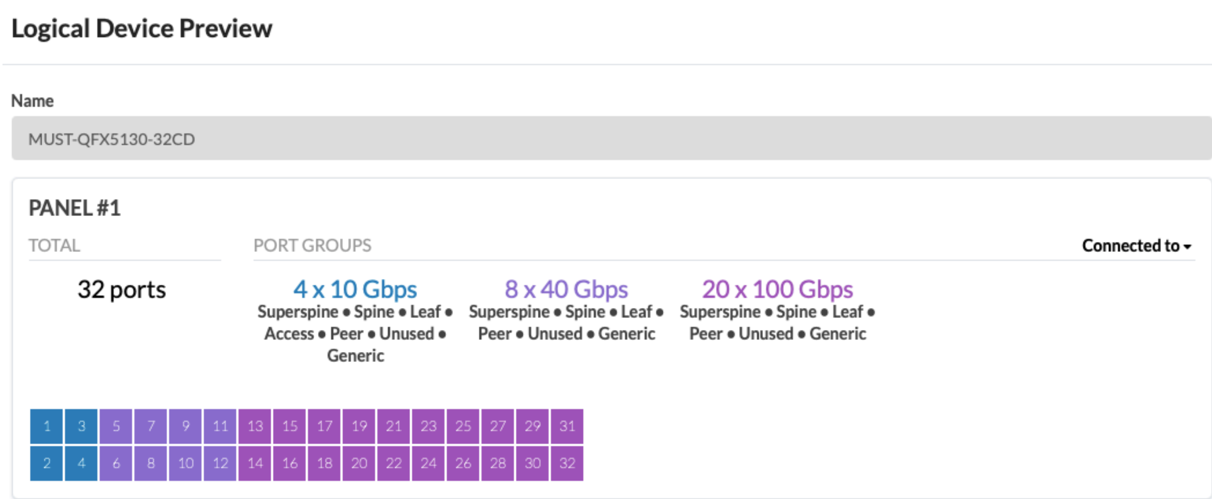
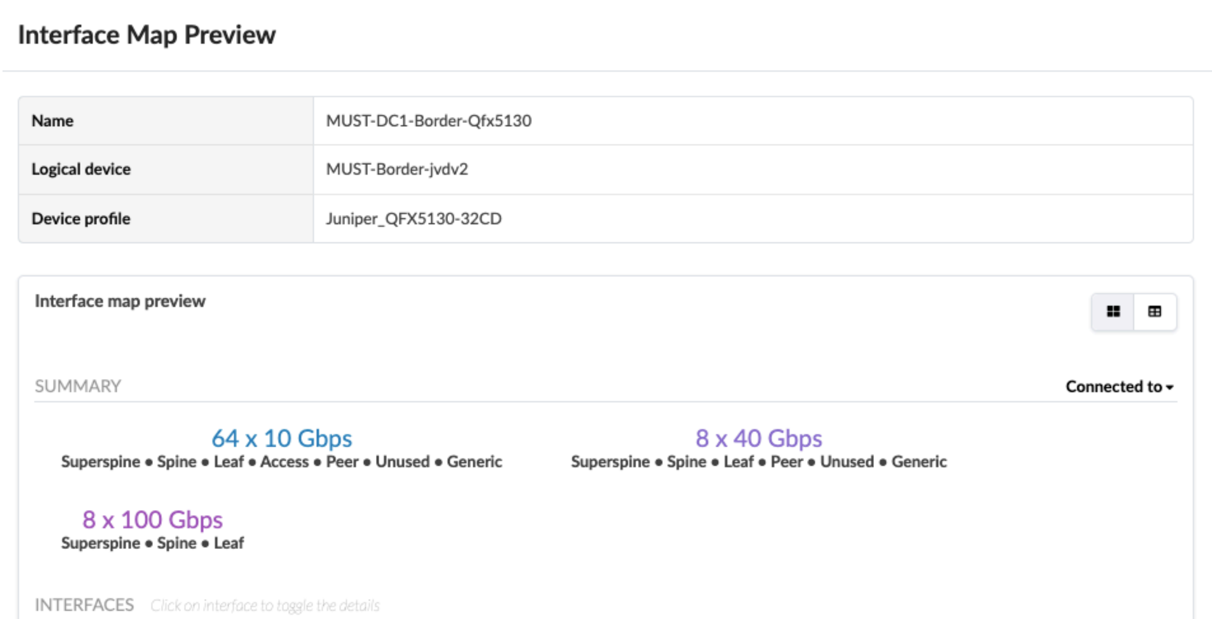


Figure 20: Border Leaf Switches Interface Map



The rest of the Logical Devices are described below. The interface maps are optional and can be omitted.

Generic Servers Logical Device

Generic servers define the network interface connections from the servers connected to the leaf switches (border and single).

Logical devices for the servers used are already pre-defined within Apstra. A similar generic system can be used for DCI; however, DCI will be covered in a separate JVD Extension document.

External Routers

External routers are connected to the border leaf switches.

Apstra does not manage external routers such as MX Series devices; hence, the MX Series router is classified as an external generic server with the relevant port and speed configuration.

> **NOTE**: A generic external system is added to the blueprint after a blueprint is created. An interface map is not needed for generic servers or external routers. The connectivity and features of external routers is beyond the scope of this document.

Apstra Web UI: Racks, Templates, and Blueprints—Create Racks

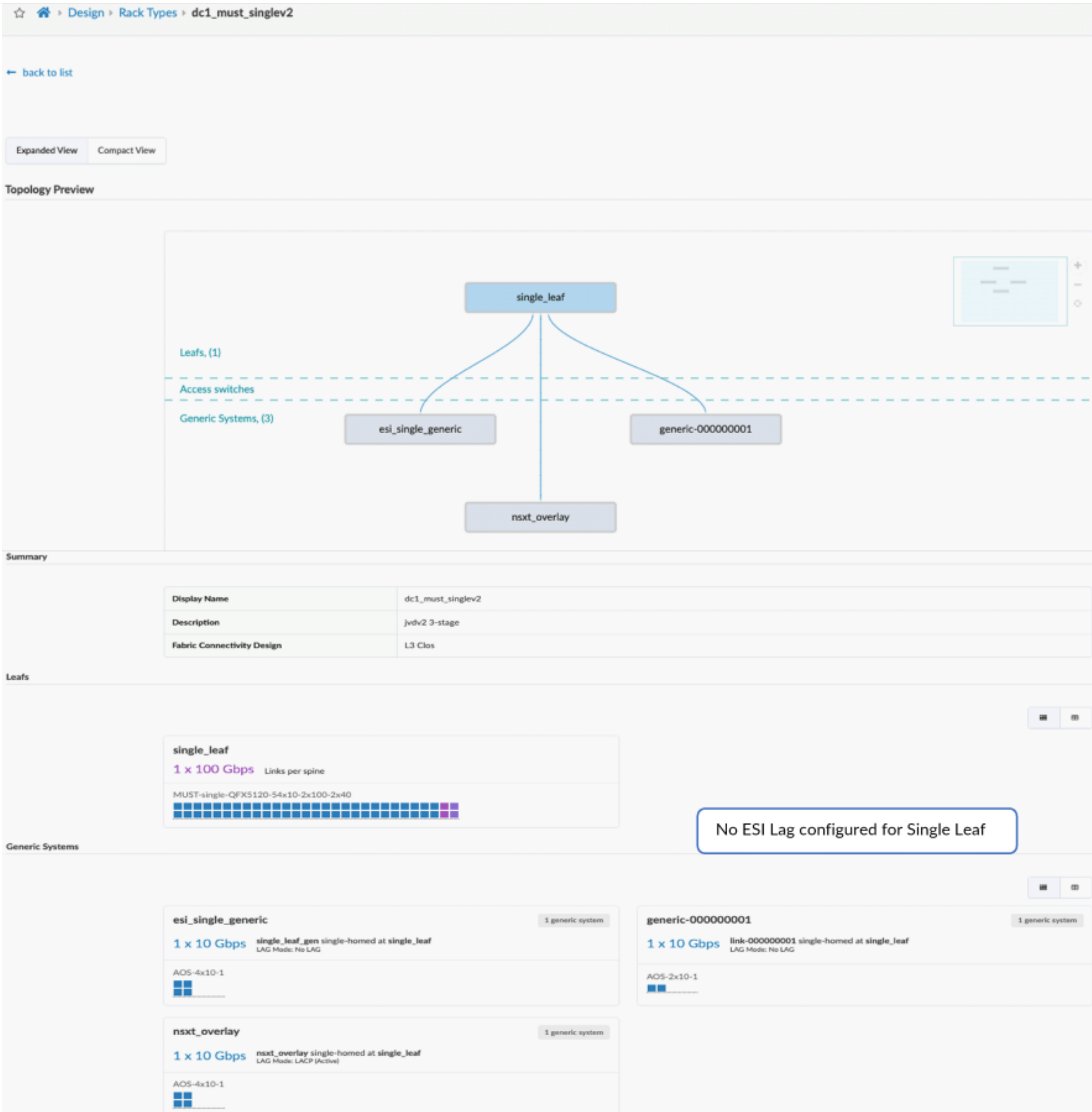
After defining the logical devices and Interface maps, the next step is to create racks to place the logical devices in rack formation. The default design for this solution is two spines, five server leaf switches, and two border leaf switches. Any rack design can be created and used any number of times, so long as the spine switches have enough ports to support it.

In Apstra, create racks under **Design** > **Rack Types**. For this solution, there are four racks. One rack for border leaf switches and three racks for server leaf switches. For more information on creating racks, refer to the Juniper Apstra User Guide.

For this design, the L3 Clos rack structure is as follows:

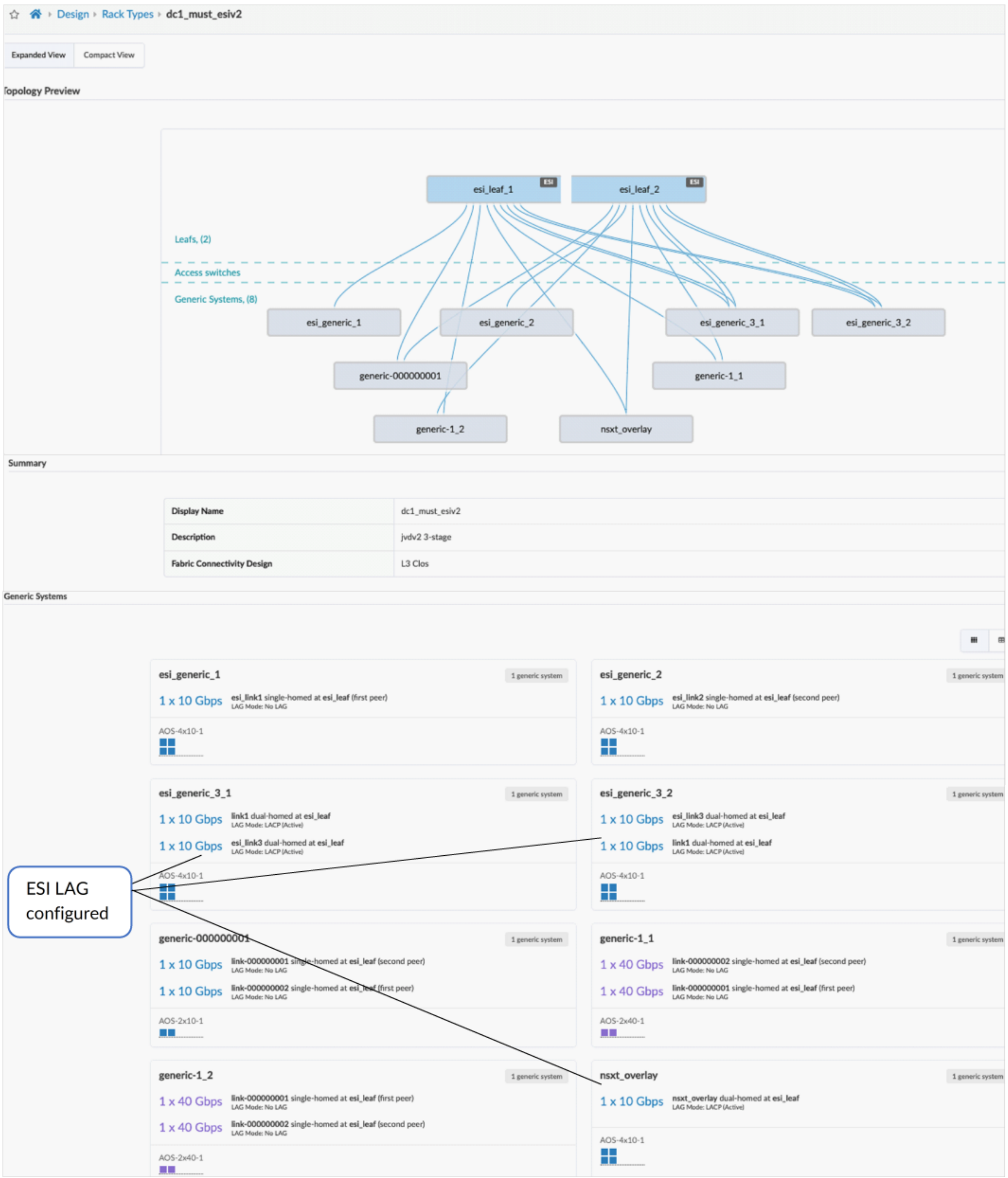
Server Leaf Switch (Single Leaf)

Figure 21: Single Leaf Rack Without ESI



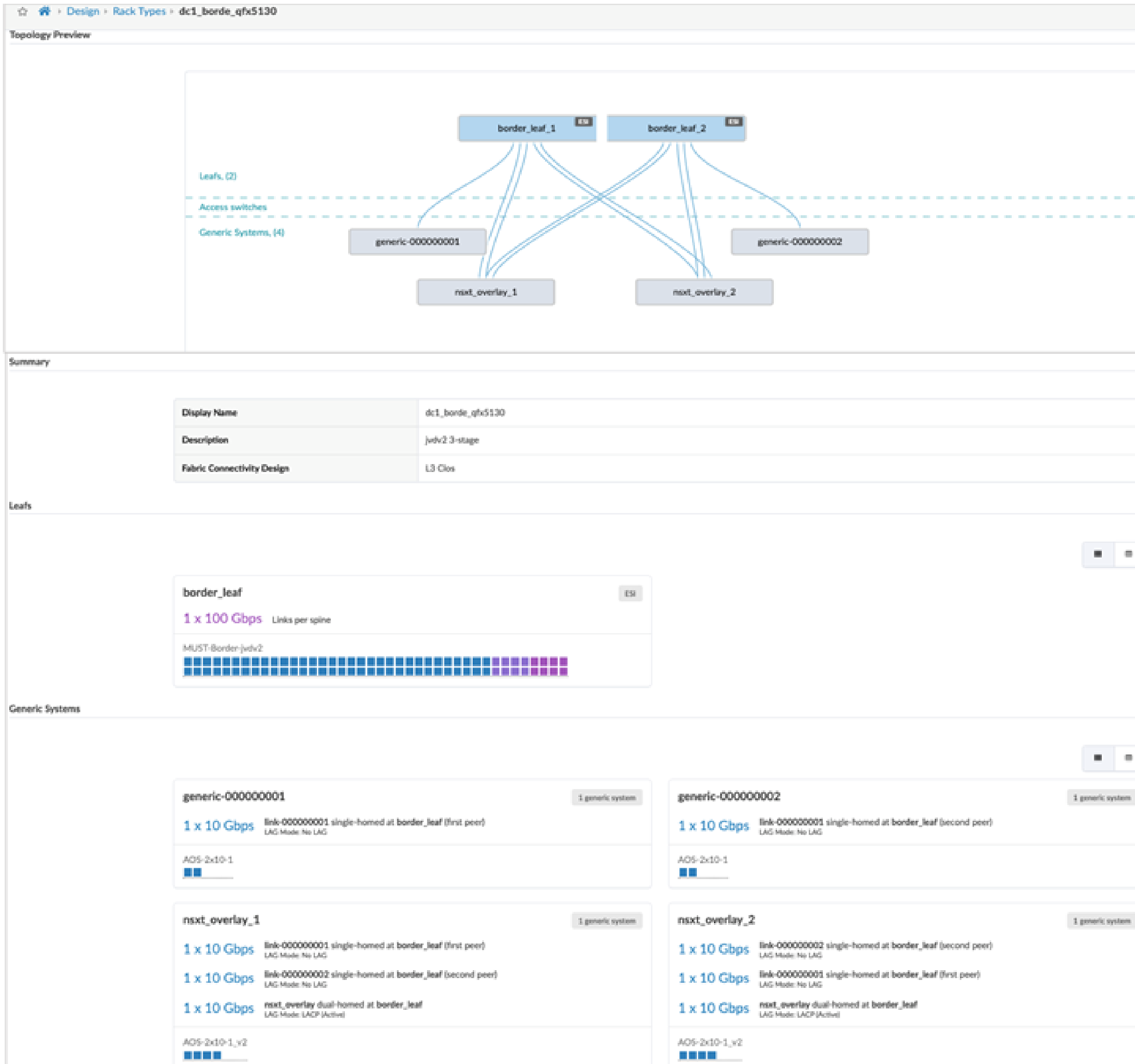
Server Leaf Switches (Two Leaf Switches)

Figure 22: Server Leaf Switches with ESI Lag for Multihomed



Border Leaf Switches

Figure 23: Border Leaf Switches Rack



NOTE: Once the blueprint is created and functional, if you need to perform any changes to the racks follow this KB article: https://supportportal.juniper.net/s/article/Juniper-Apstra-How-to-change-Leaf-Access-Switch-of-existing-rack-after-Day2-operations?language=en_US. During validation, the border leaf rack was modified to validate all devices listed in Table 5.

Create Templates

Templates define the structure and the intent of the network. After creating the racks, the spine links need to be connected to each of the racks. In this design, the rack-based templates are used to define the racks to connect as top-of-rack (ToR) switches (or pairs of ToR switches).

As described in the spine logical devices section, there are 100G links assigned to each server leaf and border leaf. The spine logical device is assigned in the template. Since there are no super spines in this design, this is left out of the templates. For more information on templates, refer to the Juniper Apstra User Guide.

NOTE: Templates are used as a base for creating the blueprints, which are covered in the next section. Templates are used only once in the lifetime of a blueprint. Hence changing the template doesn't modify the blueprint.

Figure 24: DC Rack-Based Template with Rack Assignment and Link Speed

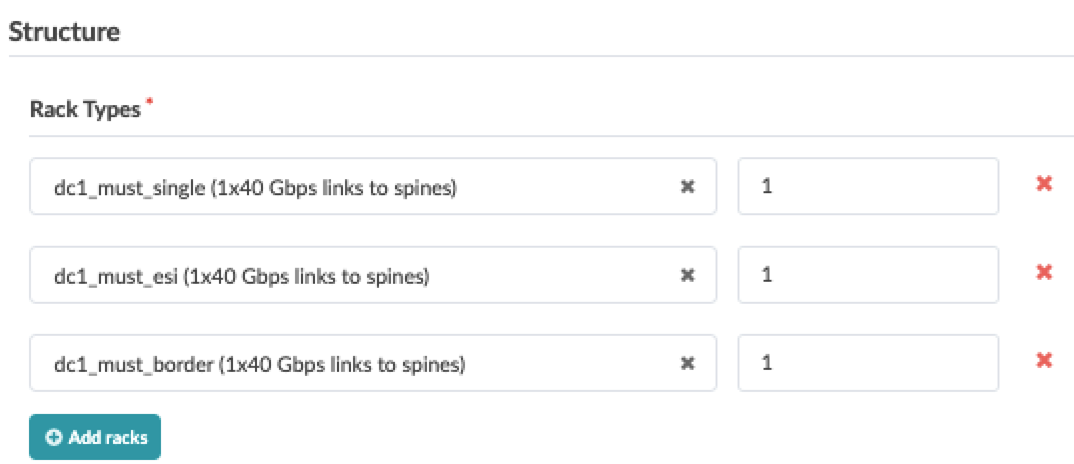
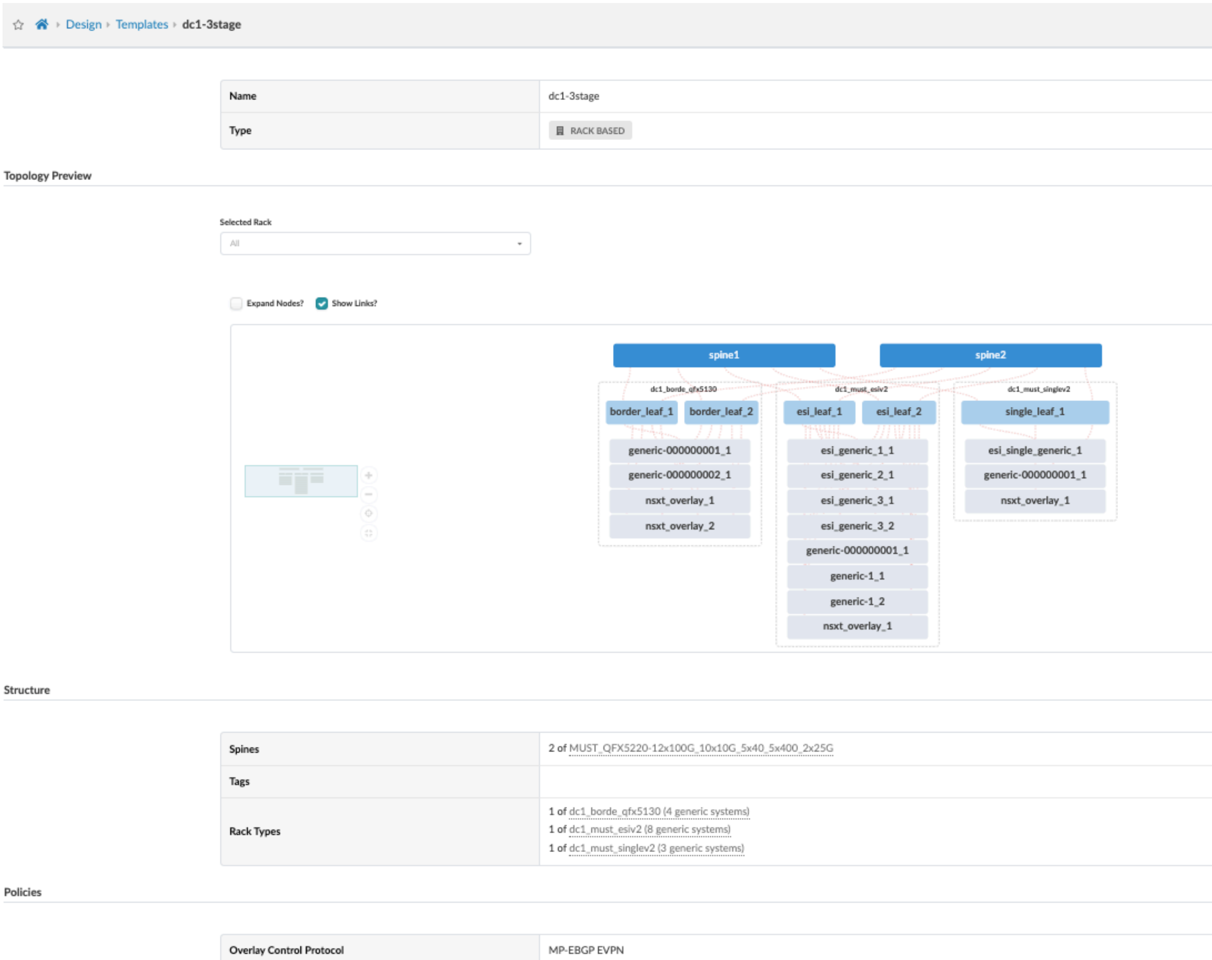


Figure 25: Figure Rack-Based Template Structure

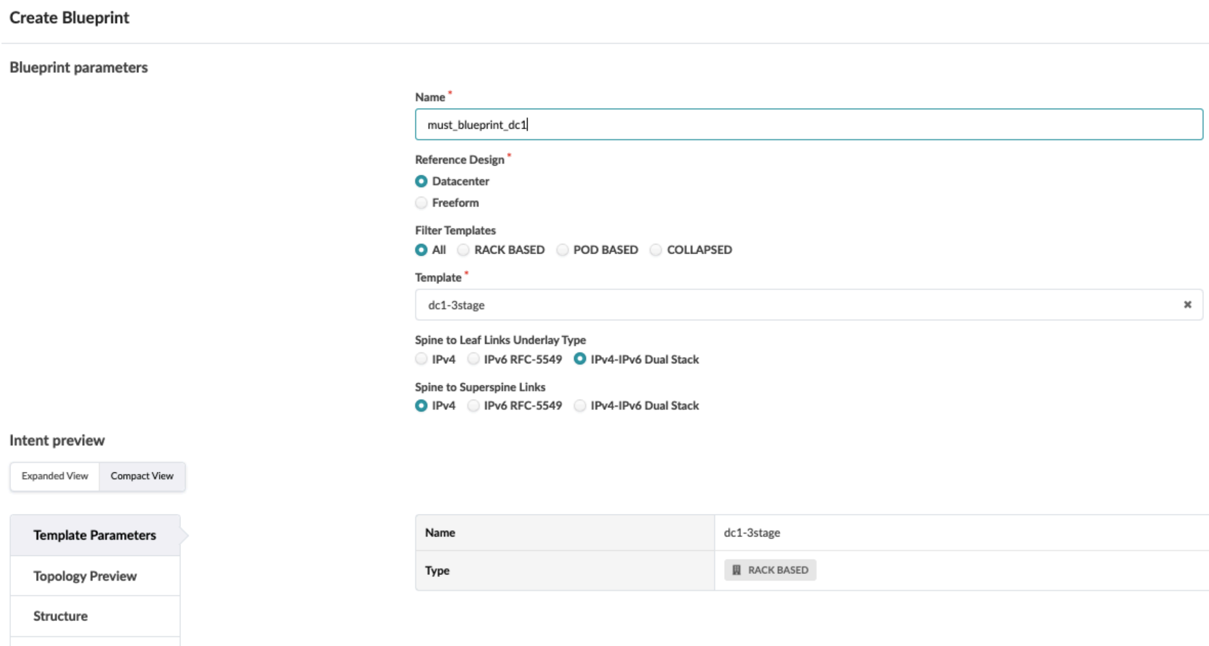


Blueprint

Each blueprint represents a data center. Templates are created under the **Design** > **Templates** section and will be available in the global catalog for the blueprints. Once the template is defined, it can be used to create a blueprint for the data center.

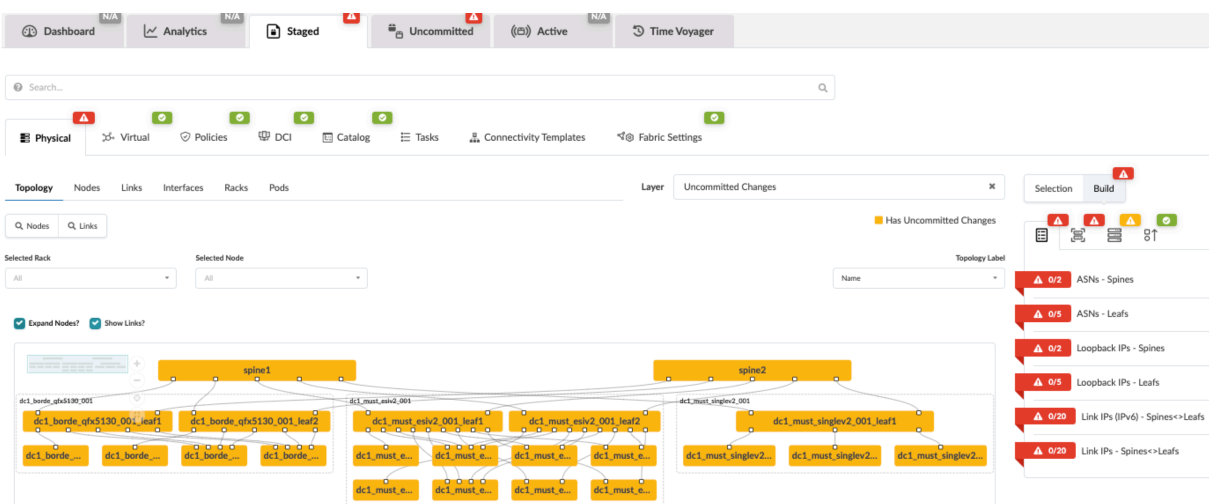
To create a blueprint, click on **Blueprints** > **Create Blueprint**. For more information on creating the blueprint, see the Juniper Apstra User Guide.

Figure 26: Create Blueprint with Dual Stack



Navigate to **Blueprint** > **Staged**. The topology shown can be expanded to view all connections. From here, the blueprint can be provisioned under Staged.

Figure 27: Blueprint Created and Not Provisioned



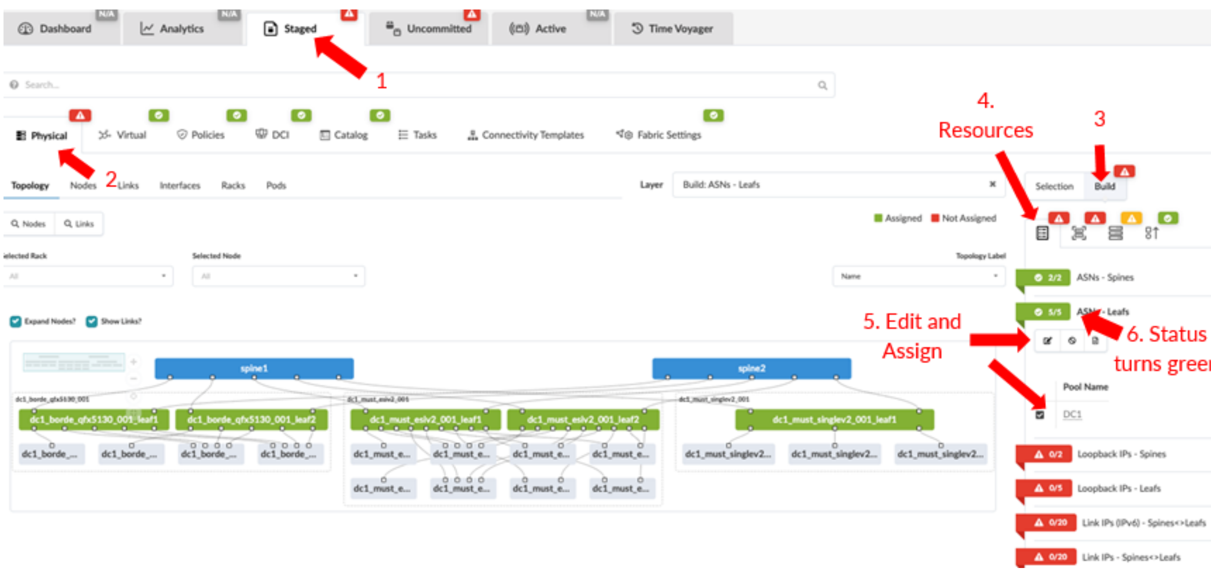
As shown above, the blueprint is created but not provisioned. The topology can be inspected for any discrepancies, and if so, then the blueprint can be recreated after fixing the template or the rack. Alternatively, navigate to **Staged** > **Racks** to edit the rack by following the steps mentioned in this article.

Apstra Web UI: Provisioning and Defining the Network

Once the blueprint is created, it means that the blueprint is ready to be staged. Review the tabs under the blueprint created.

To start provisioning, click on the **Staged tab** > **Physical** and then click Build from the right-hand side panel. For more information, refer to the Juniper Apstra User Guide.

Figure 28: Blueprint Assign Resources Under Build



Assign Resources

The first step is assigning IPs created in this **Resources** section. For this design, below are the resource values used:

1. Click **Staged** > **Physical** > **Build** > **Resources** and update as below:
   a. DC1 ASNs—Spines & leaf switches: 64512 - 64999
   b. Loopback IPs—Spines & Leaf switches: 192.168.255.0/24
   c. Link IPs—Spines <> Leaf switches: MUST-FABRIC-Interface-IPs DC1-10.0.1.0/24

Figure 29: ASN, Loopback IPs and Fabric Link IP Pools

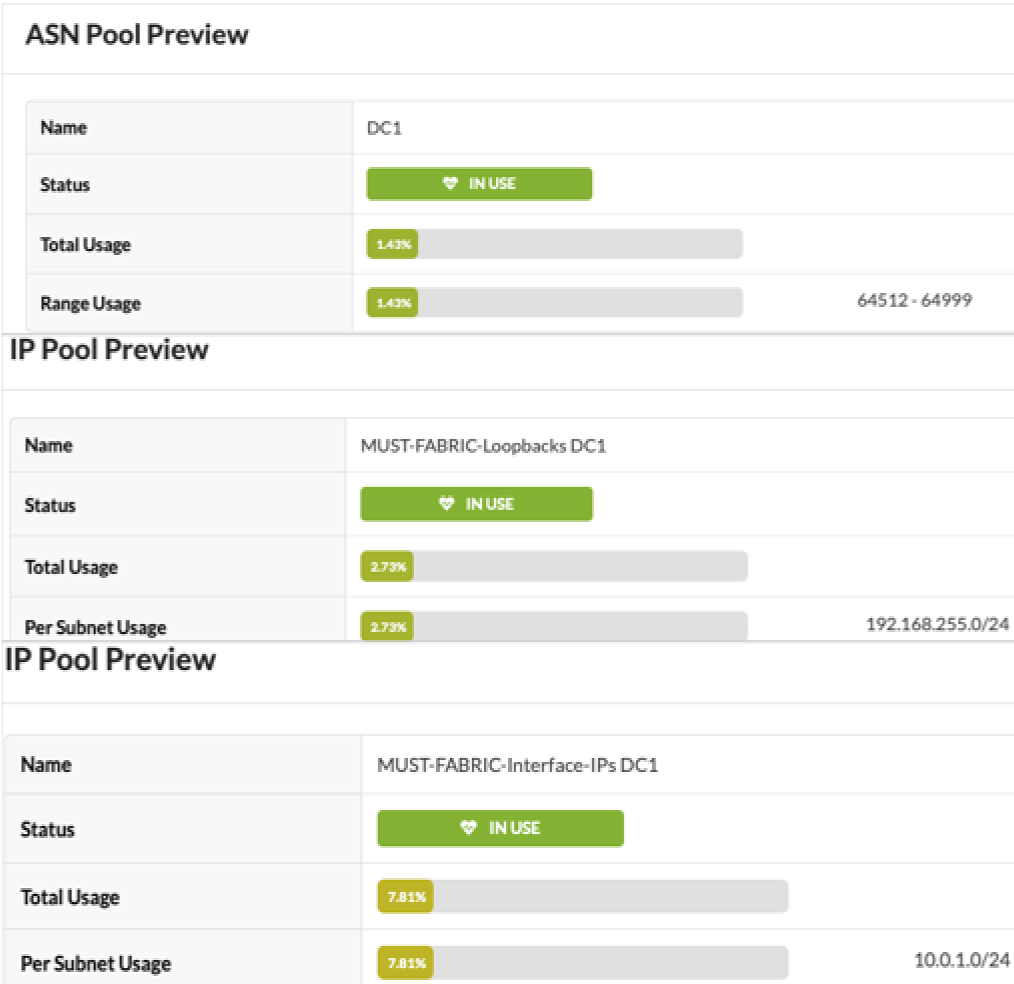
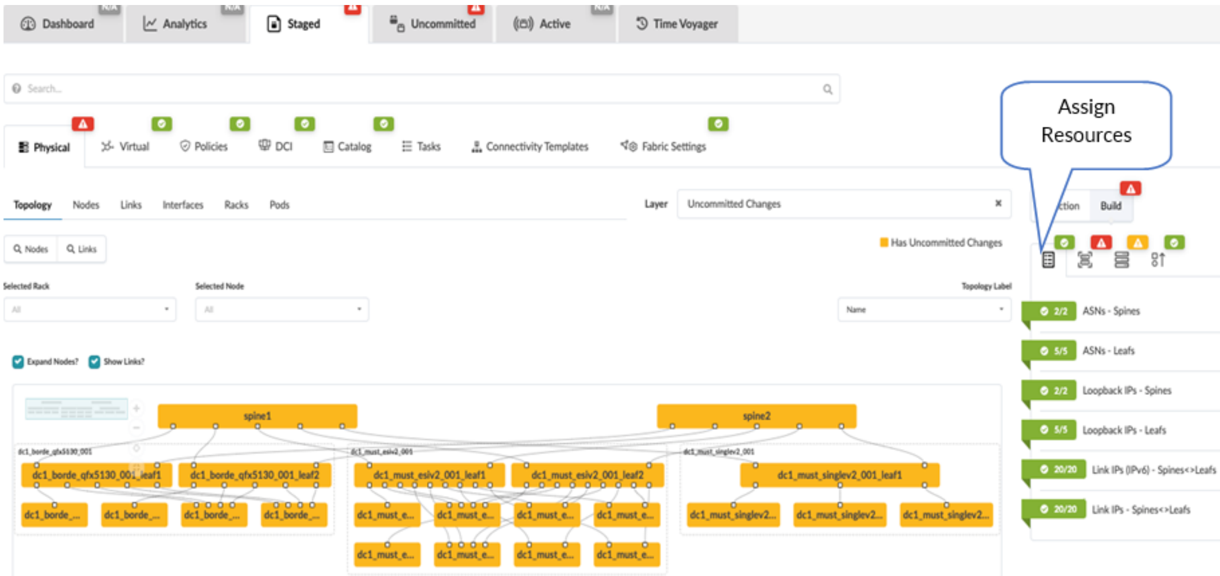


Figure 30: Resources Assigned



Assign Interface Maps to Switches

From the blueprint, navigate to **Staged** > **Physical** > **Build** > **Device Profiles**.

Next, assign devices to interface maps created in the section "Apstra Web UI: Identify and Create Logical Devices, Interface Maps with Device Profiles" on page 18 of this document.

Figure 31: Blueprint Assign Interface Maps in Device Profiles Under Build

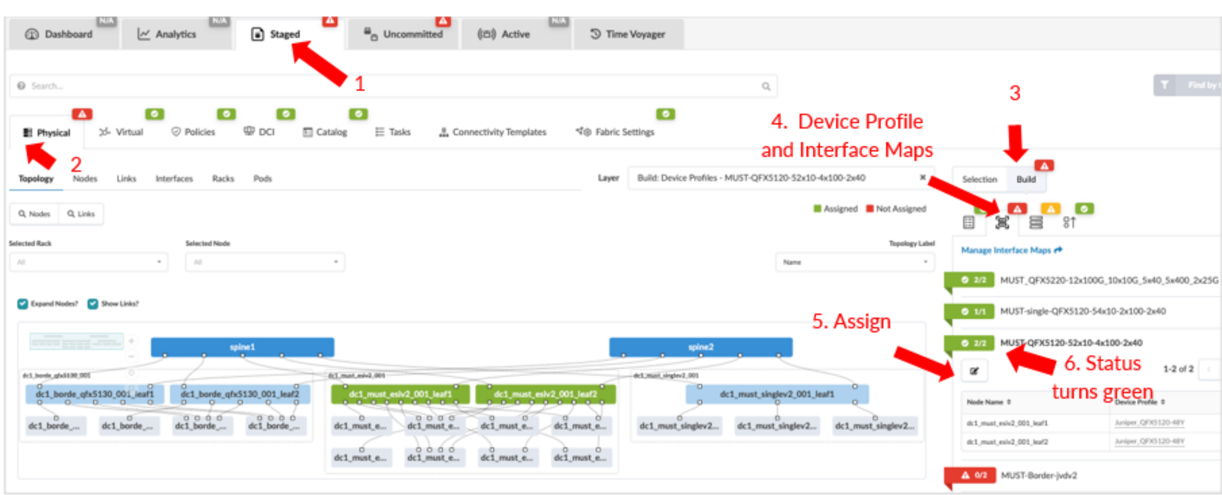
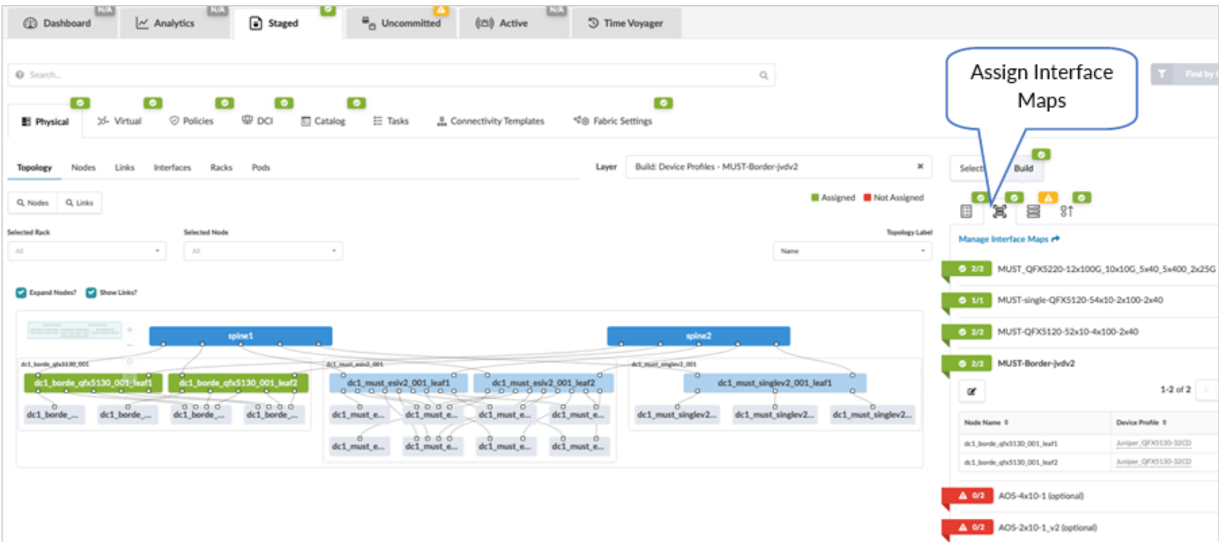


Figure 32: Interface Maps Assigned

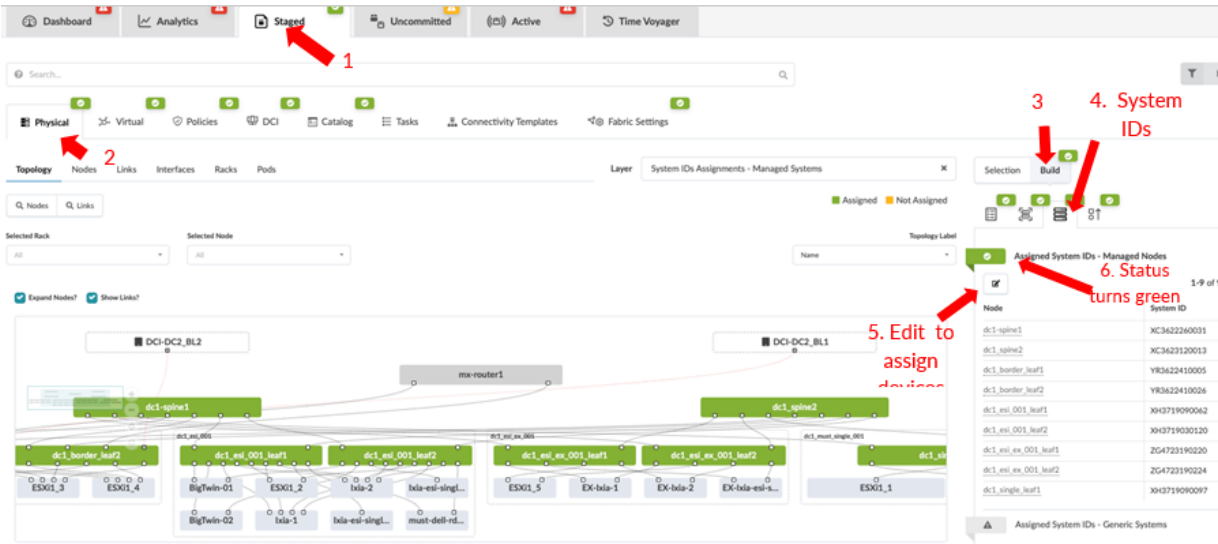


NOTE: The assignment of interface maps to generic systems or servers is optional. The status of these parameters will be marked RED and they are also marked as optional.

Assign the System IDs and the Correct Management IPs

From the blueprint, navigate to **Staged** > **Physical** > **Build** > **Devices** and click on Assigned System IDs. The system IDs are the devices serial numbers.

Figure 33: Blueprint Staged Assign System IDs Under Build



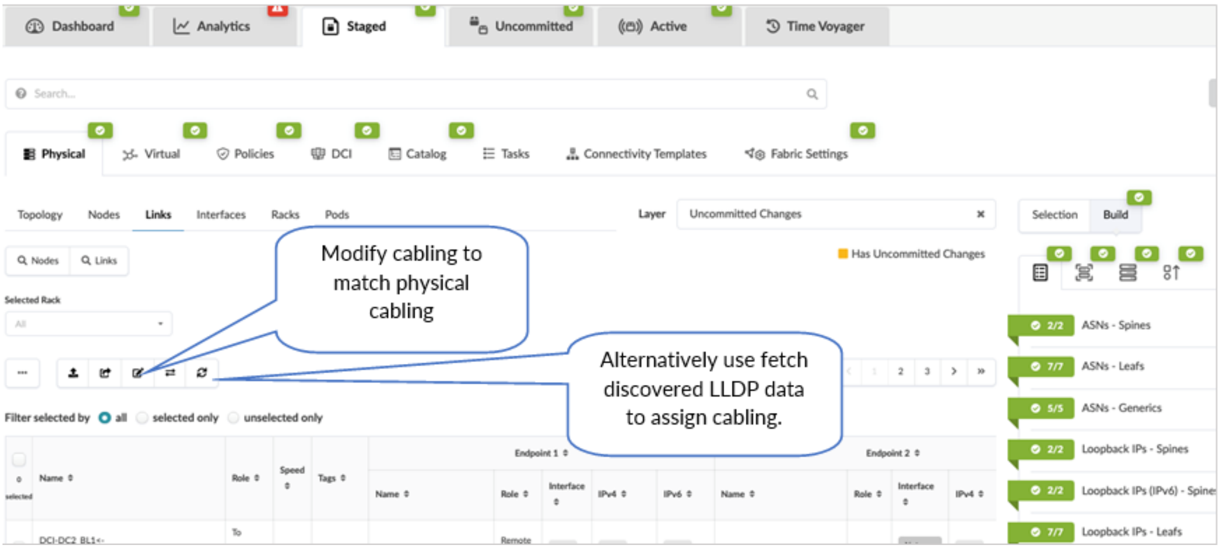
> **NOTE**: The device hostname and the display name (on Apstra) for each node or device is different these can be changed using Apstra.No system IDs are assigned to generic servers and external routers, as these are not managed by Apstra.

Ensure all the devices are added to Apstra under **Devices** > **Managed Devices** before assigning system IDs (serial numbers of the devices).

Review Cabling

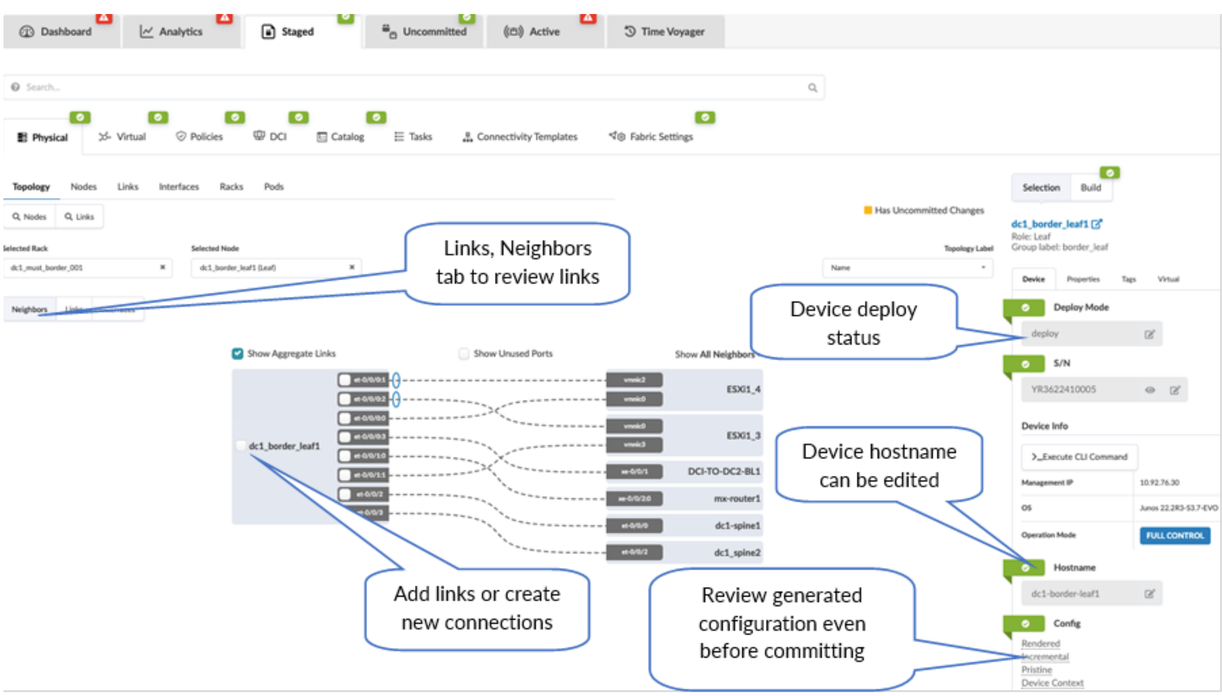
Apstra automatically assigns cabling ports on devices that may not be the same as physical cabling. However, the cabling assigned by Apstra can be overridden and changed to depict the actual cabling. This can be achieved by accessing the blueprint, navigating to **Staged > Physical > Links**, and clicking the **Edit Cabling Map** button. For more information, refer to the Juniper Apstra User Guide.

Figure 34: Review and Edit Cabling



It is best practice to review the switch names, including the generic servers, to ensure the naming is consistent. To review and modify the names of the devices, navigate to **Staged** > **Physical** > **Nodes** and click on the name of any of the devices listed to present a screen with the topology and connections to the device along with the panel on the right that shows the device properties, tags, and so on, as shown in Figure 35 on page 40 .

Figure 35: Review Device Links, Properties



Configlet and Property Sets

Configlets are configuration templates defined in the global catalog under **Design > Configlets**. Configlets are not managed by Apstra's intent-based functionality, and these are to be managed manually. For more information on when not to use configlet refer to the Juniper Apstra User Guide. Configlets should not be used to replace reference design configurations. Configlets can be declared as a Jinja template of the configuration snippet, such as Junos configuration JSON style or Junos set-based configuration. For more information on designing a configlet, refer to the Apstra Configlets user guide.

NOTE: Improperly configured configlets may not raise warnings or restrictions. It is recommended that configlets are tested and validated on a separate dedicated service to ensure that the configlet performs exactly as intended.Passwords and other secret keys are not encrypted in configlets.

Property sets are data sets that define device properties. They work in conjunction with configlets and analytics probes. Property sets are defined in the global catalog under **Design > Property Sets**.

NOTE: Configuration templates in Freeform blueprints also use property sets, but they're not related to property sets in the design catalog.

Configlets and property sets defined in the global catalogue need to be imported into the required blueprint and if the configlet is modified then the same needs to be reimported into the blueprint, as is the case with property sets too. The following figure shows configlets and property sets located on a blueprint.

Figure 36: Import Configlet into Blueprint

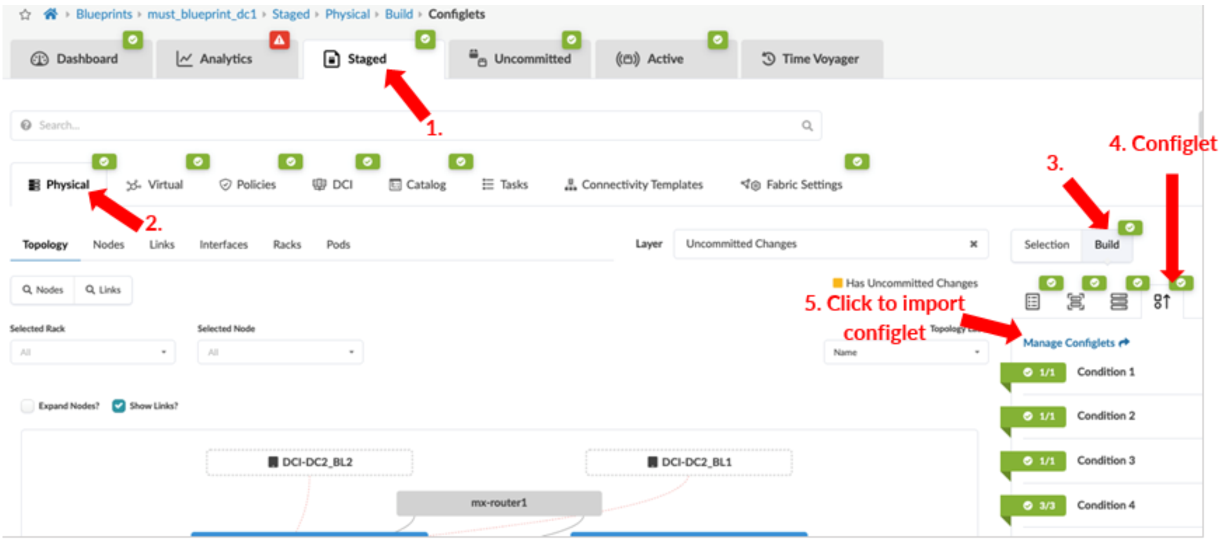
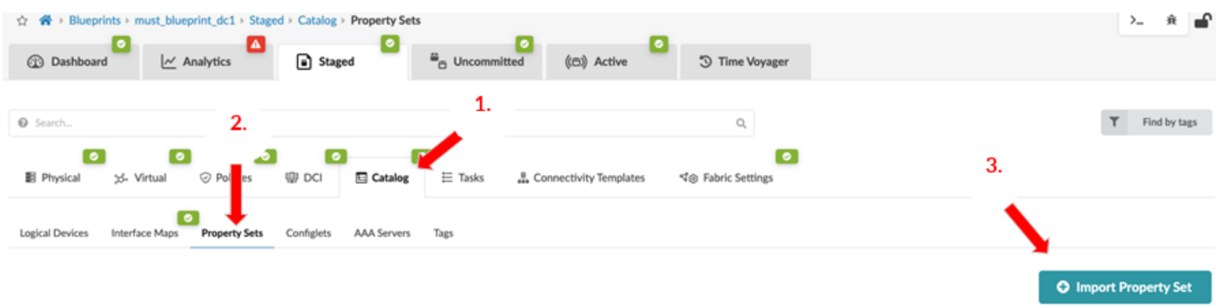


Figure 37: Import Property Set into Blueprint



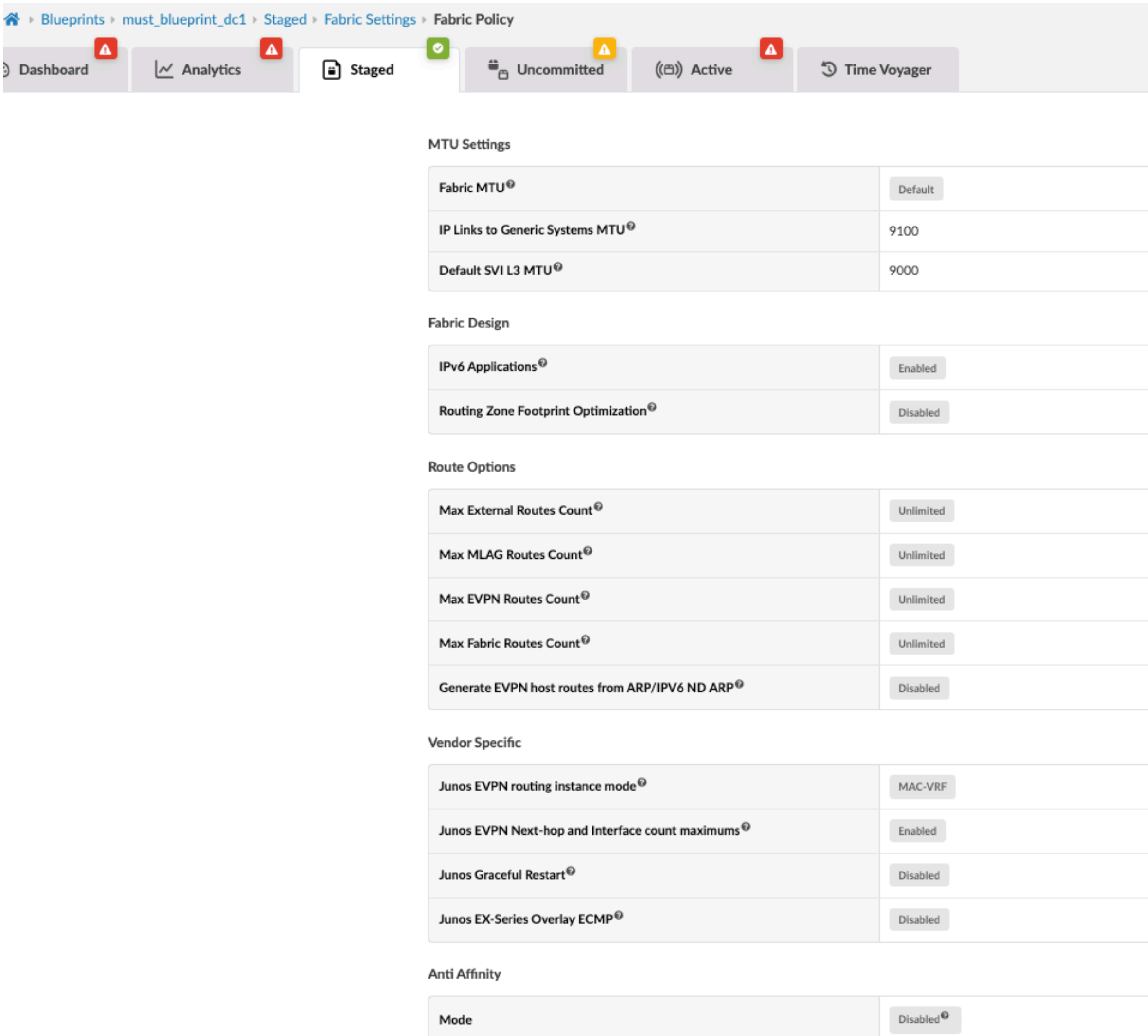
During 3-stage validation, several configlets were applied either as part of the general configuration for setup and management purposes (such as nameservers, NTP, and so on).

Fabric Setting

Fabric policy

This option allows for fabric-wide setting of various parameters such as MTU, IPv6 application support, and route options. For this JVD, the following parameters were used: View and modify these settings within the blueprint **Staged** > **Fabric Settings** > **Fabric Policy** within the Apstra UI.

Figure 38: Fabric Policy Settings



1. To simulate moderate traffic in datacenter, traffic scale testing was performed refer Table 6 on page 84 for more details. The scale testing was performed on QFX5120-48Y switches.

   The setting **Junos EVPN Next-hop and Interface count maximums** was also enabled, which allows Apstra to apply the relevant configuration to optimize the maximum number of allowed EVPN overlay next-hops and physical interfaces on leaf switches to an appropriate number for the data center fabric. Along with this the configlet is also used to set a balanced memory allocation for Layer 2 and Layer 3 entries as shown in Figure 39 on page 44.

   For more information on these features, refer to:

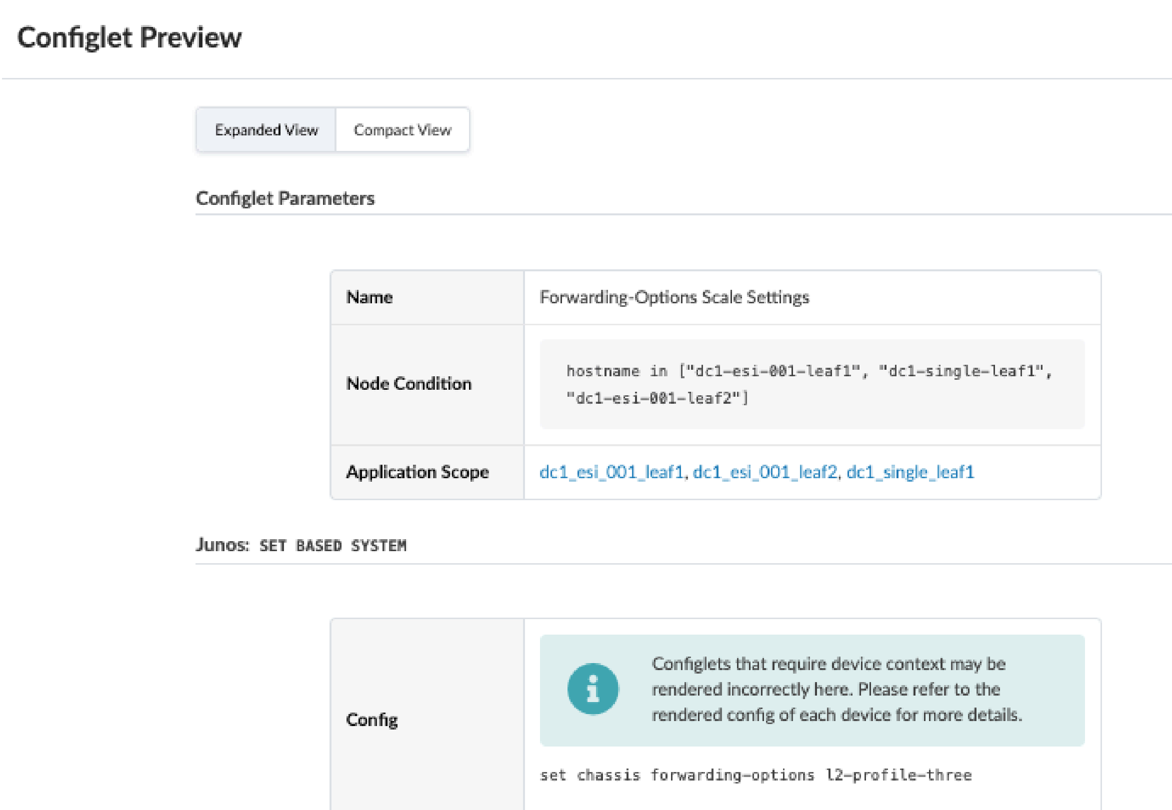
   - https://www.juniper.net/documentation/us/en/software/junos/multicast-l2/topics/topic-map/layer-2-forwarding-tables.html

- https://www.juniper.net/documentation/us/en/software/junos/evpn-vxlan/Other/interface-num-edit-forwarding-options.html
- https://www.juniper.net/documentation/us/en/software/junos/cli-reference/topics/ref/statement/next-hop-edit-forwarding-options-vxlan-routing.html

For QFX5120 leaf switches configuration:

```
{master:0}
root@dc1-esi-001-leaf1> show configuration forwarding-options | display set
set forwarding-options vxlan-routing next-hop 45056
set forwarding-options vxlan-routing interface-num 8192
set forwarding-options vxlan-routing overlay-ecmp
{master:0}
root@dc1-esi-001-leaf1> show configuration chassis forwarding-options | display set
set chassis forwarding-options l2-profile-three
```

Figure 39: Configlet on Leaf Switches for Balanced Memory



2. For the non-EVO leaf switches, the setting **Junos EVPN routing instance mode** was also enabled, as this is the default setting Apstra applies to all new blueprints from Apstra 4.2. For any blueprint created prior to Apstra 4.2, post-Apstra upgrade of the default switch for non-EVO switches is allowed. However, it is recommended that MAC-VRF normalize the configuration in a mixed setup of Junos OS and Junos OS Evolved. A VLAN-aware routing instance 'evpn-1' for MAC-VRF is created for only non-EVO Junos devices. This option doesn't affect Junos OS Evolved devices as Junos OS Evolved can only support MAC-VRF, and the same is already implemented by default.

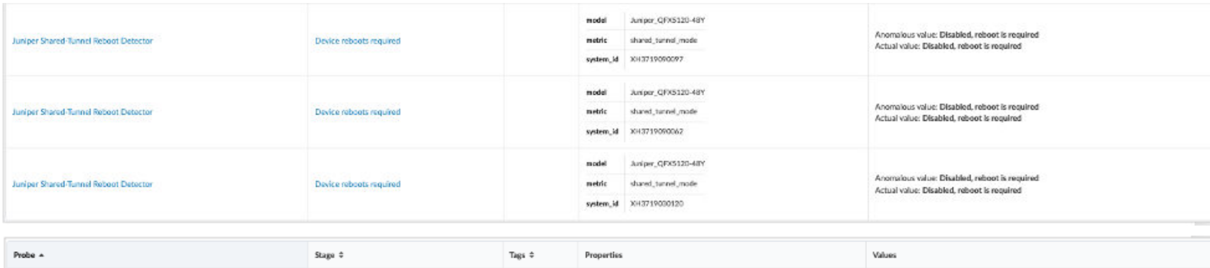
NOTE: If the blueprint is live and running in a production network, it is recommended to perform the above setting changes to MAC-VRF routing instance mode during a maintenance window as it is disruptive and requires a 'reboot' of non-EVO Junos leaf switches, in this case the QFX5120s.

For QFX5120 Leaf switches configuration:

```
{master:0}
root@dc1-esi-001-leaf1> show configuration forwarding-options | display set
set forwarding-options evpn-vxlan shared-tunnels
{master:0}
root@dc1-esi-001-leaf1> show configuration routing-instances evpn-1 | display set
set routing-instances evpn-1 instance-type mac-vrf
set routing-instances evpn-1 protocols evpn encapsulation vxlan
set routing-instances evpn-1 protocols evpn default-gateway do-not-advertise
set routing-instances evpn-1 protocols evpn duplicate-mac-detection auto-recovery-time 9
set routing-instances evpn-1 protocols evpn extended-vni-list all
set routing-instances evpn-1 protocols evpn vni-options vni 10050 vrf-target target:10050:1
set routing-instances evpn-1 protocols evpn vni-options vni 10108 vrf-target target:10108:1
set routing-instances evpn-1 protocols evpn vni-options vni 10400 vrf-target target:10400:1
```

Anomalies for "Device reboot required" will be raised for non-EVO leaf switches when the MAC-VRF routing instance mode is enabled. To fix these anomalies, reboot the leaf switches affected by the above change from the CLI.

Figure : Anomalies Raised by Apstra for QFX5120 Device Reboot After Change to MAC-VRF



Commit the Configuration

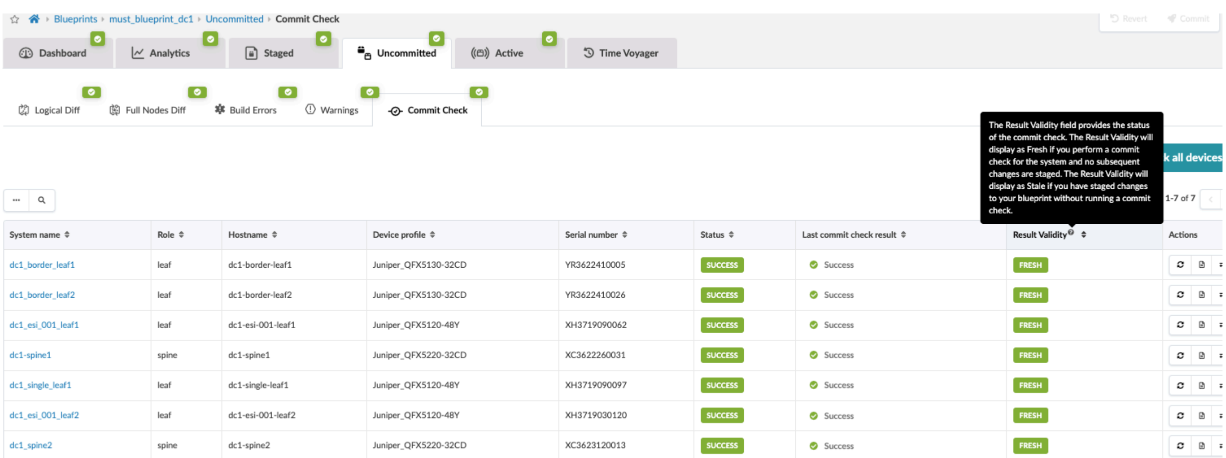
Once the cabling has been verified, the fabric is ready to be committed. This means that the control plane is set up, and all the leaf switches are able to advertise routes through BGP. Review changes and commit by navigating from the blueprint to **Blueprint > <Blueprint-name> Uncommitted**.

As of Apstra 4.2, a new feature is to perform a commit check before committing, which is introduced to check for semantic errors or omissions, especially if any configlets are involved.

Note that if there are build errors, those need to be fixed. Otherwise, Apstra will not commit any changes until the errors are resolved.

For more information, refer to the Juniper Apstra User Guide.

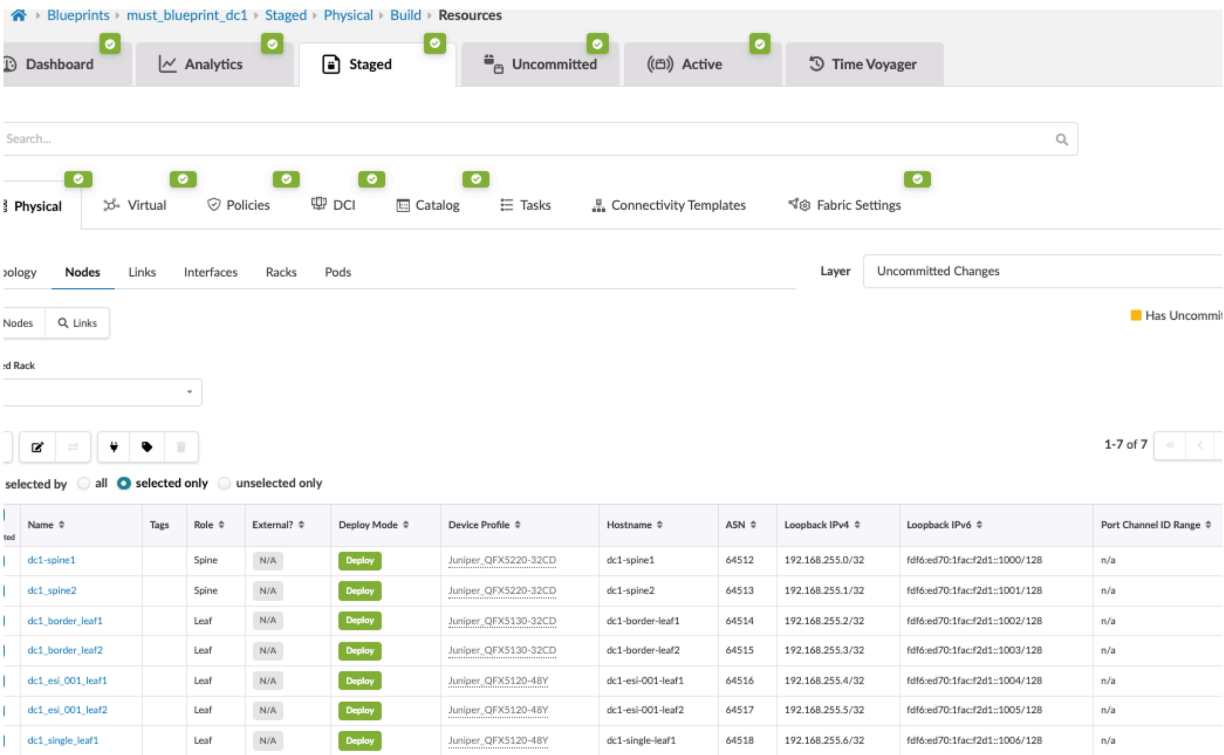
Figure 40: Blueprint Committed



Apstra Fabric Configuration Verification

After reviewing the changes and committing them to the devices, a functional fabric should be created.

Figure 41: Blueprint Nodes Deployed and IPv4 and IPv6 Loopback Assigned by Apstra



The blueprint for the data center should indicate that no anomalies are present to show that everything is working. To view any anomalies with respect to blueprint deployment, navigate to **Blueprint >** ***<Blueprint-name>*** **> Active** to view anomalies raised with respect to BGP, cabling, interface down events, routes missing, and so on. For more information, refer to the Apstra User Guide.

Figure 42: Blueprint Deployed Shows the Active Tab with No Anomalies

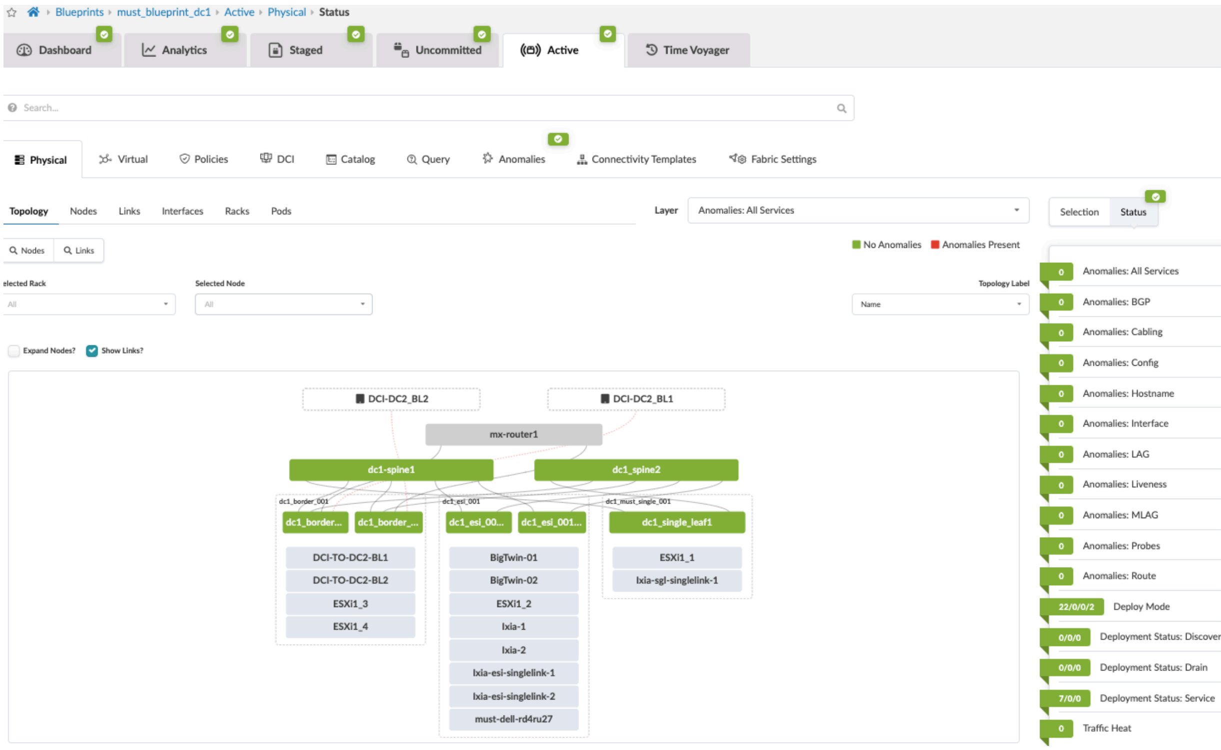
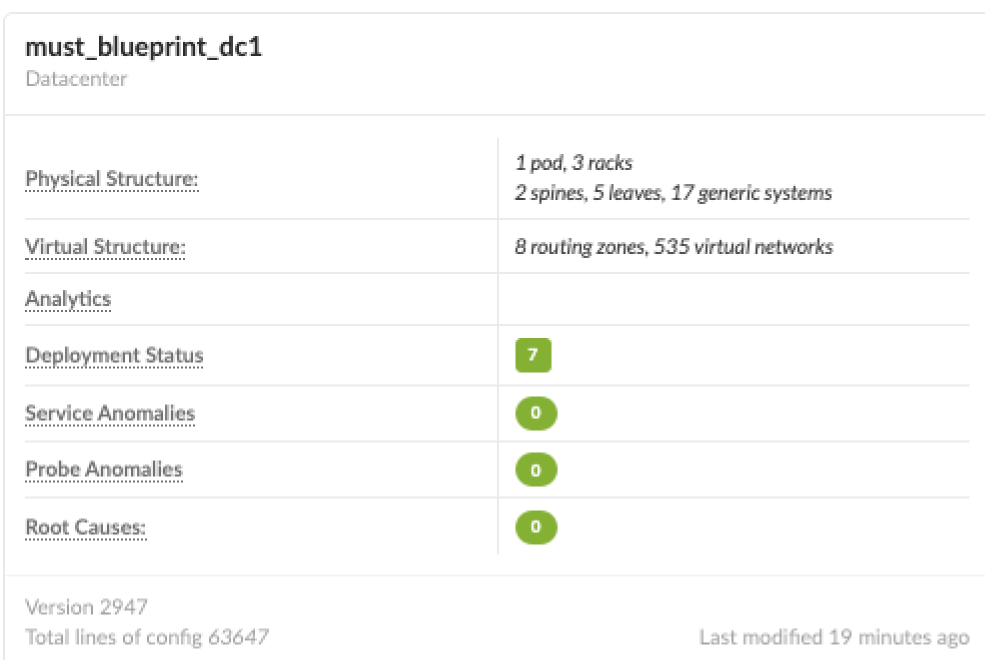


Figure 43: Data Center Blueprint Summary



To verify that the fabric is functional and the changes are configured, log into the console or CLI of each of the spine switches. From the shell of each of the spine switches, enter the following Junos OS CLI command:

```
show bgp summary | no-more
```

The output of this command should resemble the output below. It shows that BGP is established from each spine to each of the seven leaf switches for loopback and fabric link IPs.

On Spine 1:

```
root@dc1-spine1> show bgp summary | no-more
Warning: License key missing; requires 'bgp' license
Threading mode: BGP I/O
Default eBGP mode: advertise - accept, receive - accept
Groups: 2 Peers: 14 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0
                      49         42          0          0          0          0
bgp.evpn.0
                    8263       8263          0          0          0          0
Peer                     AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State|#Active/
Received/Accepted/Damped...
10.0.1.5              64520     100256      98745       0      12 4w3d 15:44:08 Establ
  inet.0: 2/3/3/0
10.0.1.7              64518     100736      99371       0      31 4w3d 19:24:11 Establ
  inet.0: 2/3/3/0
10.0.1.9              64514      17957      17900       0      73 5d 18:19:16 Establ
  inet.0: 16/17/17/0
10.0.1.11             64515      17943      17889       0      34 5d 18:13:02 Establ
  inet.0: 16/17/17/0
10.0.1.13             64516     100735      99370       0      30 4w3d 19:23:45 Establ
  inet.0: 2/3/3/0
10.0.1.15             64517     100736      99373       0      34 4w3d 19:24:21 Establ
  inet.0: 2/3/3/0
10.0.1.27             64519     100255      98745       0      18 4w3d 15:44:09 Establ
  inet.0: 2/3/3/0
192.168.255.2         64514      21707      40706       0      92 5d 18:18:25 Establ
  bgp.evpn.0: 1149/1149/1149/0
192.168.255.3         64515      18907      43483       0      31 5d 18:12:36 Establ
  bgp.evpn.0: 1147/1147/1147/0
192.168.255.4         64516     124001     244758       0      30 4w3d 19:23:43 Establ
```

```
  bgp.evpn.0: 1216/1216/1216/0
192.168.255.5         64517     238893     138433       0      34 4w3d 19:24:20 Establ
  bgp.evpn.0: 1216/1216/1216/0
192.168.255.6         64518     102398     265528       0      31 4w3d 19:23:58 Establ
  bgp.evpn.0: 1137/1137/1137/0
192.168.255.7         64519     101447     217804       0      16 4w3d 15:43:55 Establ
  bgp.evpn.0: 1199/1199/1199/0
192.168.255.8         64520     101419     217814       0      12 4w3d 15:44:00 Establ
  bgp.evpn.0: 1199/1199/1199/0
```

On Spine 2:

```
root@dc1-spine2> show bgp summary | no-more
Warning: License key missing; requires 'bgp' license
Threading mode: BGP I/O
Default eBGP mode: advertise - accept, receive - accept
Groups: 3 Peers: 14 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0
                      49         42          0          0          0          0
bgp.evpn.0
                    8263       8263          0          0          0          0
Peer                     AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State|#Active/
Received/Accepted/Damped...
10.0.1.1              64520     100269      98778       0      15 4w3d 15:49:41 Establ
  inet.0: 2/3/3/0
10.0.1.3              64519     100267      98778       0      20 4w3d 15:49:40 Establ
  inet.0: 2/3/3/0
10.0.1.17             64518     100749      99375       0      35 4w3d 19:29:47 Establ
  inet.0: 2/3/3/0
10.0.1.19             64514      17968      17915       0      92 5d 18:24:04 Establ
  inet.0: 16/17/17/0
10.0.1.21             64515      17953      17903       0      36 5d 18:17:34 Establ
  inet.0: 16/17/17/0
10.0.1.23             64516     100748      99374       0      36 4w3d 19:29:25 Establ
  inet.0: 2/3/3/0
10.0.1.25             64517     100749      99378       0      40 4w3d 19:29:58 Establ
  inet.0: 2/3/3/0
192.168.255.2         64514      21711      40714       0      93 5d 18:23:41 Establ
  bgp.evpn.0: 1149/1149/1149/0
192.168.255.3         64515      18902      43498       0      28 5d 18:16:29 Establ
  bgp.evpn.0: 1147/1147/1147/0
```

```
192.168.255.4        64516     124014     243943       0      35 4w3d 19:29:20 Establ
  bgp.evpn.0: 1216/1216/1216/0
192.168.255.5        64517     238899     137577       0      39 4w3d 19:29:53 Establ
  bgp.evpn.0: 1216/1216/1216/0
192.168.255.6        64518     102416     264691       0      34 4w3d 19:29:44 Establ
  bgp.evpn.0: 1137/1137/1137/0
192.168.255.7        64519     101454     217761       0      21 4w3d 15:49:28 Establ
  bgp.evpn.0: 1199/1199/1199/0
192.168.255.8        64520     101424     217769       0      13 4w3d 15:49:32 Establ
  bgp.evpn.0: 1199/1199/1199/0
```

If the output of the *show bgp summary | no-more* command resembles the screenshot above, a bare-bones network fabric is now complete. However, it is not yet ready for production use as the overlay network with VRFs, VLANs, and VNIs still must be applied.

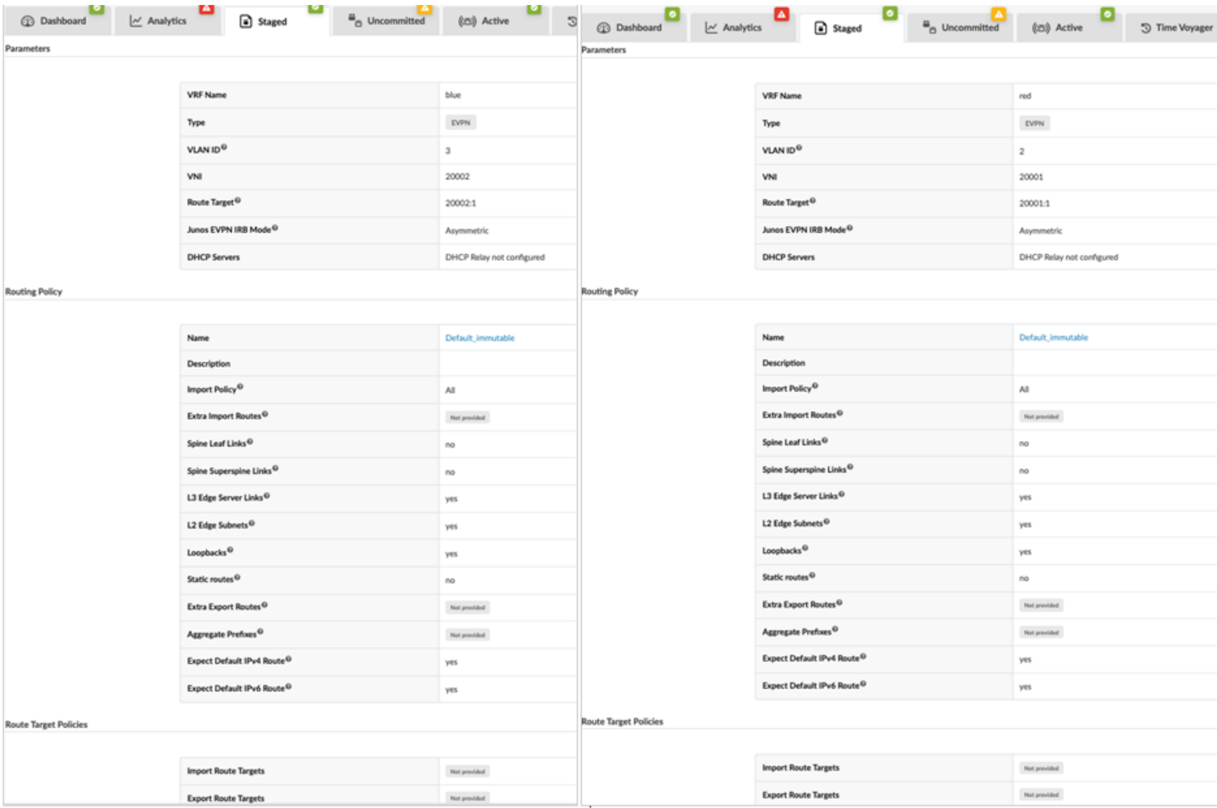
If the output of the *show bgp summary | no-more* command does not resemble the screenshot, it is essential to remedy any configuration errors before proceeding further.

Configure Overlay Network

Configure Routing Zone (VRF) for Red and Blue Tenants, and Specify a Virtual Network Identifier (VNI)

1. From Blueprints > Staged -> Virtual > Routing Zones.
2. Click Create Routing Zone and provide the following information:
   a. VRF Name: blue
   b. VLAN ID: 3
   c. VNI: 20002
   d. Routing Policies: Default immutable
3. Create another routing zone with the following information:
   a. VRF Name: red
   b. VLAN ID:2
   c. VNI: 20001
   d. Routing Policies: Default immutable

Figure 44: Red and Blue Routing Zone

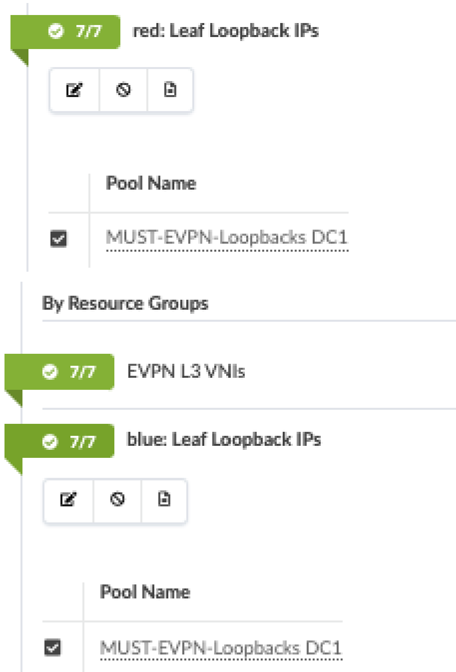


Assign EVPN Loopback to Routing

After creating the routing zones, assign the EVPN loopback below to both the Red and Blue routing zones. Navigate to **Blueprint > Staged > Routing Zone** and assign resources from the right-hand side panel.

Resources	Range
MUST-EVPN-Loopbacks-DC1	192.168.11.0/24

Figure : Red and Blue Loopback Assigned



Create Virtual Networks in Red and Blue Routing Zones

Virtual networks should be associated with routing zones (VRF). Create the virtual networks (VNIs) and associate these Virtual Networks with the routing zone (VRF) created earlier. Optionally, create any additional routing zones and virtual networks for production environments based on individual requirements.

Below are the networks created and assigned to appropriate leaf switches in the fabric. The input fields are as follows:

For Blue Network:

1. Click **Create Virtual Networks**.
2. Set type of network VXLAN.
3. Provide name: **dc1_vn1_blue** and **dc1_vn2_blue**.
4. Select the **Blue** security zone for both networks:
5. Provide VNI:
   a. 12001 for dc1_vn1_blue.
   b. 12002 for dc1_vn2_blue.

6. IPv4 Connectivity – set **enabled**.

7. Create Connectivity Template for: Tagged.

8. Provide IPv4 Subnet and Virtual IP Gateway:
   a. 10.12.1.0/24, 10.12.1.1 for dc1_vn1_blue
   b. 10.12.2.0/24, 10.12.2.1 for dc1_vn2_blue

9. Assign to leaf switches.

For Red Network:

1. Click **Create Virtual Networks**.

2. Set type of network VXLAN.

3. Provide name: **dc1_vn1_red** and **dc1_vn2_red**.

4. Select the **Red** security zone for both networks:

5. Provide VNI:
   a. 11001 for dc1_vn1_red
   b. 11002 for dc1_vn2_red

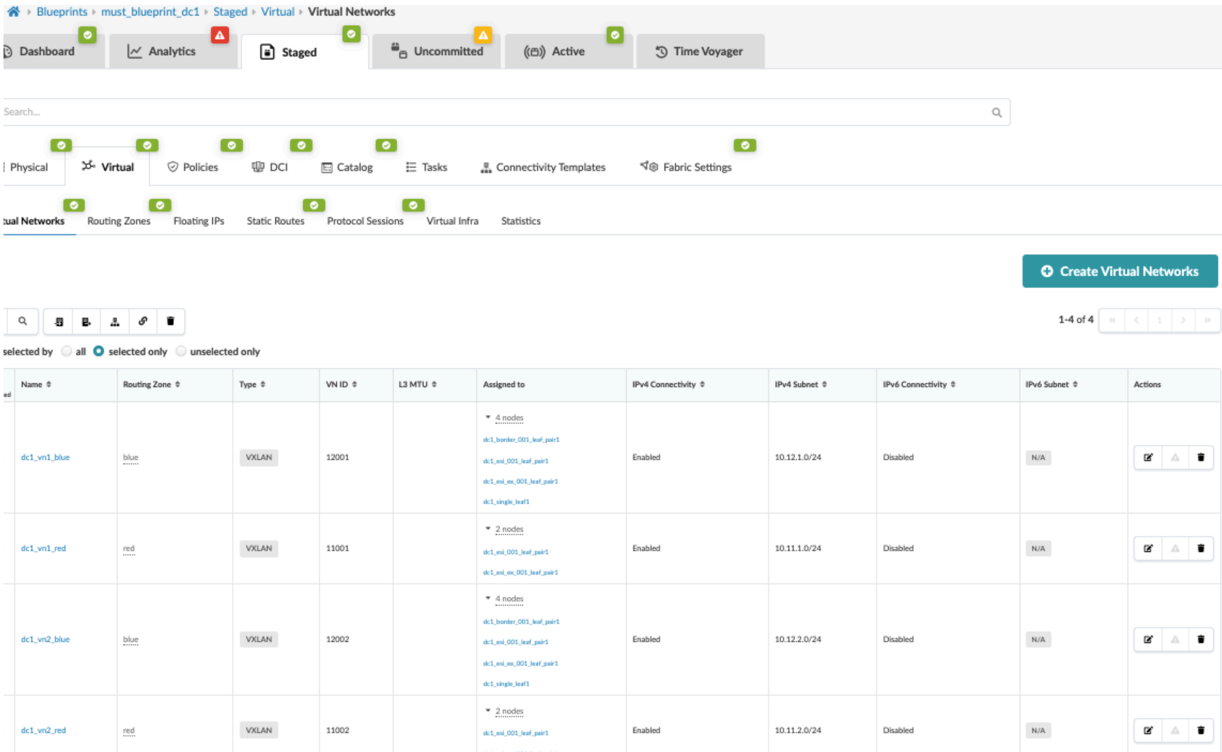
6. IPv4 Connectivity – set **enabled**.

7. Create Connectivity Template for: Tagged.

8. Provide IPv4 Subnet and Virtual IP Gateway:
   a. 10.11.1.0/24, 10.11.1.1 for dc1_vn1_red
   b. 10.11.2.0/24, 10.11.2.1 for dc1_vn2_red

9. Assign to leaf switches.

Figure 45: Virtual Networks Created



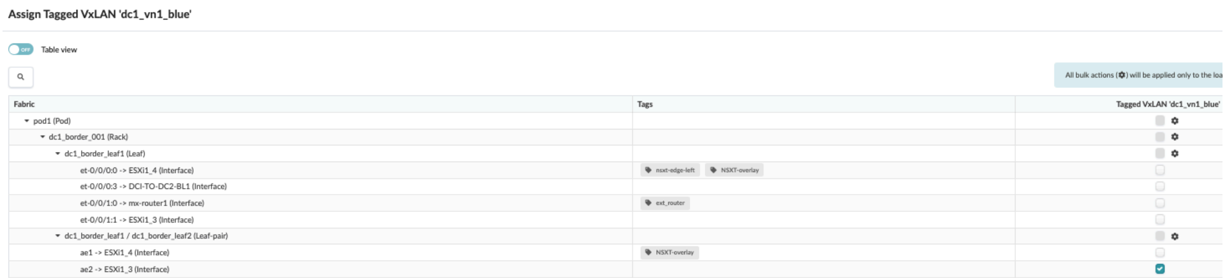
IRB Network is created, and a connectivity template is added and assigned to leaf switches as shown in Figure 47 on page 56. For more information on connectivity templates, see the Juniper Apstra User Guide.

While creating a virtual network, if the create connectivity template is selected above as tagged, Apstra creates a connectivity template, which is generated automatically for the virtual network.

Navigate to **Blueprint > Staged > Connectivity Templates** to view the templates and assign them to leaf switches. When assigned to leaf switches, a tagged aggregated ethernet interface is created connecting the servers.

Figure 46: Apstra Generated Connectivity Templates

Figure 47: Assign Connectivity Template for Each Network to Leaf Switches



Then, navigate to **Blueprint** > **Uncommitted** to review the uncommitted changes and commit the overlay configuration. Alternatively, also review the configuration generated for each leaf switch to which the overlay network is created by navigating to **Blueprint** > **Staged** > **Physical** > **Nodes** and check the configuration.

Verify Overlay Connectivity for Blue and Red Network

Having committed changes in the Apstra UI, these changes are now applied to the switches.

To begin verifying the fabric's configuration, log in to the console of each of the leaf switches.

From the CLI of the leaf switches, enter the following commands:

```
!
//begin QFX leaf switch commands//
show interfaces irb terse
show vlans instance evpn-1 vn1101
show vlans instance evpn-1 vn1102
show vlans instance evpn-1 vn1201
show vlans instance evpn-1 vn1202
!
```

This output displays multiple IRB interfaces and the configured routing instances for the Blue and Red networks.

Red Network IRB on one of the leaf switches:

```
{master:0}
root@dc1-esi-001-leaf1> show interfaces irb terse | match 10.11.*.1/24
```

```
irb.1101                up    up   inet     10.11.1.1/24
irb.1102                up    up   inet     10.11.2.1/24
```

Blue Network IRB on one of the leaf switches:

```
{master:0}
root@dc1-esi-001-leaf1> show interfaces irb terse | match 10.12.*.1/24
irb.1201                up    up   inet     10.12.1.1/24
irb.1202                up    up   inet     10.12.2.1/24
```

Since Apstra now, by default, uses MAC-VRF routing mode, the same can be seen from the below command output for all the Red and Blue network VLANs.

```
{master:0}
root@dc1-esi-001-leaf1> show vlans instance evpn-1 vn1101
Routing instance        VLAN name             Tag          Interfaces
evpn-1                  vn1101                1101
                                                           vtep-15.32772*
                                                           xe-0/0/50:0.0*
{master:0}
root@dc1-esi-001-leaf1> show vlans instance evpn-1 vn1102
Routing instance        VLAN name             Tag          Interfaces
evpn-1                  vn1102                1102
                                                           vtep-15.32772*
{master:0}
root@dc1-esi-001-leaf1> show vlans instance evpn-1 vn1201
Routing instance        VLAN name             Tag          Interfaces
evpn-1                  vn1201                1201
                                                           ae1.0
                                                           ae3.0*
                                                           et-0/0/52.0*
                                                           et-0/0/53.0*
                                                           vtep-15.32771*
                                                           vtep-15.32772*
                                                           vtep-15.32776*
                                                           vtep-15.32777*
                                                           xe-0/0/50:0.0*
{master:0}
root@dc1-esi-001-leaf1> show vlans instance evpn-1 vn1202
Routing instance        VLAN name             Tag          Interfaces
evpn-1                  vn1202                1202
```

```
                                                           ae2.0*
                                                           et-0/0/52.0*
                                                           et-0/0/53.0*
                                                           vtep-15.32771*
                                                           vtep-15.32772*
                                                           vtep-15.32776*
                                                           vtep-15.32777*
```

Verify that ERB is Configured on Leaf Switches

Within the CLI of the leaf switches, enter the following commands:

```
!
//begin QFX CLI commands//
show evpn database | match irb.110
show evpn database | match irb.120

!
```

The output of this command displays the distributed gateways on all switches.

The gateways display 10.11.1.1, 10.11.2.1 for the Red network, and 10.12.1.1, 10.12.2.1 for the Blue network. These IRB configurations apply only to devices assigned in the connectivity templates. No other fabric switches have this IRB configured unless assigned through the connectivity template.

```
{master:0}
root@dc1-esi-001-leaf1> show evpn database | match irb.110
     11001      00:1c:73:00:00:01  irb.1101                       Feb 28 11:33:36  10.11.1.1
     11002      00:1c:73:00:00:01  irb.1102                       Feb 28 11:33:36  10.11.2.1
{master:0}
root@dc1-esi-001-leaf1> show evpn database | match irb.120
     12001      00:1c:73:00:00:01  irb.1201                       Feb 28 11:33:22  10.12.1.1
     12002      00:1c:73:00:00:01  irb.1202                       Feb 28 11:33:22  10.12.2.1
```

Verify the Leaf Switch Routing Table

Within the CLI of the leaf switches, enter the following commands:

```
!
//begin QFX CLI commands//
show route table red.inet.0 10.11.1.0/24
show route table red.inet.0 10.11.2.0/24
show route table blue.inet.0 10.12.1.0/24
show route table blue.inet.0 10.12.2.0/24

!
```

The output of this command displays the routes for the VRFs Red network for one of the leaf switches.

```
{master:0}
root@dc1-esi-001-leaf1> show route table red.inet.0 10.11.1.0/24
red.inet.0: 1811 destinations, 3372 routes (1811 active, 0 holddown, 0 hidden)
@ = Routing Use Only, # = Forwarding Use Only
+ = Active Route, - = Last Active, * = Both
10.11.1.0/24       *[Direct/0] 06:21:33
                    >  via irb.1101
                    [EVPN/170] 06:14:27
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:15:18
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:17:59
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
10.11.1.1/32       *[Local/0] 06:21:33
                       Local via irb.1101
{master:0}
root@dc1-esi-001-leaf1> show route table red.inet.0 10.11.2.0/24
red.inet.0: 3061 destinations, 4622 routes (3061 active, 0 holddown, 0 hidden)
@ = Routing Use Only, # = Forwarding Use Only
+ = Active Route, - = Last Active, * = Both
10.11.2.0/24       *[Direct/0] 06:23:38
                    >  via irb.1102
                    [EVPN/170] 06:16:32
```

```
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:17:43
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:19:44
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
10.11.2.1/32       *[Local/0] 06:23:38
                       Local via irb.1102
```

The output of this command displays the routes for the VRFs Blue network for one of the leaf switches.

```
{master:0}
root@dc1-esi-001-leaf1> show route table blue.inet.0 10.12.1.0/24
blue.inet.0: 3087 destinations, 4650 routes (3087 active, 0 holddown, 0 hidden)
@ = Routing Use Only, # = Forwarding Use Only
+ = Active Route, - = Last Active, * = Both
10.12.1.0/24       *[Direct/0] 06:26:21
                    >  via irb.1201
                    [EVPN/170] 06:26:02
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 06:26:04
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 06:19:10
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 05:58:16
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:19:51
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:22:32
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
10.12.1.1/32       *[Local/0] 06:26:21
                       Local via irb.1201
{master:0}
root@dc1-esi-001-leaf1> show route table blue.inet.0 10.12.2.0/24
```

```
blue.inet.0: 3087 destinations, 4650 routes (3087 active, 0 holddown, 0 hidden)
@ = Routing Use Only, # = Forwarding Use Only
+ = Active Route, - = Last Active, * = Both
10.12.2.0/24       *[Direct/0] 06:26:26
                    >  via irb.1202
                    [EVPN/170] 06:26:07
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 06:26:09
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 06:19:15
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 06:20:38
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:20:16
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
                    [EVPN/170] 00:22:17
                    >  to 10.0.1.12 via et-0/0/48.0
                       to 10.0.1.22 via et-0/0/49.0
10.12.2.1/32       *[Local/0] 06:26:26
                       Local via irb.1202
```

The following command shows the ESI leaf switches overlay. It shows that the remote leaf VNIs are exchanged between the ESI leaf switches.

```
{master:0}
root@dc1-esi-001-leaf1> show ethernet-switching vxlan-tunnel-end-point remote
Logical System Name       Id  SVTEP-IP         IFL   L3-Idx    SVTEP-Mode    ELP-SVTEP-IP
<default>                 0   192.168.255.4    lo0.0    0

RVTEP-IP         L2-RTT                  IFL-Idx   Interface    NH-Id   RVTEP-Mode  ELP-
IP        Flags
 192.168.255.5    evpn-1                  671088642 vtep-15.32772 7000   RNVE
    VNID          MC-Group-IP
    11001         0.0.0.0
    11002         0.0.0.0
    12001         0.0.0.0
    12002         0.0.0.0
```

```
{master:0}
root@dc1-esi-001-leaf2> show ethernet-switching vxlan-tunnel-end-point remote
Logical System Name       Id  SVTEP-IP         IFL   L3-Idx    SVTEP-Mode    ELP-SVTEP-IP
<default>                 0   192.168.255.5    lo0.0    0
 RVTEP-IP      IFL-Idx     Interface    NH-Id   RVTEP-Mode  ELP-IP        Flags
 192.168.254.2   1388       vtep.32771    4989     RNVE
 192.168.255.2   1391       vtep.32774    4995     RNVE
 192.168.254.3   1389       vtep.32772    4991     RNVE
 192.168.255.3   1390       vtep.32773    4994     RNVE
 192.168.255.4   1393       vtep.32776    5392     RNVE
 192.168.255.6   1392       vtep.32775    4996     RNVE
 192.168.255.7   1381       vtep.32777    5811     RNVE
 192.168.255.8   1394       vtep.32770    5845     RNVE
L2-RTT                   IFL-Idx   Interface    NH-Id   RVTEP-Mode  ELP-IP        Flags
 192.168.255.4    evpn-1                  671088646 vtep-15.32776 5392   RNVE
    VNID          MC-Group-IP
    12002         0.0.0.0
    11002         0.0.0.0
    11001         0.0.0.0
    12001         0.0.0.0
```

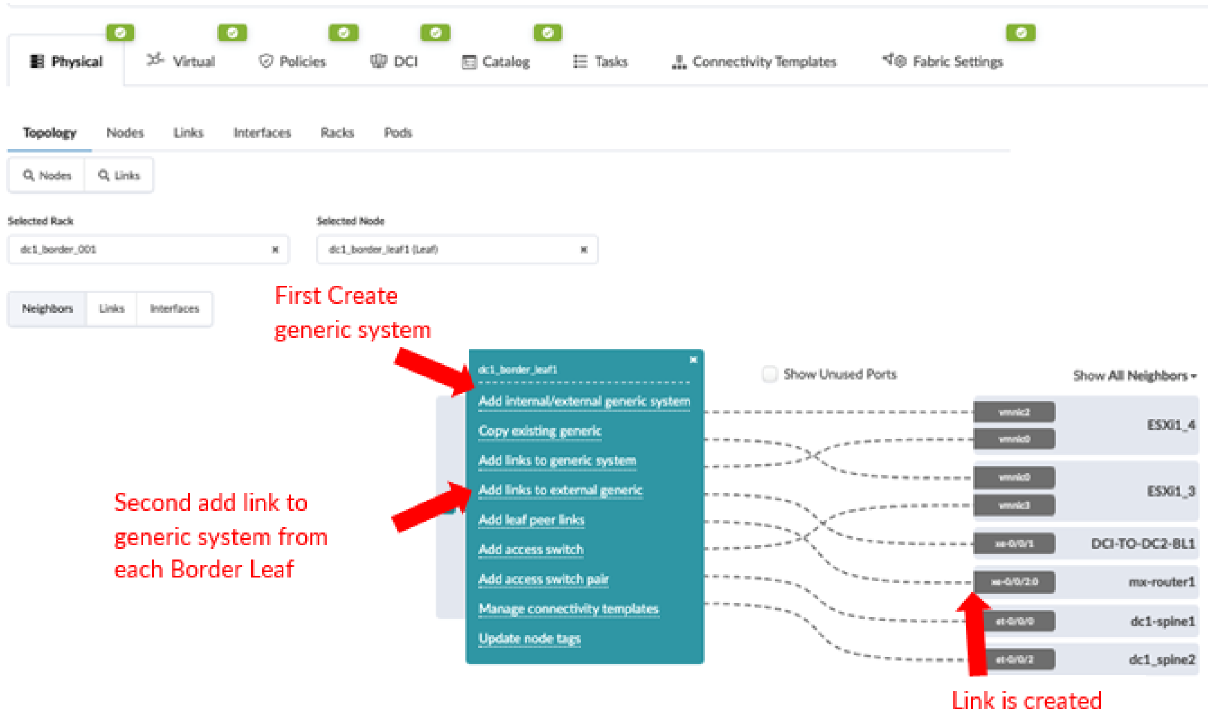
Configure External Router and Inter-VRF Routing

For this JVD, an MX204 router is used as an external router to perform external routing and also for inter-VRF route leaking between the Red and Blue networks. Configuring an external router is similar to adding a generic server. The MX204 router is connected to the border leaf switches, which act as an external gateway to the data center fabric.

To add the MX router as an external router, navigate to Apstra UI, **Blueprint > Staged > Topology,** and click on the border leaf switch to add an external generic system and the connections to the external generic system, as shown in Figure 50 on page 63.

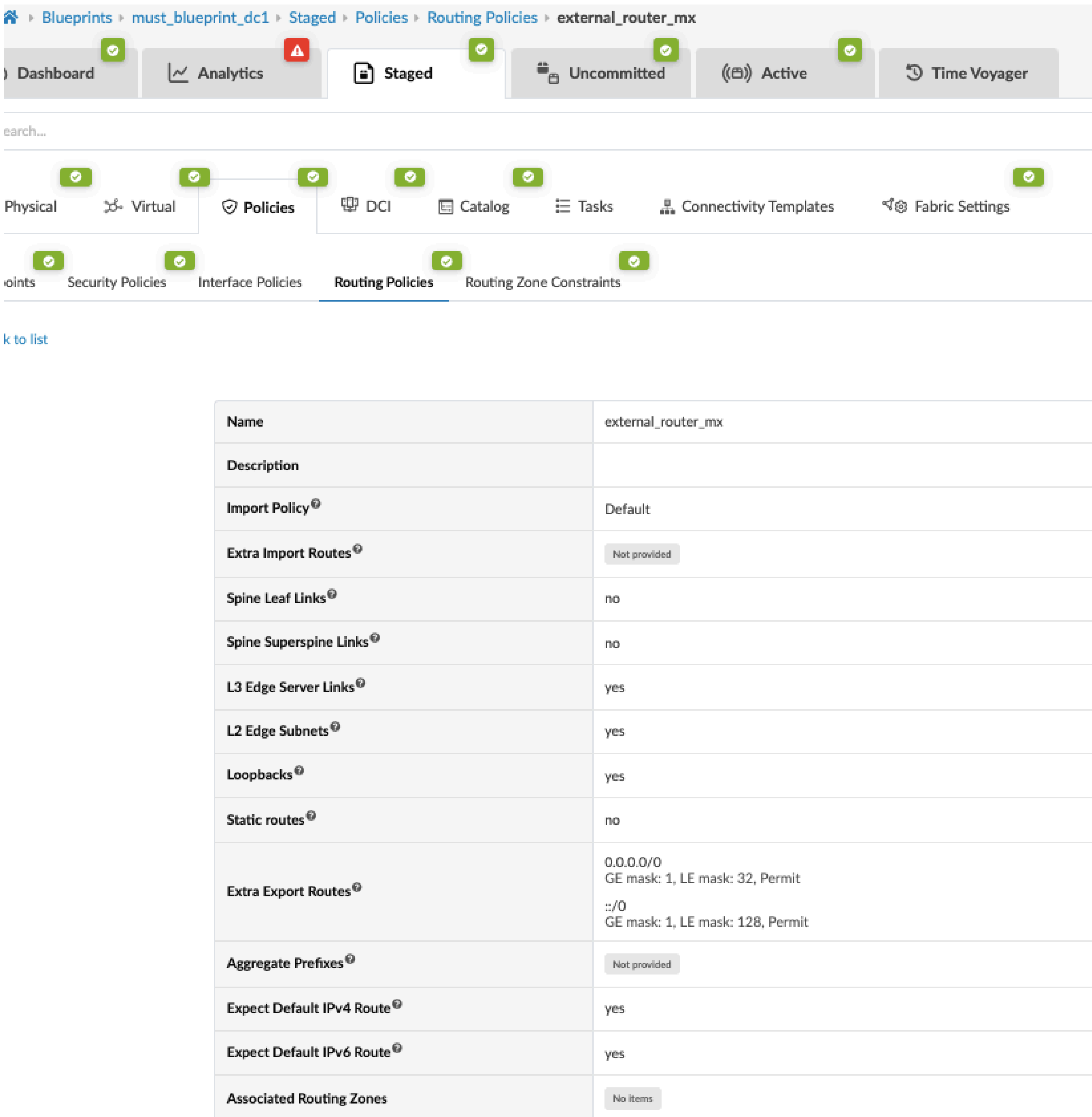
On the following graphic, select the interface for border leaf1 and the MX204 device and its interface and click **Add Link**.

Figure 48: Adding MX204 as External Generic System



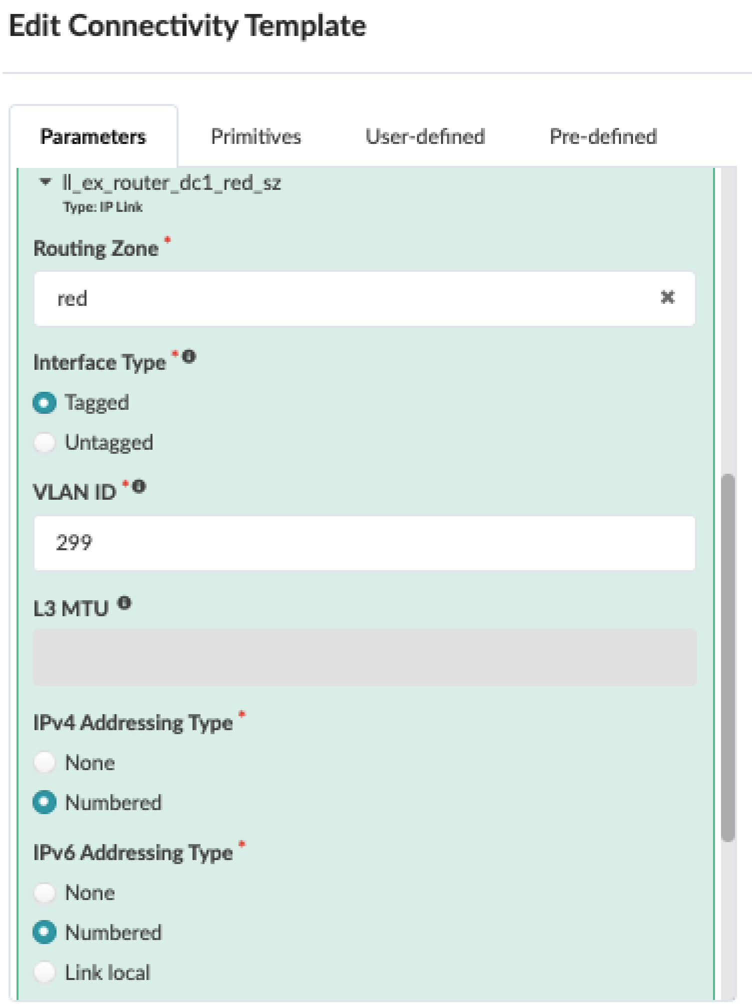
Next navigate to **Stage** > **Policies** > **Routing Policies** and create an external routing policy to export the route to the external router. This policy is then applied to the connectivity template to allow for exporting Red and Blue network routes as is covered in the next steps.

Figure 49: External Router Policy



Next, navigate to the connectivity template on the blueprint and add the below connectivity template to add IP links, BGP peering, and routing policy with MX204 (external router). In the case of this JVD, the Red and Blue networks are routed towards the MX204, where inter-VRF routing is performed. VLAN 299 is used for the Red network and VLAN 399 for the Blue network.

Figure : IP Links for Red and Blue VRF


Edit Connectivity Template
Parameters
Primitives
User-defined
Pre-defined
ll_ex_router_dc1_red_sz
Type: IP Link
Routing Zone *
red
Interface Type *
Tagged
Untagged
VLAN ID *
299
L3 MTU
IPv4 Addressing Type *
None
Numbered
IPv6 Addressing Type *
None
Numbered
Link local

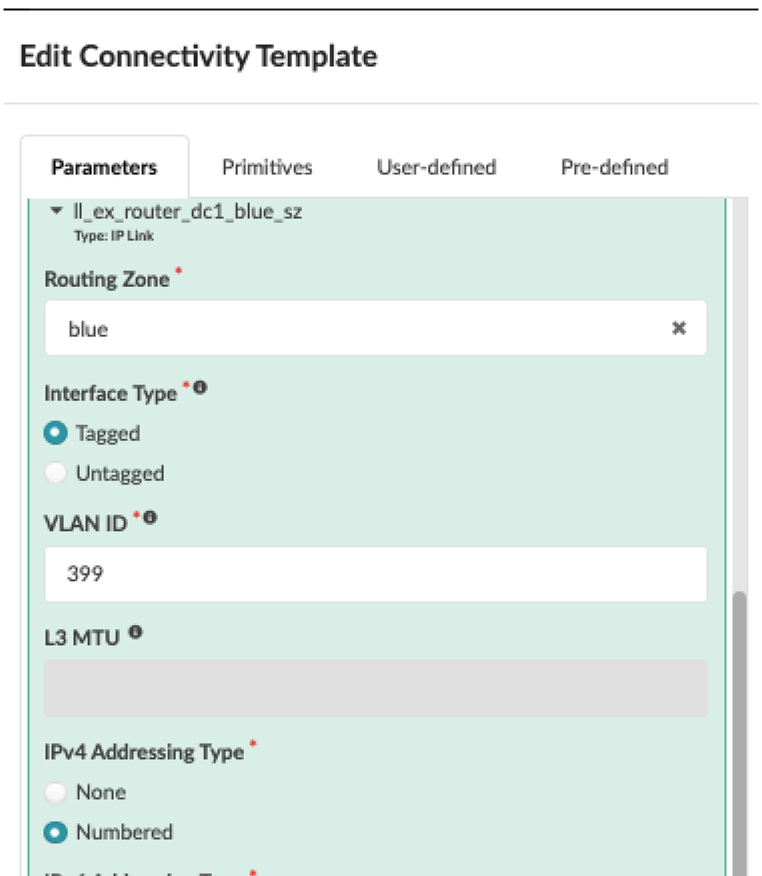
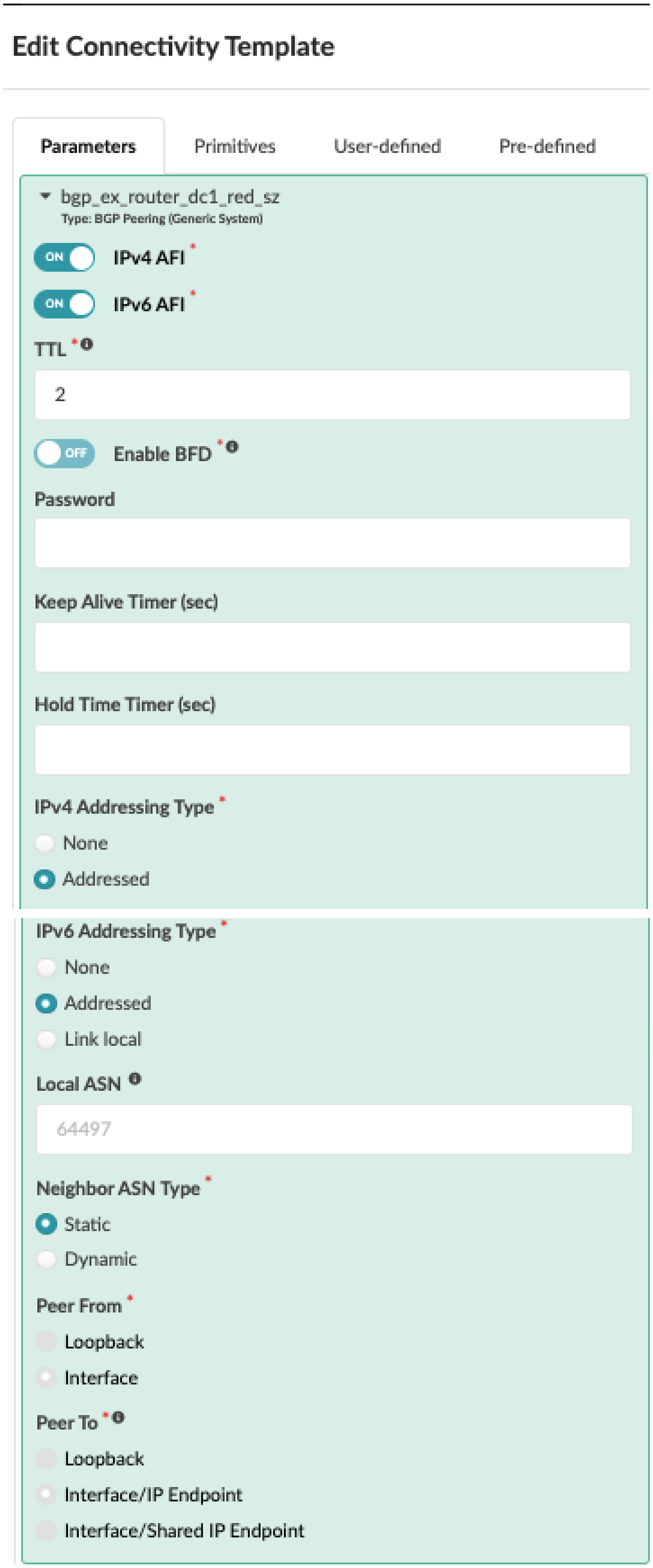

Edit Connectivity Template
Parameters
Primitives
User-defined
Pre-defined
ll_ex_router_dc1_blue_sz
Type: IP Link
Routing Zone *
blue
Interface Type *
Tagged
Untagged
VLAN ID *
399
L3 MTU
IPv4 Addressing Type *
None
Numbered

Figure : BGP Peering to MX for Red and Blue VRF



Edit Connectivity Template
Parameters
Primitives
User-defined
Pre-defined
bgp_ex_router_dc1_red_sz
Type: BGP Peering (Generic System)
ON
IPv4 AFI *
ON
IPv6 AFI *
TTL *
2
OFF
Enable BFD *
Password
Keep Alive Timer (sec)
Hold Time Timer (sec)
IPv4 Addressing Type *
None
Addressed
IPv6 Addressing Type *
None
Addressed
Link local
Local ASN
64497
Neighbor ASN Type *
Static
Dynamic
Peer From *
Loopback
Interface
Peer To *
Loopback
Interface/IP Endpoint
Interface/Shared IP Endpoint

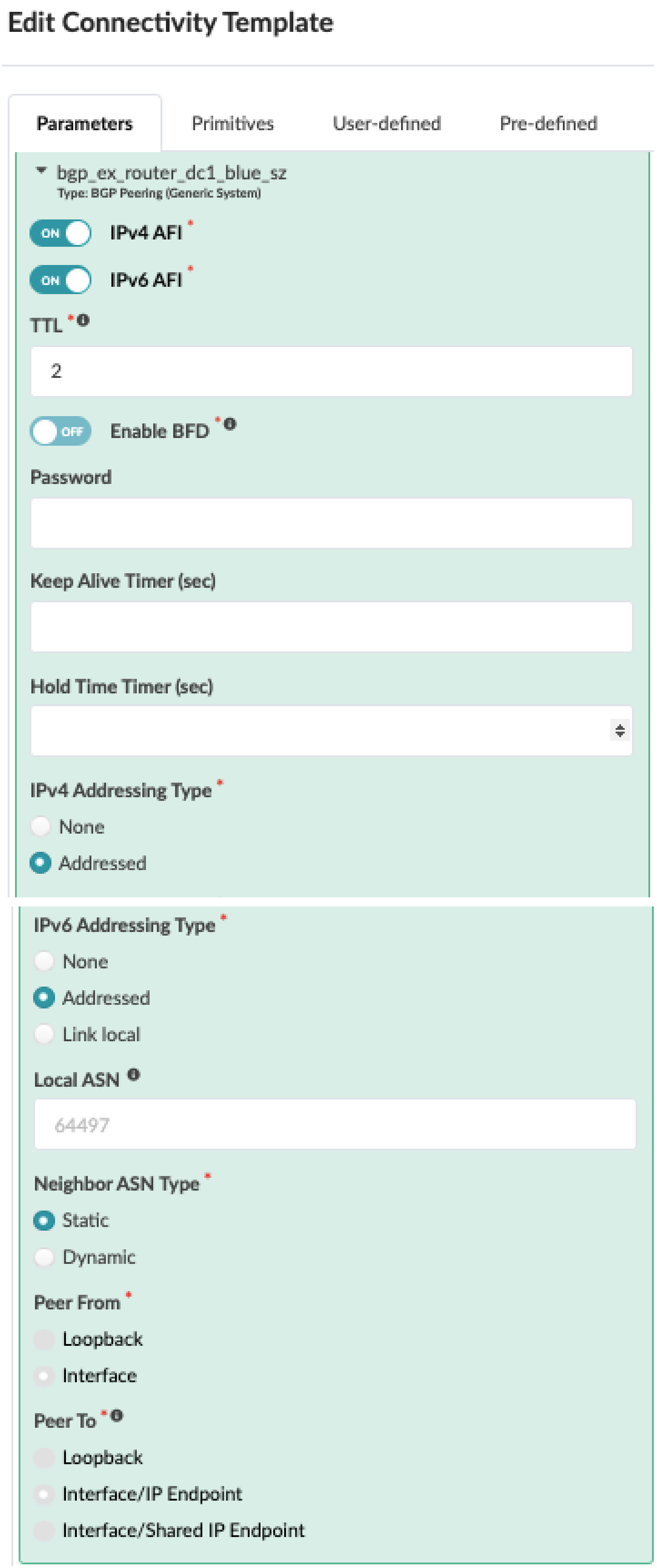

Edit Connectivity Template
Parameters
Primitives
User-defined
Pre-defined
bgp_ex_router_dc1_blue_sz
Type: BGP Peering (Generic System)
ON
IPv4 AFI *
ON
IPv6 AFI *
TTL *
2
OFF
Enable BFD *
Password
Keep Alive Timer (sec)
Hold Time Timer (sec)
IPv4 Addressing Type *
None
Addressed
IPv6 Addressing Type *
None
Addressed
Link local
Local ASN
64497
Neighbor ASN Type *
Static
Dynamic
Peer From *
Loopback
Interface
Peer To *
Loopback
Interface/IP Endpoint
Interface/Shared IP Endpoint

Figure : Routing Policy for Red and Blue VRF

Then navigate to **Staged** > **Virtual** > **Routing Zone**, click on **Red VRF Network**, and scroll below to add IP interface links from both border leaf switches. The same is performed for Blue VRF networks.

Figure 50: Adding IP Interface Links for Red Network

Interfaces 2

1-2 of 2

Filter selected by (•) all ( ) selected only ( ) unselected only

			Endpoint 1				Interface 1				Endpoint 2				Interface 2			
0 selected	Routing Zone	VLAN ID	Name	Role	Interface	L3 MTU	IPv4 Address	IPv4 Address Type	IPv6 Address	IPv6 Address Type	Name	Role	Interface	L3 MTU	IPv4 Address	IPv4 Address Type	IPv6 Address	IPv6 Addre Type
	red	299	dc1_border_leaf1	Leaf	et-0/0/1:0.299	Not provided	10.200.0.4/31	Numbered	2001:db8:dc1:10:200::4/127	Numbered	mx-router1	Generic System	n/a	Not provided	10.200.0.5/31	Numbered	2001:db8:dc1:10:200::5/127	Number
	red	299	dc1_border_leaf2	Leaf	et-0/0/1:0.299	Not provided	10.200.0.6/31	Numbered	2001:db8:dc1:10:200::6/127	Numbered	mx-router1	Generic System	n/a	Not provided	10.200.0.7/31	Numbered	2001:db8:dc1:10:200::7/127	Number

Figure 51: Adding IP Interface Links for Blue Network

Interfaces 2

1-2 of 2

Filter selected by (•) all ( ) selected only ( ) unselected only

			Endpoint 1				Interface 1				Endpoint 2				Interface 2			
0 selected	Routing Zone	VLAN ID	Name	Role	Interface	L3 MTU	IPv4 Address	IPv4 Address Type	IPv6 Address	IPv6 Address Type	Name	Role	Interface	L3 MTU	IPv4 Address	IPv4 Address Type	IPv6 Address	IPv6 Ad Type
	blue	399	dc1_border_leaf2	Leaf	et-0/0/1:0.399	Not provided	10.200.0.10/31	Numbered	2001:db8:dc1:10:200::a/127	Numbered	mx-router1	Generic System	n/a	Not provided	10.200.0.11/31	Numbered	2001:db8:dc1:10:200::b/127	Numb
	blue	399	dc1_border_leaf1	Leaf	et-0/0/1:0.399	Not provided	10.200.0.8/31	Numbered	2001:db8:dc1:10:200::8/127	Numbered	mx-router1	Generic System	n/a	Not provided	10.200.0.9/31	Numbered	2001:db8:dc1:10:200::9/127	Numb

Commit the blueprint to push configs to the two border leaf switches. Note that the external router needs to be configured manually, as Apstra does not manage the MX204. For the configuration MX204 router, the interfaces are configured using the IPs used above in Figure 50 on page 69 and Figure 56 on page 69.

MX204 configuration snippet for the Red and Blue networks:

```
xe-0/0/2:0 {
    vlan-tagging;
    unit 0 {
        vlan-id 0;
        family inet;
    }
    unit 299 {
        vlan-id 299;
        family inet {
            address 10.200.0.5/31;
        }
        family inet6 {
            address 2001:db8:dc1:10:200::5/127;
        }
    }
    unit 399 {
        vlan-id 399;
        family inet {
            address 10.200.0.9/31;
        }
        family inet6 {
            address 2001:db8:dc1:10:200::9/127;
        }
    }
}
xe-0/0/2:1 {
    vlan-tagging;
    unit 0 {
        vlan-id 0;
        family inet;
    }
    unit 299 {
        vlan-id 299;
        family inet {
            address 10.200.0.7/31;
        }
        family inet6 {
            address 2001:db8:dc1:10:200::7/127;
        }
    }
```

```
        unit 399 {
            vlan-id 399;
            family inet {
                address 10.200.0.11/31;
            }
            family inet6 {
                address 2001:db8:dc1:10:200::b/127;
            }
        }
    }
```

For inter-VRF routing, a policy is configured on the MX as below to enable inter-VRF routing between the Red and Blue VRF networks. Both VRFs are configured on the border leaf switches to BGP peer with the MX204 (external router). The MX204 uses a BGP routing policy to exchange inter-VRF routes.

NOTE: Apstra can also configure inter-VRF routing between the Red and Blue networks without needing an external router. Refer to the Apstra guide for more information. It is recommended that any changes made to any settings be thoroughly tested. For this JVD, the “Route Target Overlaps Allow internal route-target policies” setting was not used. If this setting is set to ‘No Warning’, then each of the routing zones, such as Red and Blue, can be changed to allow for route target exchange using import and export route target policies within Apstra.

MX204 configuration snippet for inter-VRF:

```
root@must-mx204-1> show configuration policy-options policy-statement RoutesToFabric
term 1 {
    from interface lo0.0;
    then accept;
}
term 2 {
    from {
        protocol [ static bgp ];
        route-filter 0.0.0.0/0 exact;
    }
    then accept;
}
term 3 {
    from {
        protocol [ static bgp ];
        rib inet6.0;
        route-filter::/0 exact;
```

```
    }
    then accept;
}
term 4 {
    then reject;
}
root@must-mx204-1> show configuration protocols bgp
group fabric {
    type external;
    multihop {
        ttl 1;
    }
    multipath {
        multiple-as;
    }
    neighbor 10.200.0.4 {
        export RoutesToFabric;
        peer-as 64514;
    }
    neighbor 2001:db8:dc1:10:200::4 {
        export RoutesToFabric;
        peer-as 64514;
    }
    neighbor 10.200.0.8 {
        export RoutesToFabric;
        peer-as 64514;
    }
    neighbor 2001:db8:dc1:10:200::8 {
        export RoutesToFabric;
        peer-as 64514;
    }
    neighbor 10.200.0.6 {
        export RoutesToFabric;
        peer-as 64515;
    }
    neighbor 2001:db8:dc1:10:200::6 {
        export RoutesToFabric;
        peer-as 64515;
    }
    neighbor 10.200.0.10 {
        export RoutesToFabric;
        peer-as 64515;
    }
```

```
    neighbor 2001:db8:dc1:10:200::a {
        export RoutesToFabric;
        peer-as 64515;
    }
}
```

Apstra UI: Blueprint Dashboard, Analytics, probes, Anomalies

The managed switches generate vast amounts of data about switch health and network health. To analyze these with respect to the data center network, Apstra uses Intent-Based Analytics that combines the intent from the graph[1] with switch-generated data to provide the data center network view using the Apstra Dashboard.

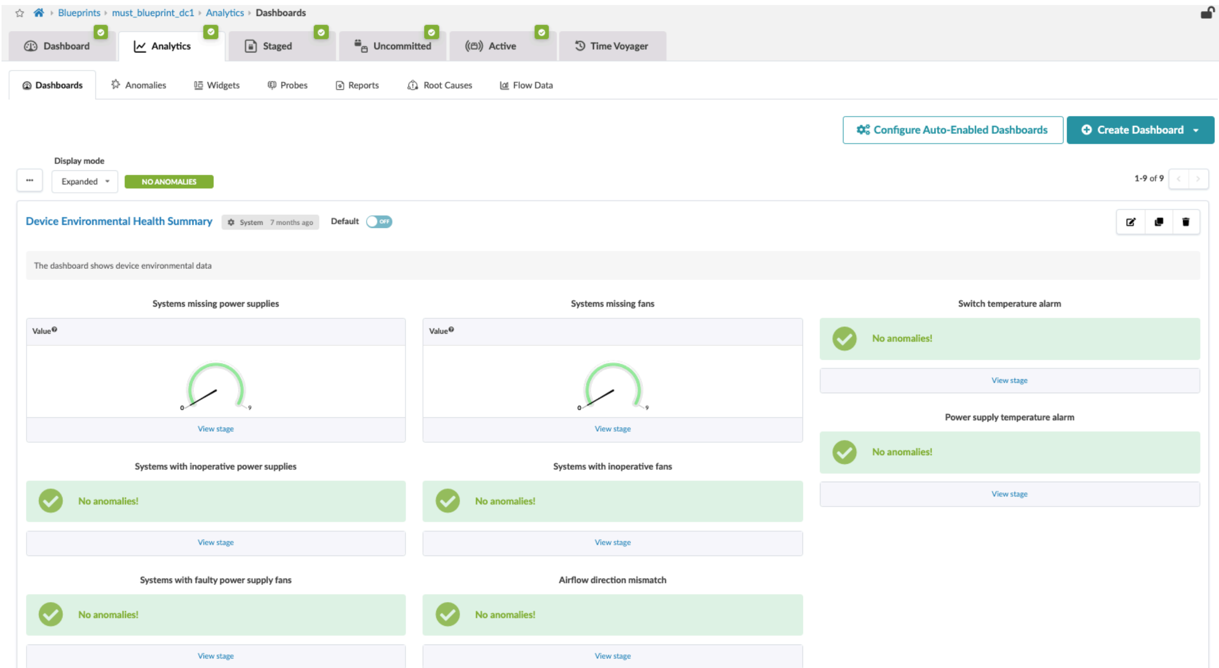
NOTE: Apstra uses a graph model to represent data center infrastructure, policies, and so on. All information about the network is modeled as nodes and relationships between them. The graph model can be queried for data and used for analysis and automation. For more information on Apstra graph model and queries refer to the Apstra user Guide.

Analytics Dashboard, Anomalies, Probes and Reports

Apstra also provides predefined dashboards that collect data from devices. With the help of IBA probes, Apstra combines intent with data to provide real-time insight into the network, which can be inspected using Apstra GUI or Rest API. The IBA probes can be configured to raise anomalies based on the thresholds. It recommended to analyze the amount of data generated by probes to ensure the disk space of Apstra server is able accommodate IBA operation. By adjusting the log rotation setting, the disk usage can be reduced.

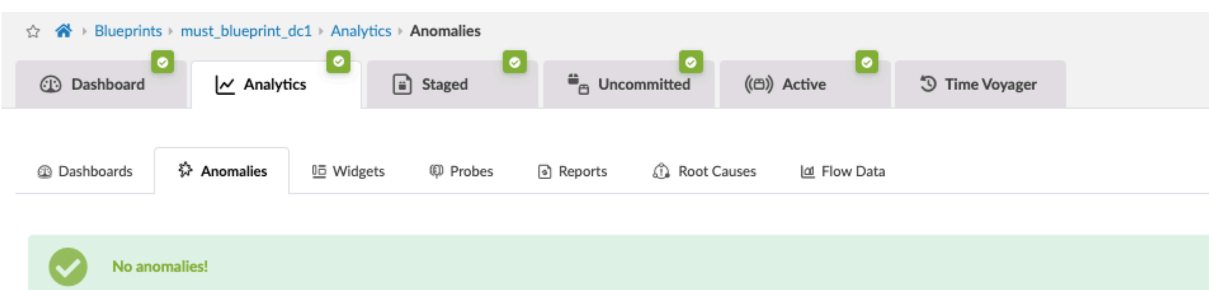
Apstra allows the creation of custom dashboards; refer to the Apstra User Guide for more information. From the blueprint, navigate to **Analytics > Dashboards** to view the analytics dashboard.

Figure 52: Analytics Dashboard



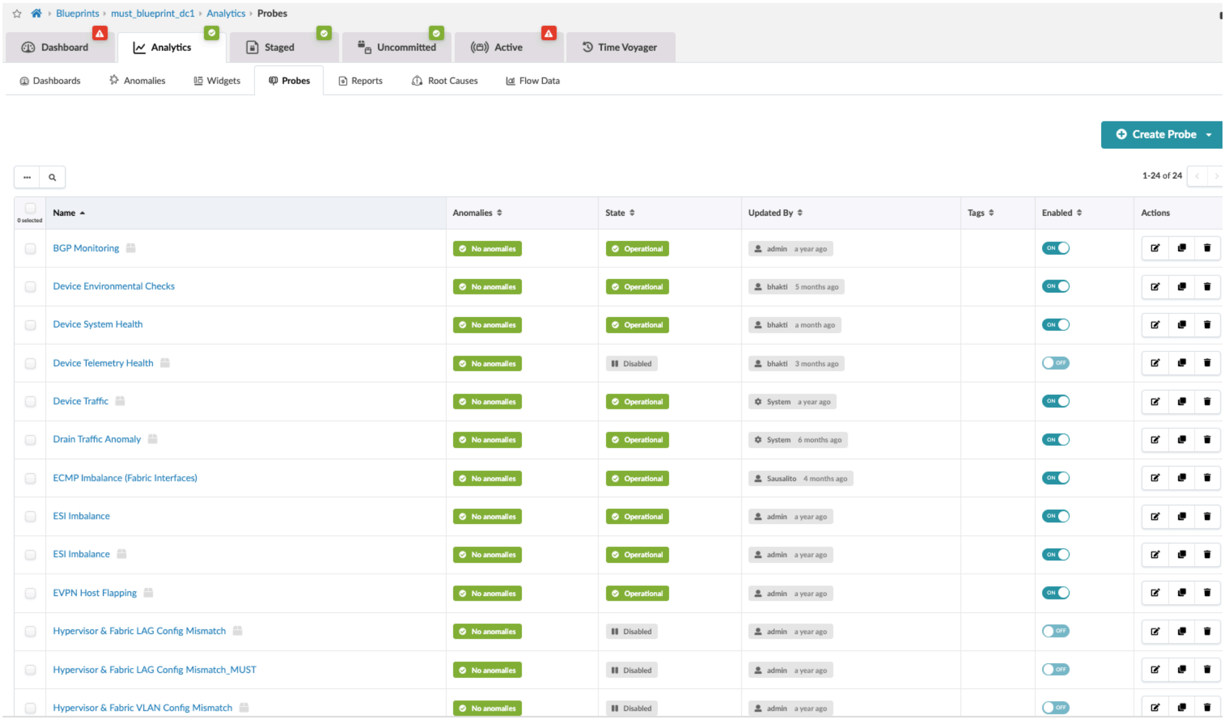
The analytics dashboard displays the status of all device health statuses. In case of anomalies, click on the anomalies tab to view anomalies. The blueprint anomalies tab displays a "No Anomalies!" message in case no anomalies are detected by the IBA probes. For more information, refer to the Apstra User Guide.

Figure 53: Blueprint Anomalies



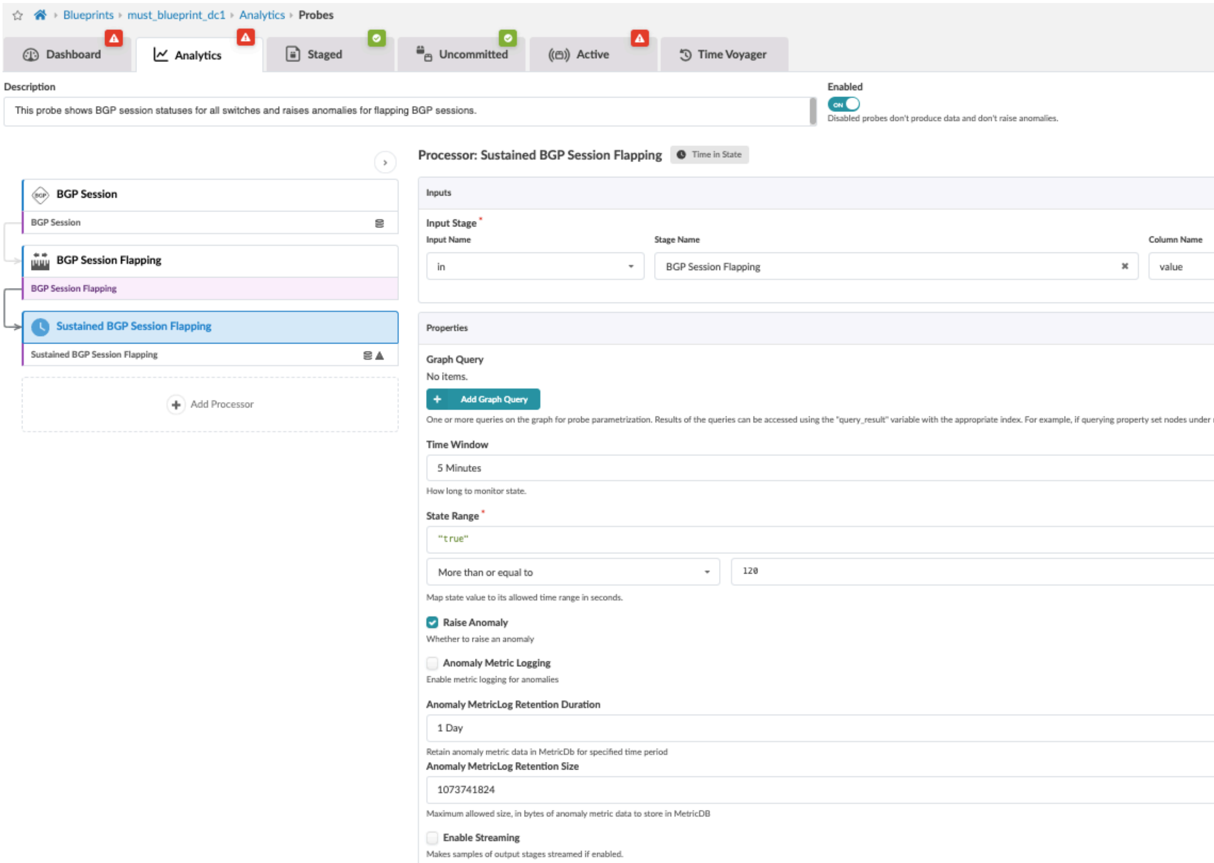
To view the probes configured, navigate to **Blueprint > Analytics > Probes**. Here, actions can be performed to edit, clone, or delete probes. For instance, if a probe anomaly needs to be suppressed, the same can be performed by editing the probe.

Figure 54: Apstra Predefined Probes



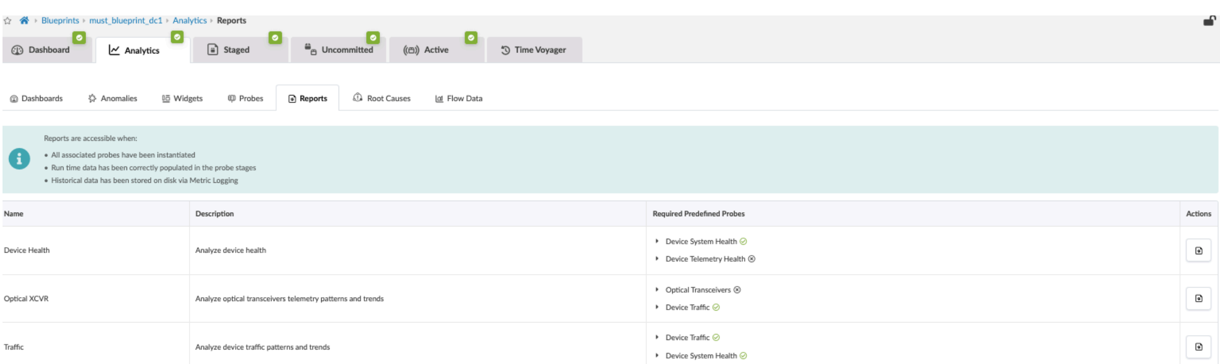
To raise or suppress an anomaly, mark or unmark the **Raise Anomaly** check box.

Figure : Configure Probe Anomaly



To generate reports, navigate to **Blueprints > Analytics > Reports**. Here, reports can be downloaded to analyze health, device traffic, and so on.

Figure 55: Generate Health Report



Root Cause Identification (RCI) is a technology integrated into Apstra software that automatically determines the root causes of complex network issues. RCI leverages the Apstra datastore for real-time network status and automatically correlates telemetry with each active blueprint intent. Root cause use cases include, for instance, link down, link miscabled, Interface down, link disconnect, and so on.

Figure 56: Enable Root Cause Analysis

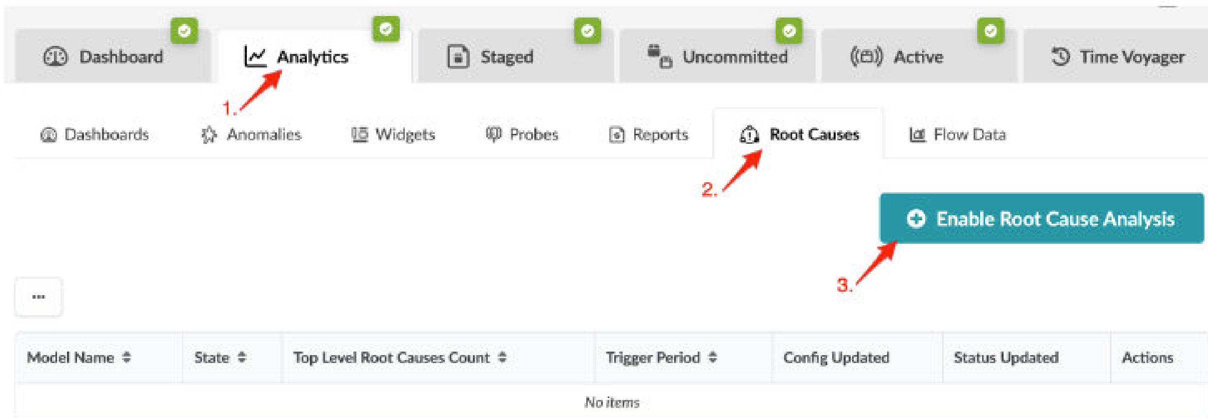
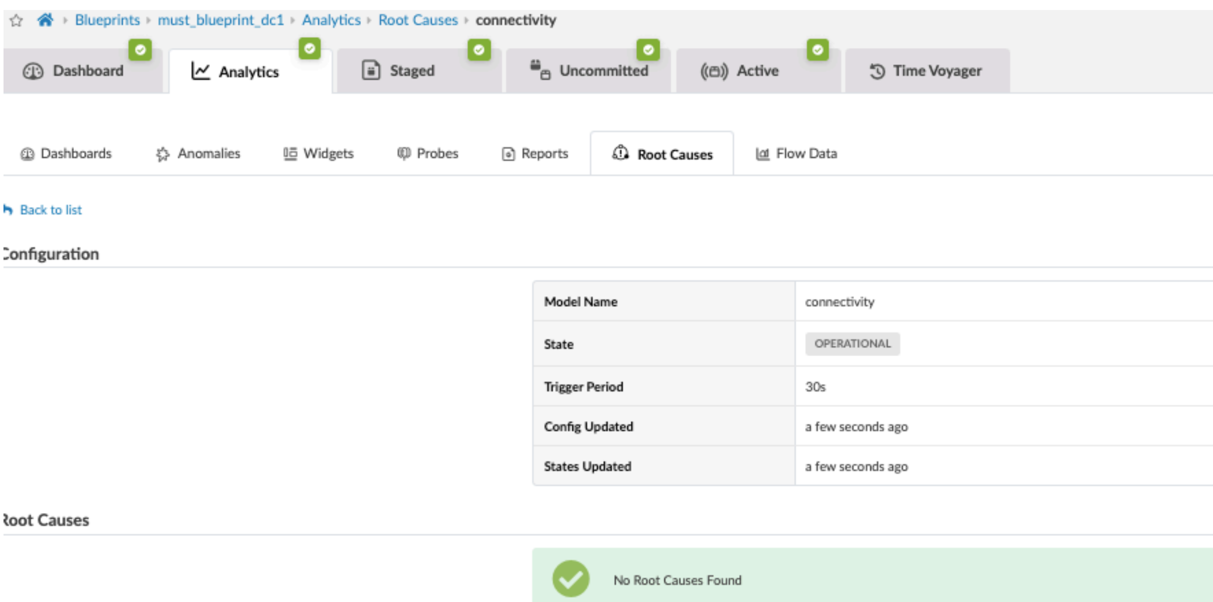


Figure 57: Root Cause Enabled for Connectivity



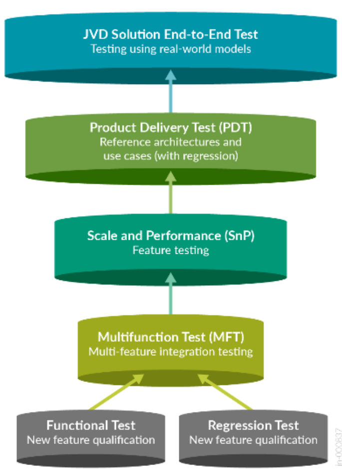
Validation Framework

IN THIS SECTION

Extensive testing of best practice architectures is key to the Juniper Validated Design (JVD) program. JVDs qualify and quantify these best practice architectures, allowing you to know exactly what you're buying and to spend your time deploying and managing your network instead of designing it.

JVDs employ a layered testing approach to deliver reliability and repeatability. Individual features receive functional testing. Multifunction testing builds on this functional testing to see if multiple features work together. Product delivery testing builds upon multifunctional testing to validate that these features combined perform as expected for tested use cases, and JVD testing builds upon product delivery testing by testing multiple products together (including third-party integrations where appropriate) to ensure that all these products combined make an industry-leading solution.

Figure 58: Validation Framework



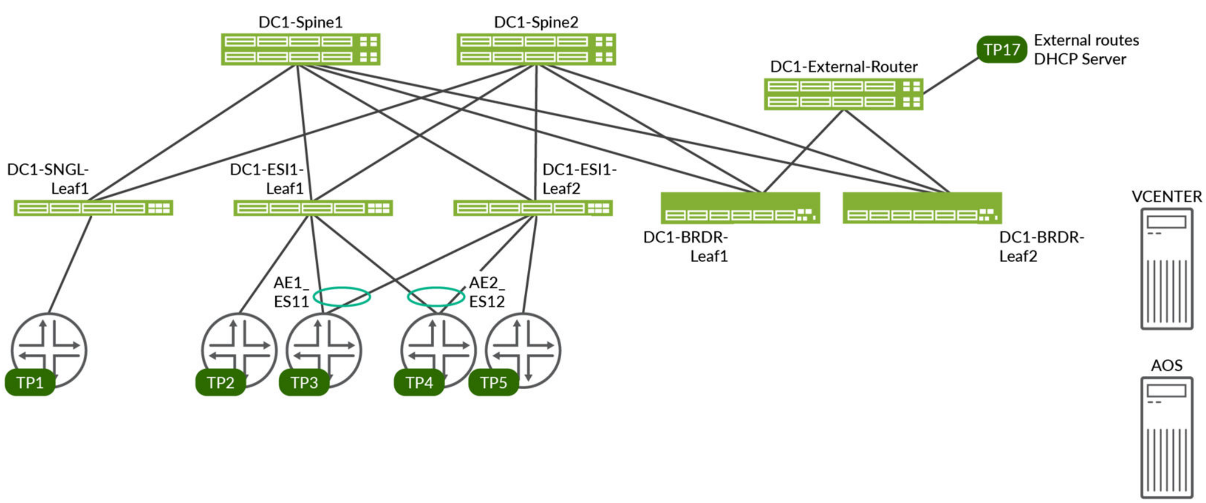
Testing with real-world applications and traffic provides more accurate data regarding performance and response to different configurations. The standardized nature of JVDs ensures the same network architecture is deployed in multiple testing environments, and the use of JVDs by multiple customers allows for any lessons learned in production deployments to rapidly benefit all JVD customers. The more JVDs that are deployed worldwide, the greater the value they provide to all.

Test Bed

The test bed environment consists of a 3-stage EVPN/VXLAN fabric managed by Juniper Apstra, with four ESI server leaf switches configured as two redundant pairs, one single (non-redundant) server leaf (non-ESI), and two redundant border leaf switches connected to two spines. An external router is also connected to the border leaf switches. A traffic generator is connected to the test ports on the external router and the ESXi servers.

To ensure all the platforms specified in the Supported Devices and Positioning Table 1 on page 7 are validated, two data center topologies connected using DCI were used. Since there were multiple devices for each role, the devices were swapped, and the tests were repeated with each combination. For instance, border leaf switches were swapped with QFX5130-32CD, PTX10001-36MR, ACX7100-32CD, and so on.

Figure 59: 3-Stage Lab Topology



VRF Characteristics:

RED VRF

- VLANs 400–649 with IRB v4/v6:
  - on DC1-SNGL-LEAF1 single access port
  - on DC1-ESI-LEAF1 single access port, AE1 and AE2
  - on DC1-ESI1-LEAF2 single access port, AE1 and AE2
  - on DC1-BRDR-LEAF1 to distribute routes to external-router
  - on DC1-BRDR-LEAF2 to distribute routes to external-router
- VLANs 400–649 on each test port with 10 unique MAC/IP per VLAN
- DHCP client on TP3
- External DHCP server on TP17

Blue VRF

- VLANs 3500–3749 with IRB v4/v6:
  - on DC1-SNGL-LEAF1 single access port
  - on DC1-ESI-LEAF1 single access port, AE1 and AE2
  - on DC1-ESI1-LEAF2 single access port, AE1 and AE2
  - on DC1-BRDR-LEAF1 to distribute routes to external-router
  - on DC1-BRDR-LEAF2 to distribute routes to external-router
- VLANs 3500–3749 on each test port with 10 unique MAC/IP per VLAN
- DHCP client on TP3, TP4, TP5
- External DHCP server on TP2

Platforms / Devices Under Test (DUT)

To review the software versions and platforms on which this JVD was validated by Juniper Networks, please see the Validated Platforms and Software section in this document.

Test Bed Configuration

Contact your Juniper Networks representative to obtain the full archive of the test bed configuration used for this JVD.

Test Objectives

IN THIS SECTION

The primary objective of this JVD testing is the qualification testing of the 3-stage fabric with Juniper Apstra. The design is based on an ERB (Type 2 and Type 5) EVPN/VXLAN fabric with the spine, server leaf, and border leaf switches. The goal is to ensure the design is well-documented and will produce a reliable, predictable deployment for the customer. The qualification objectives include validation of blueprint deployment, device upgrade, incremental configuration pushes/provisioning, Telemetry/Analytics checking, failure mode analysis, and verification of host traffic.

Test Goals

The 3-Stage Fabric with Juniper Apstra JVD testing uses the following flow:

- Initial design and blueprint deployment through Apstra
- Validation of fabric operation and monitoring through Apstra analytics and telemetry dashboard
- Scale testing
- Validation of end-to-end traffic flow
- System health, ARP, ND, MAC, BGP (route, next hop), interface traffic counters, and so on
- Test for anomalies

- In order to pass validation, the 3-stage fabric with Juniper Apstra must also pass the following scenarios:
  - Node Reboot - simulated real-world switch outage.
  - Field scenarios like interface down/up and Laser on/off impact to the fabric and check anomalies reporting in Apstra.
  - Traffic recovery was validated after all failure scenarios.

Refer to the test report for more information.

Test Non-Goals

Test non-goals for this JVD were to test the following switches are tested for non-baseline use in the following roles:

- QFX10002-36Q as a border leaf

Other features tested:

- DCI Interconnectivity between data centers
- Interoperability with NSX-T Edge Gateway
- Host connectivity between fabric-connected hosts created by Apstra towards NSX-managed hosts

Results Summary and Analysis

For the 3-stage JVD, comprehensive functional testing was performed on devices listed in Devices Under Test (Validated Devices) No Link Title to validate the Junos OS Release 23.4R2-S3 and Apstra 4.2.1:

- Baseline System Test:
  - Enabling devices for Apstra, applying pristine configuration, and designing logical devices and interface maps.
  - Apstra Provisioning of the entire 3-stage using the Data Center Reference Architecture feature of Apstra, involving racks, Templates, and blueprints, assigning interface maps and resources to switches, and cabling switches.
  - Modifying Apstra blueprints to swap border leaf switches during testing.

    - Apstra commits to deploy configurations to devices.
    - Provisioning virtual networks and routing zones, assigning EVPN loopbacks for VRFs, and IRB interfaces through Apstra.
- Operational and Trigger Tests:
    - Operational testing of switches was carried out for the following:
        - Device upgrade to 23.4R2-S3 release
        - Reboot devices cause no issues when the devices boot up
        - Process Restarts—l2ald, interface-control, rpd—aim to minimize packet loss and fully restore the control and data plane.
        - Move 4 MAC hosts from one port to another without connectivity issues.
        - BFD failover tests by deactivating BGP on the leaf switches with ESI configured to allow for traffic convergence.
        - Reset DHCP Bindings to ensure fabric forwards the DHCP requests and address assignment should be released and reassigned.
        - Extended negative tests (process restart, deactivate BGP, link failures) in an 8-hour cycle to ensure switches restore to baseline state and resume normal traffic forwarding.
    - Connectivity tests for the following items were carried out:
        - Service leaf link failure.
        - Multihomed link failure.
        - Leaf-to-spine link failure.
    - Resiliency tests for overlay connectivity testing for the below scenarios:
        - Intra-VLAN.
        - Inter-VLAN to every host.
        - Traffic to external route.
        - DHCP client/server flows.

Scale Testing numbers are as follows:

Table 5: Multi-dimensional Scale Numbers Tested

Features	Tested Scale Numbers	Tested Scale Numbers with EX4400* ESI Leaf Pair
VLANs	500	500
V4 host entries (MAC-IP)	35500	17500
V6 host entries (NDP)	1400	1400
VNI	500	500
VTEP	6	6
ESI	4	4
IRB	500	500
BGP Routing Table	343000	148900
EVPN Table	35500	17500

The scale numbers above are not device maximums; they only reference the scale at which these multidimensional test cases are performed.

NOTE: The maximum VLANs per aggregated Ethernet (AE) interface is 2,000 on the QFX5120 and 1,000 on the EX. Attempting to define more VLANs than this on these platforms will cause a commit warning of too many VLAN IDs on an untagged interface.

Overall, the JVD validation testing didn't detect any issues, and all performance parameters were within the threshold and performed as expected. Traffic profiles tested on all server leaf switches for intra-VRF, inter-VRF, and external routes were 1000 pps with a random packet size of 256-1024 bytes.

Recommendations

The 3-Stage EVPN/VXLAN Fabric with Juniper Apstra JVD follows an industry-standard ERB design. It simplifies the data center provisioning process. Not only does it help in managing the data center for

Day-0 and Day-1 operations, but it also simplifies Day-2 operations by enabling customers to upgrade devices, manage devices, and monitor device telemetry. As an inherently multi-vendor management platform, Apstra also provides customers the ability to choose vendors, something that is especially valuable today, as data center technology is evolving rapidly with the advent of AI technology.

Junos OS Release 23.4R2-S3 is the minimum recommended software version for this JVD.

The Juniper hardware listed in the Devices Under Test (Validated Devices) No Link Title are the best-suited switch platforms in terms of features, performance, and the roles that are specified in this JVD.

Tested Optics

Table 7: Optics used during testing

Part number	Optics Name	Device Role	Device Model
740-032986	QSFP+-40G-SR4	External Router	MX204
740-070749	JPSU-650W-AC-AO	External Router	MX204
740-061405	QSFP-100GBASE-SR4	Spine	QFX5220-32CD
740-065630	QSFP28-100G-AOC-1M	Spine	QFX5220-32CD
740-065631	QSFP28-100G-AOC-3M	Spine	QFX5220-32CD
740-032986	QSFP+-40G-SR4	Spine	QFX5220-32CD
740-065632	QSFP28-100G-AOC-5M	Spine	QFX5220-32CD
740-065463	SFP+-10G-AOC3M	Server Leaf	QFX5120-48Y-8C
740-021308	SFP+-10G-SR	Server Leaf	QFX5120-48Y-8C
740-038624	QSFP+-40G-CU3M	Server Leaf	QFX5120-48Y-8C
740-061405	QSFP-100GBASE-SR4	Server Leaf	QFX5120-48Y-8C
740-031980	SFP+-10G-SR	Server Leaf	QFX5120-48Y-8C

740-054053	QSFP+-4X10G-SR	Server Leaf	QFX5120-48Y-8C
740-032986	QSFP+-40G-SR4	Server Leaf	QFX5120-48Y-8C
650-114386	2x100G QSFP28	Server Leaf	EX4400-24MP
740-065631	QSFP28-100G-AOC-3M	Server Leaf	EX4400-24MP
740-021308	SFP+-10G-SR	Server Leaf	EX4400-24MP
740-031980	SFP+-10G-SR	Server Leaf	EX4400-24MP
740-065630	QSFP28-100G-AOC-1M	Border Leaf	QFX5130-32CD
740-032986	QSFP+-40G-SR4	Border Leaf	QFX5130-32CD
740-065632	QSFP28-100G-AOC-5M	Border Leaf	QFX5130-32CD
740-032986	QSFP+-40G-SR4	Border Leaf	QFX5700
740-065631	QSFP28-100G-AOC-3M	Border Leaf	QFX5700
740-021308	SFP+-10G-SR	Border Leaf	QFX5700
740-061405	QSFP-100GBASE-SR4	Border Leaf	QFX5700
740-031980	SFP+-10G-SR	Border Leaf	QFX5700
740-030658	SFP+-10G-USR	Border Leaf	QFX5700
740-021308	SFP+-10G-SR	Border Leaf	ACX7100-48L
740-030658	SFP+-10G-USR	Border Leaf	ACX7100-48L
740-031980	SFP+-10G-SR	Border Leaf	ACX7100-48L
740-065463	SFP+-10G-AOC3M	Border Leaf	ACX7100-48L
740-030076	SFP+-10G-CU1M	Border Leaf	ACX7100-48L

740-061405	QSFP-100GBASE-SR4	Border Leaf	ACX7100-48L
740-065631	QSFP28-100G-AOC-3M	Border Leaf	ACX7100-48L
740-065630	QSFP28-100G-AOC-1M	Border Leaf	ACX7100-48L
740-058734	QSFP-100GBASE-SR4	Border Leaf	ACX7100-32C
740-061405	QSFP-100GBASE-SR4	Border Leaf	ACX7100-32C
740-032986	QSFP+-40G-SR4	Border Leaf	ACX7100-32C
740-065632	QSFP28-100G-AOC-5M	Border Leaf	ACX7100-32C
740-065630	QSFP28-100G-AOC-1M	Border Leaf	PTX10001-36MR
740-061405	QSFP-100GBASE-SR4-T2	Border Leaf	PTX10001-36MR
740-032986	QSFP+-40G-SR4	Border Leaf	PTX10001-36MR

Revision History

Table 53: Revision History

Date	Version	Description
December 2024	JVD-DCFABRIC-3STAGE-02-01	Recommended Junos version updated to 23.4R2-S3 from 22.2R3-S3