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Cox Network Automation Strategy:
A Case Study

A custom Heavy Reading report produced for Cisco Systems and Cox Communications

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1. INTRODUCTION

Network operators are under continued pressure to scale capacity, meet customers' fast-changing needs, and rapidly deploy new services, all while keeping capital and operational costs down. To meet these requirements, operators globally are increasingly turning to network automation.

North American cable operator Cox Communications is at the leading edge of the automation trend as it seeks to drive automation tools and processes across all its engineering and operations groups. This white paper presents a case study of Cox's network automation strategy. Working closely with Cisco Systems, the Cox team is building processes and defining promising use cases. This case study focuses on two early wins related to remote PHY device (RPD) activation and commercial services Metro Ethernet configuration management and security compliance. These use cases have already demonstrated quantifiable results for Cox.

2. COX NETWORK AUTOMATION STRATEGY

Network automation itself is not new to Cox but, historically, it had been adopted in a bottom-up approach with varying degrees of sophistication across engineering domain teams. Cox's management realized greater focus and coordination was required to unlock the full potential of automation. In early 2020, the company formed a dedicated Network Automation and Services team led by executive director Matt Hayes, with a mandate to work closely with all engineering groups to develop and implement networkwide automation.

Cox's network automation strategy is based on three pillars:

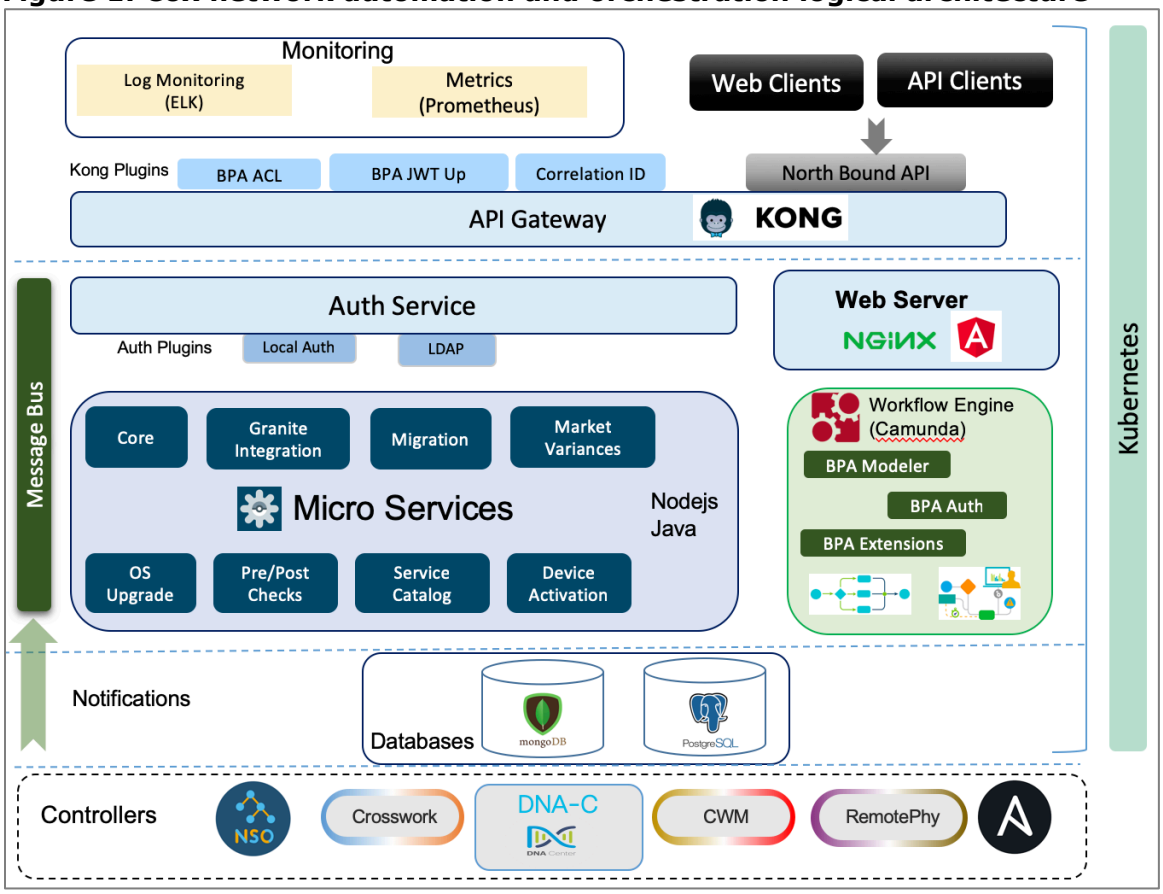
- **"Demystify" automation tooling** by identifying which tools to build around and structure support around those toolsets. One model for self-serve automation and another model that would be more tightly integrated with operations/business support systems (OSS/BSS) for more sophisticated automation.
- **Build foundational capabilities** for network and process automation across the engineering and operations organization with an emphasis on reusing capabilities as much as possible across groups and domains.
- **Drive value across the business** by connecting network insights and analytics to network automation.

According to Hayes, building out the automation structure, tools, and capabilities (i.e., the first two strategic pillars) is progressing concurrently. Work on extracting insights and business intelligence (i.e., the third strategic pillar) will follow as the organization gains data and implementation experience.

At the heart of the strategy is the Cisco Network Services Orchestrator (NSO) and Cisco Business Process Automation (BPA), Cox's integrated network automation and orchestration platform. Significantly, NSO also integrates on the backend into Cox's OSS and BSS to create fully automated processes that go well beyond mimicking human interaction with network devices. The hooks into OSS/BSS enable the automation to auto-update ticketing systems, populate inventory management systems, and pull next available IP assignments.

NSO removes much of the overhead administrative burden on network operations staff. It uses standard YANG models to abstract configuration data across a multi-vendor and cross-domain network. This data model abstraction is a critical foundation component to moving away from command line interface (CLI)—from human APIs toward machine APIs.

Figure 1: Cox network automation and orchestration logical architecture



Source: Cox, 2020

3. CISCO ROLE IN IP AUTOMATION

Cox's microservices automation architecture consists of Cisco NSO and BPA. Heavy Reading describes these key Cisco products below.

3.1 Network Services Orchestrator (NSO)

NSO is an intent-based, model-driven platform for automating provisioning, monitoring, and managing applications and services across multi-vendor networks. It accomplishes this goal by abstracting device configurations and service definitions from the underlying physical and virtual infrastructure, separating intent from implementation. NSO loosely couples the teams building apps and services to the teams operating infrastructure, bridging the two communities so they can work together without getting in each other's way.

NSO northbound APIs are exposed through RESTful web services that include bindings to common languages such as C, Python, and Java, remote procedure call (RPC)-based protocols such as NETCONF and RESTCONF, and human-to-machine interfaces, including a web user interface (UI) and network CLIs (important for traditional network operations teams). Southbound, NSO communicates with Cisco equipment over 170 third-party platforms and operating systems (OS) through network element drivers (NEDs), software components that convert intent into device-specific commands and configurations.

To date, more than 200 service provider and enterprise customers worldwide are using Cisco NSO.

3.2 Business Process Automation (BPA)

Cisco BPA is a scalable, microservices-based containerized platform with a standards-based, scalable workflow engine. It provides standard applications, including OS upgrade, device activation (i.e., zero-touch provisioning), configuration compliance, golden configuration generator, device migration, and others. BPA is a controller-agnostic platform, pre-integrated with Cisco NSO and Ansible, and is extensible to work with other Cisco and third-party orchestrators and controllers.

BPA offers fine-grained authorization and access control for applications and modular reusable artifacts such as workflows and services. It has an embedded API gateway for authentication/authorization, auditing, and rate limiting. In addition, BPA provides dynamic UI form builders (automatic rendering) with YANG models to any depth. It offers Kafka message bus for handling events from southbound controllers and is security hardened with secure sockets layer (SSL)/transport layer security (TLS) encryption in transit and vault integration for sensitive data storage.

To date, Cisco counts 15 BPA customers worldwide.

3.3 Why Cisco?

Cox needed orchestration and automation to be truly multi-vendor and multi-domain, and Cisco's NSO and BPA have a proven track record of interoperability. The architecture is based on many open standards, including BPMN2.0, Elastic, Logstash, Kibana (ELK) for logging and streaming telemetry, Camunda and BPMN2.0 for a workflow engine, KONG for microservice API gateway, and YANG for abstraction to connect to network devices, to name a few. These open standards enable orchestration as users integrate southbound with multi-vendor environments in the network. Further, they enable the workflow to integrate northbound with provisioning, inventory management, alarming, IP management, and ticketing systems. This level of integration is required to move beyond simply mimicking human interaction on the CLI. Integrating this deeply enables the operator to rethink network operations and generate more efficient business processes for device turn-up, configuration management, service orchestration, and service assurance (health checks and break/fix).

Additionally, Cisco Professional Services offered as part of BPA is a key advantage. Hayes leads a new and relatively small network automation team at Cox. The ability to draw from Cisco's extensive network automation expertise and "flex up" with additional manpower from Cisco for new initiatives when needed is a major benefit, according to Hayes.

4. USE CASES

This section focuses on two early automation use cases that are already producing benefits in commercial deployments.

4.1 Remote PHY device network

Remote PHY is an important component of MSOs' strategies to boost broadband capacity for their customers while continuing to use a hybrid fiber/coax (HFC) network. Remote PHY involves moving the physical layer function from the centralized cable modem termination system (CMTS) headend to a network edge location much closer to the end customers. The architecture delivers higher bandwidth to customers by decreasing the coax length from the node to the customers' modems (which also reduces analog amplifier chains). Connectivity from the remote node back to the CMTS is over Ethernet at 10Gbps rates.

Cox has been a leader in distributed access architecture (DAA) and has an aggressive strategy to roll out remote PHY throughout its footprint with a planned installation and turn-up of 60,000–100,000 nodes over the next five years. The process of replacing analog nodes with new RPDs started in 4Q19. Along with RPD deployments, Cox is concurrently upgrading the access network to support mid-split service, a network upgrade that more than doubles upstream bandwidth by increasing upstream spectrum from 5–42MHz to 5–85MHz. To enable mid-split capability, there is significant work in the outside plant in terms of taps, bypass filters, and amplifiers. And, finally, a node configuration must be implemented on the inside plant electronics. Through network automation, Cox is building the capability to have the outside plant technician trigger the inside plant configuration process. This process removes human-to-human collaboration and yields efficiency and time savings.

Cox's engineering management knew that automated turn-up and provisioning for both RPD deployment and mid-split functionality would be essential, just on the volume of the turn-up process alone. Thus, the Cox team integrated the network automation platform (Cisco NSO and BPA) with its OSS on the backend and with its ATMOS mobile app on the frontend. Using the combination of processes, complete RPD activation—including flow through provisioning, IP configuration, and security—has reduced activation time by two hours per RPD. Cox expects two hours and five minutes for every mid-split activation.

These benefits are easily quantifiable. Cox expects to save an estimated $3.35m over the next three years for this use case alone. In addition to the time and money savings, automation will provide other key benefits:

- Improve data integrity/standardization through consistent, templatized configurations.
- Improve Cox employee experience by eliminating remedial administrative tasks such as updating inventory records and change management tickets.
- Improve efficiency by eliminating the need for human-to-human coordination between inside and outside plant teams.
- Scale up network capacity quickly and easily, something that has proven essential as fallout from COVID-19 has placed unprecedented demands on the network.

4.2 Metro Ethernet network

The commercial services Metro Ethernet SOC2 compliance requirement is another early automation win for Cox. This automation use case is representative of the bottom-up approach that domain teams have leveraged to solve real business challenges. The intent moving forward is to take these highly impactful automation use cases and standardize them in BPA/NSO across the domains. According to Hayes:

> *Utilizing a more "bottom up" style approach to automation versus the "top down" style of BPA/NSO, the domain teams who best understand their functional areas and technology challenges are creating successful automation solutions that empower their teams to operate on the network more efficiently and with greater accuracy. Building on their success, we look to leverage BPA/NSO to provide additional resources and integration points to supercharge their automation efforts, merging the best in class automation solutions from each approach, across all domains, in our future roadmaps.*

In contrast to the greenfield RPD deployment use case, the Cox Business Fiber network is a Multiprotocol Label Switching (MPLS)-based "services-oriented" network, with nearly 38,000 Nokia enterprise-grade devices deployed. The network delivers Layer 2 Ethernet services, IP-VPN services, voice transport, and dedicated internet access to enterprise verticals, including government, healthcare, and education, where network security is paramount.

Since August 2019, Cox has been using network automation for configuration management and security compliance across all 38,000 network devices. As a security compliance check, Cox analyzed 61 million lines of configuration against 15 compliance points (in accordance to American Institute of CPAs SOC 2 certification requirements) and remediated any non-conformance. In addition to security compliance, Cox uses automation for general configuration updates across the entire network.

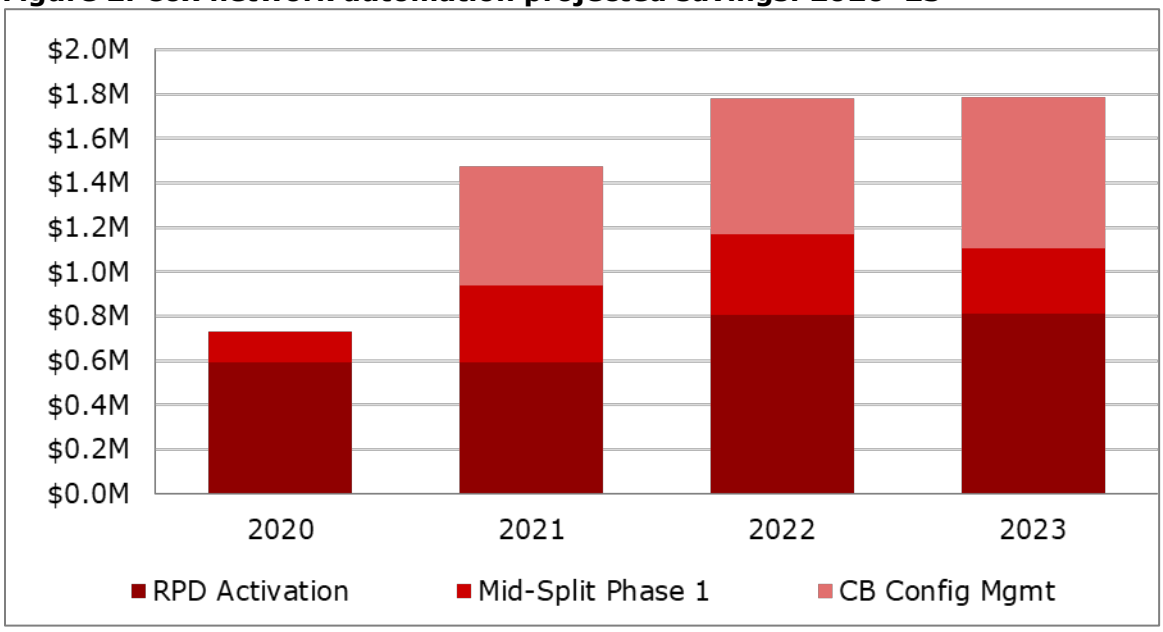
Automation has produced quantifiable benefits. With the manual process, Cox used to be able to execute these updates just three times per year. With network automation, Cox has moved to a continuous integration/continuous development (CI/CD) model for network updates, which translates to an estimated $1.9m in savings through 2023 based on expected time savings compared to manual configuration.

Similar to the RPD use case, Metro Ethernet automation also delivers benefits beyond the easily quantifiable metrics of time/cost savings. These additional automation benefits include the following:

- Enable agility and scale not possible with manual human-based interaction with 38,000 devices, particularly with respect to frequent SOC 2 conformance checks, which are not feasible in a large network without automation.
- Move to a programmable network and implement CI/CD level agility across the network.
- Improve employee experience by eliminating remedial and repetitive transactions.

Figure 2 below shows Cox's projected savings from the RPD/mid-split and Metro Ethernet configuration use cases over the next three years.

Figure 2: Cox network automation projected savings: 2020–23



Source: Cox Communications, 2020

5. CONCLUSION AND NEXT STEPS

On the horizon, according to Cox's Hayes, is 10Gbps XGS passive optical network (PON) deployments, which are greenfield builds that share many similarities with RPD activation. Based on the RPD automation workflows, the team is building a similar set of activation and zero-touch provisioning capabilities for XGS PON and anticipates similar benefits. Cox expects to launch XGS PON automation by early 2Q21. Reusing automation workflows in other domains is part of its overall strategy to build on success.

One of the more promising areas Cox sees moving forward is tying together network metrics, analytics, and automation. This is where the MSO intends to unlock value through closed-loop control for network operations. It will enable a proactive self-healing network, leading to improved customer and employee experiences.

Heavy Reading notes that automation business cases gain upper management buy-in based on how they enable scalability to meet growth objectives while maintaining current staffing levels. As Cox noted, moving from human-based APIs to machine-based APIs also improves the employee experience by reducing tedious, repetitive, and error-prone tasks that engineers do not like to do and allowing them to focus on higher value tasks. And as Cox moves into its third strategic pillar of analytics and business insights over time, mitigating network problems before they become perceptible to customers will improve overall customer experience and contribute to customer loyalty and differentiation.

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