Next-Generation Network Configuration and Management

Juniper's support for OpenConfig and other emerging models brings the vision of vendor-neutral, programmable network infrastructure closer to reality.

Table of Contents

OpenConfig: The Time Has Come

It's one of those cases where we'll all look back and shake our heads, wondering how network operators of years past got their jobs done. There are all the incompatible protocols and data formats, the hodgepodge of SNMP and vendor-specific MIBs, and the event-driven accessibility of telemetry and operational state information. It is not an easy environment to manage network elements in, let alone program the configuration of network infrastructure.

The bridge between the old world and the new is being built by the OpenConfig group, a working group of network operators and network equipment vendors, who are bringing software-defined networking principles such as declarative configuration and model-driven management to network management.

Juniper is proud and excited to be supporting the efforts of the OpenConfig group as well as new network management models being developed by other entities. This paper focuses on how the common data models and streaming telemetry paradigms being developed in OpenConfig combine with functionality of specific Juniper technologies to deliver on the promise of next-generation network configuration and management.

OpenConfig Group: Overview and Objectives

The OpenConfig group is focused on reducing the operational complexity of configuring and monitoring network elements. Over the past year, OpenConfig has been actively developing a collection of consistent and scalable data models (written in YANG) that provide the building blocks of a programmable configuration framework and enable vendor-independent streaming telemetry and also expose device Opstate via models. Over time, OpenConfig models can provide a comprehensive abstraction of the device. Of course, driving adoption and support is also a key goal, and this is enabled by actively engaging with vendors, relevant standards bodies, and the support of open source initiatives that promote the adoption of these next-generation network management capabilities.

Juniper has been actively engaged with the OpenConfig group in enabling support for configuration of core Internet routing protocols and the delivery of key network element information via OpenConfig defined models and complementary protocols. The next sections examine these elements in greater detail.

Bringing Consistency to Data Models

Perhaps the key objective of the OpenConfig initiative is to develop consistent, vendor-neutral data models for the configuration and management of network platforms. Today there are at least as many different configuration schemas for routing protocols as there are vendors. Many vendors even employ multiple mechanisms for configuring the exact same functionality across their different platforms. This complicates life for operators and significantly impacts the operational costs associated with network operation.

By defining a common, vendor-neutral model for commonly used features and protocols the configuration process can be dramatically simplified. For example, with these models in hand an operator can serialize configuration data into the preferred format for consumption by a vendor/platform in a consistent manner without having to worry about generating the appropriate vendor-specific CLI commands to affect a particular configuration.

Over the years, absent a unifying initiative such as OpenConfig, Juniper has provided operators with a consistent model-based approach to configuration. The use of this model has allowed network operators using Juniper platforms to achieve consistent operation—it also makes it easier to support the unified OpenConfig model across platforms and product families as OpenConfig models are deployed.

Enabling Declarative Configuration

One of the core tenets of OpenConfig operation is the use of declarative configuration, which allows operators to specify their configuration intent and have the network element determine how to implement that intent. Simply put, the burden of having to define the process is lifted from the network operator and placed on the device.

From its inception, the Juniper Networks® Junos® operating system has enabled declarative device configuration. Operators who adopt the OpenConfig models and deploy them on Junos OS devices can be assured that they are able to apply the models in a declarative manner without having to engage in applying configuration syntax step by step in order to achieve the desired configuration.

Vendor-Neutral Framework that Supports Vendor-Specific Features

The models and functionality defined by OpenConfig do not attempt to be all things to all people—meaning they do not attempt to support or accommodate all the features, functions, and "nerd knobs" of each vendor in their baseline models. However, due to the flexible nature of the Junos OS implementation and packaging of OpenConfig support, Juniper customers are free to extend and augment the capabilities of the baseline OpenConfig models and the corresponding mapping capabilities to enable the use of Juniper-specific features—while retaining the vendor independence of the baseline models.

In supporting the OpenConfig models, Juniper has taken care to provide clear deviations where there might be differences between the baseline definition (in terms of units, application hierarchy, etc.) and where there might be gaps in coverage. Customers can choose to extend the baseline models themselves, or Juniper can opt to provide augmentations to the baseline models for commonly utilized Junos OS functionality that isn't in the baseline models in order to streamline deployments for customers. This is part of our ongoing evaluation of how to best support our customers using OpenConfig.

Bringing Order to Data Model Chaos

Over the past couple of years there has been an explosion of data modeling initiatives within IETF working groups. While it is very encouraging to see the energy behind the application of a common model-based approach to IETF technologies, there are a number of challenges that arise when operators attempt to actually use these models in production networks.

Two key challenges that consistently come up with the application of IETF (and other) models are the notions of consistency and composability. While vendor-specific models can address these by virtue of being a self-contained ecosystem, the creation and enforcement of these objectives in an open environment requires considerable diligence and focus. Our native YANG implementation allows us to support multiple models regardless of source OpenConfig, IETF, Custom. We'll highlight just two areas where OpenConfig is bringing a consistent, unified approach to model creation, providing notable benefits—consistency of structure and composability.

Consistency of Structure

The technology-specific models being developed within IETF working groups or technology organizations create considerable opportunity for new approaches to be explored. Unfortunately, this creates inconsistent approaches to key operational elements such as operational state information.

The OpenConfig initiative is attempting to provide consistent treatment of operational state information across all models. While this might seem like a small issue, it makes the consistent accessing of information across model components a more straightforward undertaking moving forward.

Composability

The composability of a system refers to how easily components can be selected and assembled to satisfy specific user requirements. Composability is partly dependent on the consistency of structure, because inconsistency adds complexity and delay in meeting those requirements.

By providing a consistent approach to the structure of the various constituent models, the OpenConfig group has been able to realize a high degree of reusability and thereby reduces the complexity and time required to create the component combinations that satisfy operators' objectives.

For example, the interfaces model can take advantage of the capabilities of the system inventory model to provide for the flexible naming of interfaces and their placement within the larger structure—or it can be used in a nearly standalone capability (although with the loss of some functionality) to provide a consistent and simple means to configure interfaces in switching and routing platforms. Further, the MPLS and BGP models can be used independently of platform-specific capabilities while still enabling consistent and self-contained access to relevant configuration and operational state information.

Juniper Support for OpenConfig: A Closer Look

As an industry leader in the development and adoption of open standards, Juniper has been excited to work with the OpenConfig group in adding support for OpenConfig capabilities to our platforms.

For example, by enabling native support for the YANG modeling language within Junos OS platforms, we have enabled support for not just the OpenConfig developed models but also for emerging models from the IETF as well as custom-developed models our customers might want to use to add custom workflows or services.

Juniper has also been providing YANG modules that define the Junos OS configuration hierarchy as well as a number of Junos OS YANG extensions. These can be used with existing YANG-based tools to develop network management applications that can be used to generate configuration profiles or validate configuration data prior to uploading it to a network element. Users can also export device-specific YANG modules directly from the network element by using the "show system schema module <module-name> format yang <output-file>" command.

This tightly integrated support for YANG as a first-class citizen within Junos OS makes the support for OpenConfig models a natural extension of the baseline Junos OS feature set, greatly simplifying life for network operators. OpenConfig models can be imported into the system and through the use of built-in scripting and translation capabilities operators can natively configure the system using the OpenConfig models.

As models have been posted to OpenConfig (https://github.com/openconfig/public), Juniper has been actively engaging with OpenConfig to review the models and provide code that supports the updates to the models, as well as support for configuration of this core functionality. This early engagement has enabled Juniper to structure delivery and development to provide a flexible means for customers to adopt the OpenConfig models and stay abreast of the latest developments.

Modular Delivery

In support of the OpenConfig objectives to rapidly iterate, Juniper is decoupling the delivery of OpenConfig model support from the base Junos OS installation process. This means that as the models mature and are made available, Juniper can ship OpenConfig bundles that can be applied against the base Junos OS release that supports the necessary YANG and model functionality.

This also means that as long as operators are running a tested and qualified release in their network that supports this functionality, they can incrementally adopt the use of OpenConfig models as they come out and as the corresponding OpenConfig bundles are made available from Juniper.

Next-Generation Network Management Tools

In addition to providing native support for YANG, Junos OS has been extended to support the serialization of configuration and operational data in JSON format. Juniper's design has allowed us to separate model implementation from the transports/streaming formats/protocols that external Network Management tools can use to communicate with the device. This allows extensibility and flexibility to become easy (Netconf or gRPC, JSON or XML.) Coupled with the future ability to support gRPC as a transport protocol for configuration and telemetry information, this enables operators to start embracing the next generation of network management capabilities.

Future Developments

As Juniper prepares to release the first images to support OpenConfig models, Juniper engineers are providing regular updates that showcase the use of the OpenConfig capabilities in Junos OS.

Conclusion

For most network operators, the next generation of consistent, vendor-neutral data models for programmable configuration and management cannot arrive soon enough.

The OpenConfig group is leading the long-overdue, industry-wide upgrade of SNMP-based network monitoring and management, and Juniper is pleased to support, complement, and add value to the initiatives of OpenConfig. We look forward to the day when network operators can recall today's disjointed, chaotic network management practices with nothing more than a wry smile.

Learn More

For additional information, please access any or all of the following resources:

- OpenConfig website
  http://www.openconfig.net/
- Demo of BGP configuration using OpenConfig
  https://vimeo.com/139447948
- NETCONF and YANG explained in a layman's terms
  http://forums.juniper.net/t5/Automation/Netconf-and-YANG-explained-in-a-layman-s-term/ba-p/280280
- Towards the path to Network Innovation
  http://forums.juniper.net/t5/Automation/Towards-the-path-to-Network-Innovation-part-2-of-the-YANG-blog/bap/281087
- Junos OS documentation: Using Juniper Networks YANG Modules
  http://www.juniper.net/documentation/en_US/junos15.1/topics/task/operational/netconf-yang-module-obtaining-and-importing.html
- Juniper OpenConfig Blog
  http://forums.juniper.net/t5/Automation-Programmability/Network-Programmability-with-OpenConfig-and-Junos/ba-p/289136
- Juniper Telemetry Blog
  http://forums.juniper.net/t5/Analytics/Open-Source-Universal-Telemetry-Collector-for-Junos/ba-p/288677

About Juniper Networks

Juniper Networks challenges the status quo with products, solutions and services that transform the economics of networking. Our team co-innovates with customers and partners to deliver automated, scalable and secure networks with agility, performance and value. Additional information can be found at Juniper Networks or connect with Juniper on Twitter and Facebook.

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