Achieving Automation with YANG Modeling Technologies

IDC OPINION

Automation and agility in network operations are currently limited by the installed base of traditional network management tools and techniques. This becomes a liability in an environment where mobility, IoT, and cloud investments depend on diverse, dynamic, and distributed network architectures. Applying model-based abstractions to the management of networks is emerging as an alternative to traditional means of network operations and service provisioning. Specifically, modeling technologies based on the YANG data modelling language are enabling service innovators to approach automation of network management and service provisioning in a way that enables business outcomes through operational agility and scalability and allows for customer-focused innovation.

To understand how service providers (SPs) are turning to model-based management tools, IDC conducted a number of interviews with technology leaders in SPs. These interviews yielded an adoption index to quantify the level of acceptance and impact of model-based network management approaches. For large and midsize service providers, IDC finds that:

- Among leading SPs, engagement with YANG-based modeling technologies is high.
- The adoption of YANG-based modeling technologies is expanding in key and high-impact domains such as business network services.
- For most established implementations, staff and process commitments are in place to rapidly increase model-based network management.

METHODOLOGY

During 2016, IDC interviewed 10 leading SPs about their experiences with model-based abstractions of networks and services. Interviewees were required to be familiar with and experienced in the YANG data modeling language and the NETCONF protocol, as well as alternative modeling technologies and protocols. SPs were selected based on the maturity of their deployments of YANG-based technologies and NETCONF protocol implementations as well as the size and scale of network operations.

In addition, IDC interviewed four network equipment suppliers about the support of YANG and NETCONF in their products. These interviews expanded on mid-2015 supplier audits of network management standards with 15 additional network equipment suppliers and 10 network management suppliers. Ongoing interviews with additional network equipment suppliers, Network Functions Virtualization (NFV) infrastructure suppliers, and OSS and network management suppliers were also considered.

Through the interviews, IDC found that support for the NETCONF protocol is seen as one of several options for network element configuration. While the NETCONF protocol is helpful, buyers are primarily focused on YANG modeling technologies as the fundamental innovation that helps them achieve their technology and business goals.

SITUATION OVERVIEW

Network management teams are facing unprecedented change as SPs are under pressure from their enterprise customers to deliver and support more agile service offerings. The core of the challenge is that the traditional network operation processes are focused on internal processes and are not based on directly customer-driven requests. To meet this challenge, SPs are looking to update their technology platforms to deliver services in a more efficient manner as well as to improve customer responsiveness.

The Role for Model-Based Management: Business Outcomes

Model-based abstractions of networking functions provide the foundation for a more dynamic approach for service providers to run their networks. But operational efficiency is not enough. Standardized and interoperable management interfaces to networking equipment are equally important because they enable leading adopters to gain an edge on onboarding new technologies faster and support more rapid provisioning of services.

Datacenter and cloud operations are ramping up on software-based tools for automation and workload optimization. SP network operations are trailing in the adoption of corresponding software-based tools and procedures. But now model-based management platforms are emerging as a tool for network operations to use on an increasingly distributed infrastructure footprint for business needs. Automation, agility, and business alignment are key requirements driving this adoption.

Automation

Automation is a key step to improve the agility of network operations and infrastructure. Each of the SPs interviewed rated automation of network management as either important or very important. The majority of SPs interviewed believe that model-based abstractions are fundamental to how automation is implemented. As a top 10 global SP stated, "NETCONF/YANG is a fundamental part of the company's transformation to automate services."

SPs are identifying model-driven abstraction and automation using technologies like YANG and NETCONF as essential to support these automation initiatives and key to increased usage by business customers, for which the network delivers a competitive edge.

Network Virtualization

Network virtualization efforts, particularly Network Functions Virtualization and software-defined networking (SDN), are shifting network platforms to an open and software-based foundation. The more open ecosystems associated with virtualized network elements are bringing agility to SPs and creating an increasing need to maintain service life-cycle integrity amid network element platform innovations.

Speed

As SPs invest in automation and network virtualization, a range of traditional delays from ordering and shipment to acceptance testing are shrinking or going away. Operational delays are still common, but

initiatives are getting under way to automate the remaining operational steps to provisioning, activation, and life-cycle management of network elements and services.

One North American service provider specifically cited YANG modeling technologies as a key accelerator both for reducing the time to roll out business network services and to speed up the time to earn revenue from the infrastructure. SPs report that they are looking to use YANG-based technologies to reach the same ability to rapidly onboard networking functions as the web-scale providers.

Dynamic Change Management

New and unpredictable demand patterns put pressure on operations teams to improve the efficiency of their change management processes. Lengthy and massive change cycles are unwieldy and unproductive. Model-based abstraction technologies help pulling together legacy and modern infrastructure into a cohesive set of managed resources.

Alignment: Business Priorities and Implementations

SP business teams (e.g., product management and marketing teams) are becoming more aware of and engaged with technology platforms to support their ongoing needs. Infrastructure teams increasingly need to provide higher-level abstractions of services to interface the needs of the business teams. But this needs to be done while maintaining the ability to support rapid changes to the infrastructure. Some SPs cite the need to work across distributed teams with varying responsibilities (e.g., headquarter sites may need to review changes implemented by regional teams), which may or may not be an independent regional action. The shift to empower local sites to act on their own is an example of the kind of technology autonomy that some organizations are more comfortable delivering today than back in the days that traditional network management tools (i.e., based on SNMP and CLI) were designed for.

Model-Based Technologies

Model-based technologies have been around for some time, but their application to network infrastructure operations is a fairly recent development. The application of models to network elements provides a basis for work on higher-level models both in the supporting infrastructure domain and for defining network services. Modeling technologies as employed in general IT operations include influences ranging from application development to datacenter infrastructure management and other areas to data analytics techniques.

Modeling in the service provider networking domain is defined by the need to work with a combination of in-house infrastructure experts and business unit product management teams to match the available infrastructure functions with requirements for specific market offerings. As indicated by several SPs, model-based management technologies are key to bridging the gap from traditional and proprietary network element management approaches of the past to a more modern and agile DevOps-based approach, effectively growing the value of the network platform.

Common model-based management technologies for networking include the YANG modeling language, the TOSCA application template language, the NETCONF and RESTCONF protocols, and proprietary application programming interfaces (APIs) and modeling tools. Automation technology for applications is a well-established management approach and includes tools like Puppet, Chef, and Ansible. Of these, network function modeling and network service modeling are most closely associated with NETCONF and YANG, respectively. For the automation of virtualized network
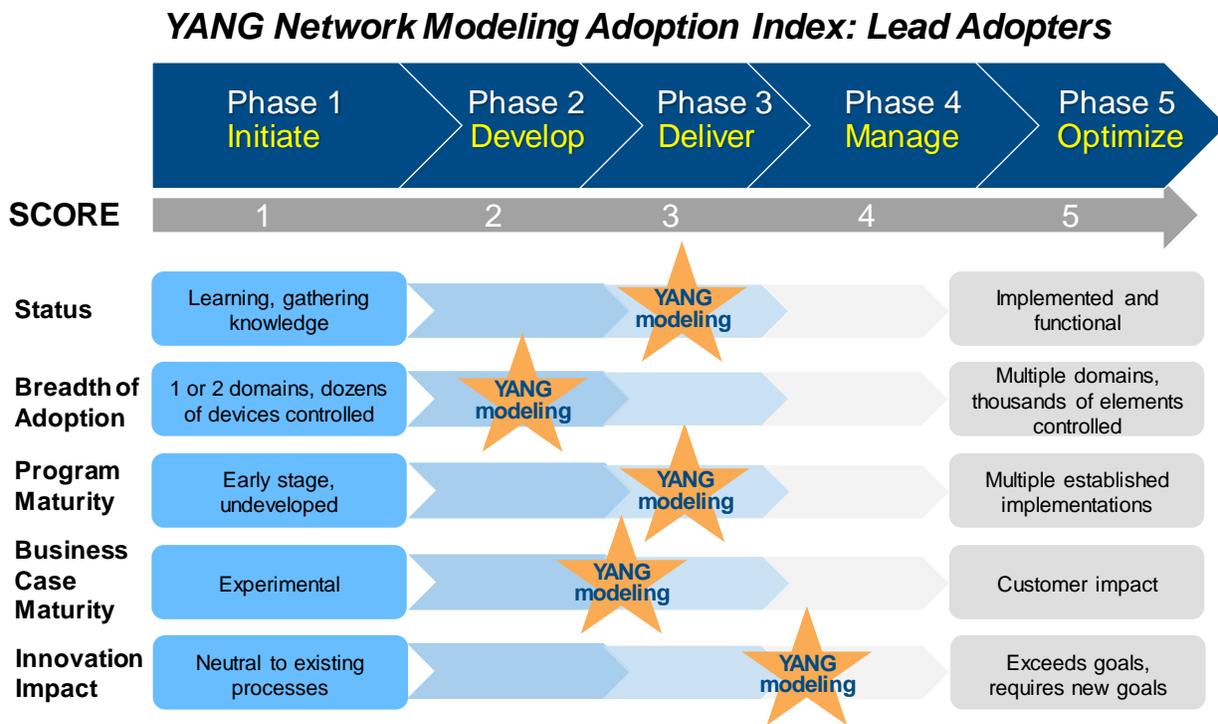
services, YANG models are a key foundation for automation and virtualization. With models of specific network functions, created with YANG, planning and operations teams can focus on service creation and integrity rather than work with the details of each network function's attributes and components.

Network Modeling Maturity Index

During 2016, IDC interviewed leading SPs about their adoption of model-based technologies for network element management. Interviewees were required to be familiar with and experienced in the YANG data modeling language and the NETCONF protocol, as well as alternative modeling technologies. On the basis of IDC's models for IT adoption maturity and business value, the interviews were compiled to form IDC's Network Modeling Maturity Index (see Figure 1).

FIGURE 1

IDC's Network Modeling Maturity Index, 2016

YANG Network Modeling Adoption Index: Lead Adopters

	Phase 1 Initiate	Phase 2 Develop	Phase 3 Deliver	Phase 4 Manage	Phase 5 Optimize
SCORE	1	2	3	4	5
Status	Learning, gathering knowledge		YANG modeling		Implemented and functional
Breadth of Adoption	1 or 2 domains, dozens of devices controlled	YANG modeling			Multiple domains, thousands of elements controlled
Program Maturity	Early stage, undeveloped		YANG modeling		Multiple established implementations
Business Case Maturity	Experimental	YANG modeling			Customer impact
Innovation Impact	Neutral to existing processes			YANG modeling	Exceeds goals, requires new goals

Source: IDC, 2016

Buyer Preferences: The Adoption Criteria for Modeling Technology

Among the SPs interviewed, modeling technologies are viewed as an essential step toward greater network agility. Buyers are increasingly expecting model-based technologies to be supported in newly purchased network functions. As a growing number of network functions shift onto commercial server platforms, buyers need to automate basic tasks like configuration.

The SPs interviewed strongly emphasized the need for dynamic and flexible network and service creation capabilities. Top of mind for many SPs are the costs associated with traditional (e.g., SNMP

and CLI) approaches: staff skill sets, proprietary SNMP MIBs, proprietary equipment configuration, and the lack of suitability for enterprise business network services.

Business outcomes are also important to SPs. The ability to meet the expectations of business customers, the openness to support network virtualization strategies, and the potential to respond to advanced automation capabilities are also important buying criteria. The prevailing sentiment of SPs shows a nascent but notable focus on customer satisfaction that has traditionally been absent from telecom network configuration developments.

Current Adoption Levels

Top SPs are adopting tools for modeling network functions. Most investments to date have been to support business network services. The kinds of solutions that SPs are seeking out today reflect how network functions are operated and how they are mapped into service offerings.

Table 1 shows that the average adoption metrics in North America and EMEA vary widely: outliers in both North America and EMEA result in regional averages that are lower than the overall average for the 10 in-depth service provider interviews.

North American respondents are most engaged with the innovation impact of YANG and NETCONF, with an average adoption score of 2.8 out of 5, where 1 showed significant immaturity and 5 showed routine and advanced business case practices. The maturity of North American SP business cases for the adoption and use of YANG is notable. Interviews show that North American SPs are working with YANG as a tool for staff transformation as well as technology innovation. While EMEA respondents are also interested in updating the skills and priorities of key network staff, the business case details have been less advanced than those of North American SPs. The challenges of technology transformation happening in parallel with updated staff priorities and skills are being dealt with by SPs, with help from the advancements in YANG and NETCONF and network modeling.

IDC expects to see increased use of network modeling technologies and strategies including YANG and NETCONF in the coming months. During 2016, SPs report using YANG and NETCONF for business network services, as reflected in Table 1 (see the Breadth of Adoption column). Both growth of enterprise customers as a segment for SPs and the expanded use of modern network platforms across SP core, edge, and access networks will prompt expanded engagement with network modeling including YANG and NETCONF based on IDC interviews.

TABLE 1

Network Modeling Adoption Criteria Scores, 2016

	Status	Breadth of Adoption	Program Maturity	Business Case Maturity	Innovation Impact
North American SPs (n = 5)	2.8	2.4	2.8	2.8	3.5
EMEA SPs (n = 4)	2.8	2.3	2.8	2.3	3.4
AP SPs (n = 1)	3	2	3	2	3
Average SPs (n = 10)	3.1	2.6	3.1	2.8	3.8

Source: IDC, 2016

FUTURE OUTLOOK

Increasing risks associated with security threats, new levels of customer connectivity expectations, and growing complexity in end-user devices all drive the need for SPs to move away from traditional network management tools and approaches. These aspects were simply not considered when the investments were made in current-generation management tools (e.g., based on CLI and SNMP). The ability to maintain service integrity in virtualized network environments, the rise of APIs, the pace of digital business, and the increasing use of cloud-hosted services further illustrate the gaps in what traditional network management provides.

Software: APIs and Platforms

APIs are critical to how networks and network management tie into larger service architectures. In discussing the use of YANG for providing APIs, an EMEA tier 1 service provider noted that having a standard interface to network devices is the key payback of the YANG modeling language.

For all of the SPs interviewed, supplier support for open management interfaces is essential. Supplier support for YANG and NETCONF is initially limited to business network services functions, and all SPs expressed frustration with the slow delivery of solutions based on YANG and NETCONF.

As a step toward modernizing and automating operations, a prominent North American SP is requiring YANG and NETCONF support as a replacement for SNMP and CLI capabilities saying, "For our RFPs, it is a mandatory requirement for NETCONF/YANG support on all Layer 1-3 networking products." The SPs interviewed expressed interest in alternative interfaces like HTTP-based RESTful interfaces such as RESTCONF as an alternative to NETCONF for application-centric cases. One midsize North American SP admitted that while it does not currently use the NETCONF protocol, its requests for proposals always mandate support for NETCONF and RESTful APIs.

Real-time management of operations requires easily adapted software interfaces and models. As one SP pointed out, YANG-based streaming data helps substantially with providing timely deliverable of key statistics and performance data.

For SPs, network management automation serves two objectives: it enables scalable operations, and it frees up resources to focus on projects in new areas. Engineering resources previously consumed with basic network management and element configuration tasks can now be applied to more strategic and directly revenue-generating activities.

CHALLENGES/OPPORTUNITIES

The adoption of model-based management technologies is under way, but it will take time to achieve wide implementation. Specific barriers to wider adoption include commercialization, backward compatibility, and staff skills development.

Model-Based Technology: From Innovation to Industrialization of Models

Model-based technologies are growing in popularity with the shift to more software-defined infrastructures. But, as a newer technology option, the YANG modeling language emerged as an industrywide standard rather than from incumbent suppliers. Unlike supplier-defined de facto standards based on commercial products that create a single authoritative source, YANG models can be built and used independently of suppliers. As such, best practices for creating YANG models, managing YANG models, and using authoritative YANG models are weak – at the same time that the telecom industry is adopting open source technologies and practices.

As each organization develops and refines its YANG model for a specific network element, duplicative work projects across the industry are common. The ability to drive common YANG models emerges when SPs find or upload YANG models for sharing on public repositories like GitHub or via standards work. In some cases, collaboration and best practices may be a challenge: YANG models for configuring key BGP elements can be a sensitive issue for some SPs. While the ease of use and wide standards work related to YANG and NETCONF are helpful developments, the decentralized activity to build models creates challenges for managing programmer resources and preserving interoperability.

Integration

A significant portion of current infrastructures are still built with network elements that do not support model-based configuration or management. Supporting the installed base using model-based management means will remain a challenge for some time. Network equipment suppliers are just beginning to deliver support for NETCONF and YANG in the more recent products. Initial support is limited to router suppliers, with signs of support from optical suppliers. Implementers will need to find tools and techniques to effectively bring both legacy network elements and ancillary domains into model-based network and services platforms.

OSS suppliers are currently not broadly indicating platform support for YANG, making services orchestration a challenge for those pursuing a model-based service life cycle. Much of the industry momentum, and SP projects to date, have focused on network equipment modeling for specific routers.

Abstraction and Virtualization Maturity

Modeling technology to support abstractions is expanding from focusing on fundamental automation to support service agility. The SP market is still working to find the appropriate level of virtualization of the network to support business goals. Some technology leaders continue to view the infrastructure as a foundation, while others see a platform built on network infrastructure including platform software, and still others seek a pure software platform with all hardware translated into virtual resources.

As the industry efforts to develop effective orchestration and management technologies evolve, refinements and extensions to network modeling should be expected.

Organizational Culture and Skills

SPs are working hard to instill customer-focused priorities into the daily activities of operations and business staff. The staff skills and culture change is one way that SPs are improving competitiveness. YANG and NETCONF provide a focused strategy to shift skill sets away from traditional and proprietary network element management approaches toward more agile technologies and, especially, automation.

One specific barrier to adoption cited by multiple SPs is the existence of many and variable YANG models for networking functions – more broadly, adding web services software skills to the infrastructure teams.

CONCLUSION

The value of networking will increase faster than ever as networks shift from providing basic conduits for connectivity to become a tool for customer reach. Model-based abstractions of network functions provide a timely and agile approach for how organizations run their networks. As leading successful SPs reported to IDC in interviews for this project, network modeling technologies such as YANG offer a means of tackling key business challenges and support delivering business outcomes.

Three key takeaways:

- Model-based abstractions of network functions will increase as a priority for both SP buyers and network equipment suppliers. SP buyers are increasingly expecting model-based technologies to be supported in newly purchased network functions.
- Competitive pressures and customer expectations of business network services have encouraged many technology innovations, including network virtualization, fueling the business case for network modeling technologies such as YANG.
- SPs working to drive automation and agility find traditional approaches to network management are increasingly out of date and are turning to network modeling, including NETCONF and YANG, as a way to update technologies and practices.

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