WaveSuite Network Insight

Harnessing the power of machine learning and automation to lower network TCO

Application note
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Introduction

Many businesses are becoming increasingly reliant on optical networks for their success. Several factors are driving this growing dependence, including the need for higher network capacity, lower service latency, network slicing capabilities, bigger data centers, more wholesale network capacity and enhanced IoT and 5G service offers.

These businesses are looking to stay competitive by turning their optical networks into CAPEX- and OPEX-friendly platforms that can create value by enabling new service innovation, accelerating service deployment and improving the customer experience. But as networks become more complex and budgets shrink, it is becoming tougher for businesses to get more value from the network in isolation.

The Nokia WaveSuite Network Insight applications and data lake environment provide tools that make it easier for network operators to automate their networks. This automation will help operators optimize their networks so that they can extract more capacity to grow revenue and lower network total cost of ownership (TCO).

The data lake environment enables operators to securely gather network data and apply machine learning to a broad range of network automation tasks. WaveSuite Network Insight applications use Nokia Bell Labs-verified machine learning algorithms to provide user-friendly ways to automate and simplify network operations. The applications also facilitate service troubleshooting by streamlining the association between services and the underlying physical network to help identify potential issues before they impact IP or optical services.

WavePrime professional services provides consulting, software development and system integration capabilities to help network operators rapidly deploy automation. Services consultants can help network operators deploy WaveSuite applications as customized automated workflows. Operators can also work with members of the Nokia WaveHub innovation ecosystem to explore new approaches that will further extend network automation to all aspects of optical networks and related services.

A new era of machine learning automation

Machine learning is a foundational capability of the modern world. For example, it has given rise to web search, social media community identification, anomaly detection, recommender systems, self-driving cars, and text, speech and image recognition. Machine learning has become so ubiquitous that it can now be applied to less complex tasks through simplified mobile application development environments that do not require programming skills.

As optical networks become more open, programmable and instrumented with streaming telemetry, the time is right to use capabilities such as machine learning to apply automation to network operation tasks. Doing so will enable new cost-saving approaches for operating and optimizing optical networks. In addition, the availability of flexible workflow automation software development environments facilitates the rapid deployment of network and service automation applications. These environments enable network operators to customize automation for their specific environments so they can roll it out at their own pace.
Applying machine learning automation to optical networks

Nokia Bell Labs is at the forefront of applying machine learning to automate optical networks. Nokia has combined this industry-leading research with its unmatched technical expertise in optical networking to develop foundational elements for applying machine learning to optical networks. These elements focus on:

• Matching tailored machine learning algorithms with key optical network performance features
• Optimizing data models for more efficient streaming telemetry
• Minimizing the impact of network data collection on the optical data communications network (DCN)

The Nokia WaveSuite Network Insight applications and data lake environment use these innovations to provide the tools and environment that operators need to automate optical networks and lower network TCO.

Getting quality optical network data

Accurate machine learning algorithm prediction largely depends on gathering quality training data. This dependency is even greater when machine learning is applied to optical networks because of the underlying physics and complexities of networking light. One key to successful machine learning for optical networks is to gather large amounts of training data from diverse optical network environments.

WaveSuite Network Insight data lake

The Nokia WaveSuite Network Insight data lake environment is designed to facilitate data capture. It uses advanced streaming telemetry to collect equipment information, network topology, and analog and digital key performance indicators (KPIs). It also collects environment telemetry and data from other WaveSuite applications to create a comprehensive data lake from which machine learning algorithms can learn. The data lake environment allows for continuous learning to optimize network performance and operations in changing physical and business conditions.

WaveSuite Network Insight also provides a secure and user-friendly machine learning environment where optical network operators can use their own data or securely share it with Nokia or its trusted partners to train and validate machine learning algorithms. Nokia Bell Labs consultants can help operators achieve their desired outcomes by matching machine learning algorithms with data features to maximize the accuracy of prediction and classification, and triggering of automated workflows.

In addition to a dynamic repository for machine learning data, the WaveSuite data lake environment provides tools that enable network operators to work with the data, including:

• Visualizations
• Historical records
• File export using standardized formats
• Real-time customizable dashboard alarms
• Network topology views
• Alerts and reports on specific data set features
The data lake environment actively monitors and analyzes the history and impact of network configuration and topology changes over time. By analyzing network behavior between snapshots, it can isolate network modifications that triggered changes in network performance. It can also visualize and motorize network KPIs from past and current values. Users can determine what data feature subsets are to be monitored.

The visualization tool can monitor and illustrate the impact of real-time streaming telemetry on the optical network data communications network (DCN). It can also dynamically monitor the CPU and storage used by the data lake environment resources, and it provides the ability to set thresholds for alarms and reports.

**WaveSuite Network Insight Health & Analytics**

The WaveSuite Network Insight Health & Analytics application puts machine learning algorithms in a user-friendly open wrapper to make them easier to deploy and operate. It supports workflow automation by enabling algorithms to trigger desired outcomes using interfaces to:

- Other WaveSuite applications
- Nokia Network Services Platform (NSP) management and SDN control for optical and IP/optical networks
- Nokia WavePrime network planning software
- Third-party software

**Figure 1. WaveSuite Network Insight machine learning environment**

Operators can use the Nokia WaveHub Labs environment to create a digital twin of their optical network and use it to test the impact of workflow automation and machine learning outcomes before deploying them in a live environment. They can also call on Nokia WavePrime professional services to help develop and customize workflow automation for unique network environments.
Interactions with other WaveSuite applications

Nokia WaveSuite applications can be deployed independently or together. When deployed together, they provide an integrated solution that enables operators to use automation to lower network TCO and grow revenue by delivering a differentiated customer experience. The WaveSuite Node Automation and Service Enablement applications add service assurance, service equipment installation and commissioning data to the data lake. This data helps operators accelerate problem root cause analysis and automate the deployment of corrective measures before they impact services.

Figure 2. WaveSuite: comprehensive machine learning automation for optical networks

Operators can use the WaveSuite applications to create automated workflows for a variety of tasks, including:
- Predictive maintenance
- Planning for traffic growth
- Optimizing and reengineering the network
- Identifying network issues before they impact services
- Streamlining services to lower OPEX
- Enhancing differentiation to capture more revenue
WaveSuite Node Automation

WaveSuite Node Automation applications use a revolutionary approach to streamline service equipment deployment and activation. These applications simplify equipment selection by associating service catalogs with abstracted views of supporting equipment. They automatically create and track workflows throughout the service lifecycle and make it easy to associate installation and troubleshooting functions with company installers, contractors or end customers. For work order execution, these applications leverage the flexibility and ubiquity of mobile devices or zero-touch provisioning (ZTP) software to automate tasks and accelerate time to revenue.

To facilitate network troubleshooting, the WaveSuite Commissioning Expert application provides data related to equipment installation and initial service testing and activation to the data lake. Machine learning algorithms can use this data to associate installation and configuration issues (including human errors) with potential network problems.

WaveSuite Service Enablement

WaveSuite Service Enablement applications allow optical network operators to increase revenue without making a large CAPEX and OPEX investment. These open applications enable operators to create more consumable networks that support more customers and new go-to-market channels. They expand network revenue potential by using a hierarchical optical service value chain data model to virtualize the network and support new services and business partnerships.

For example, a physical network operator could sell a virtual slice of its network to a partner. As the partner sells services to customers the physical network operator can rapidly generate revenue without being involved in the partner’s business transaction. The WaveSuite Service Enablement applications and associated customer portals help automate the sale of optical services by supporting all aspects of the optical service lifecycle throughout the business hierarchy involved in selling them.

The Service Enablement applications also contribute service-related data to the WaveSuite Network Insight data lake. The WaveSuite Network Insight Health & Analytics application uses this data to troubleshoot the underlying physical network to identify potential issues before they impact services.

WaveSuite Network Insight Optimizer

Optical network operators face growing capacity demand, and the cost of addressing these requirements can significantly impact their bottom line. With the introduction of software-defined networking (SDN), optical networks will see increased client port speeds and more dynamic service requests. For network operators, the challenge is to extract maximum efficiency and bridge the gap between where their networks are today and where they need to be in the future.

Advances in coherent wavelength modulation formats, together with Colorless Directionless Contentionless – Flexgrid (CDC-F) wavelength routing, are enabling new approaches to optical network optimization. Rather than defining beginning-of-life (BOL) network infrastructure based on worst-case, end-of-life (EOL) fiber infrastructure parameters, operators can now use a continuous “learn and optimize” approach that adapts to approaching EOL conditions.

With the WaveSuite Network Insight Optimizer applications, an operator can use this approach to periodically tune the network to maintain optimal performance and availability and stay ahead of deteriorating network conditions. When EOL conditions eventually threaten network performance, the application can make proactive network re-optimization recommendations before they impact service deployment velocity. The result is a more robust and adaptable network that is ready to face the unpredictable nature of SDN service dynamism.
Figure 3. WaveSuite Network Insight Optimizer: evolving to a network "Learn and Optimize" approach

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<th>Continuously optimize mode of operation</th>
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<td>Deploy BOL based on EOL parameters:</td>
<td>Adapt BOL towards EOL based on:</td>
</tr>
<tr>
<td>• based on worst case assumptions</td>
<td>• span loss</td>
</tr>
<tr>
<td>• static, don’t adapt philosophy</td>
<td>• QoS parameters from modern coherent</td>
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The WaveSuite Network Insight Optimizer applications ensure that network performance matches initial business objectives defined by the Nokia WavePlanner network planning software. These applications help operators extract more network capacity and value by enabling them to migrate from their current, more static, optical networks and operations to more innovative and automated networks and operations.

The Network Insight Optimizer applications use a proven Nokia network management and control software base to reduce the risk involved in migrating to open SDNs.

- **Link Optimize** assures optimal optical link performance based on current and future optical transmission performance indicators.

- **Channel Optimize** dynamically adjusts programmable wavelength modulation formats according to measured transmission parameters. It also enables operators to manually adjust these formats.

- **Spectrum Streamline** rearranges wavelength channel routes throughout the network to optimize performance and spectrum utilization. It allows static optical networks to take full advantage of CDC-F-based wavelength routing as it is introduced. The pace of migration to wavelength routing is based on the analysis of wavelength spectrum fragmentation and the simulated impact of future expansions if spectrum is not streamlined for maximum wavelength deployment efficiency.

- **Multilayer Analysis** enables wavelength layer 0 and/or optical transport network (OTN) layer 1 failure simulation. It also offers network assessment and resilience verification capabilities that can identify critical failure scenarios and provide recommendations to ensure the most appropriate go-forward strategy based on criteria provided by the network operator.

- **Scenario Analysis** performs what-if analyses of current network consumption, extracts key statistics, extrapolates growth trends, identifies bottlenecks and recommends the most appropriate mitigation activities.
Operators can use these applications with the WaveSuite Network Insight Health & Analytics application to create customized workflow automation that supports wavelength performance tuning with closed-loop operation. This automation will allow them to complete a self-paced migration from static optical networks and operations to more dynamic, modern and automated optical networks that can help lower network TCO.

Interactions with Nokia management and control software

The Nokia Network Services Platform (NSP) delivers best-in-class SDN capabilities for multilayer, cross-domain, multi-technology and end-to-end coordinated management of IP routing and optical networking. These capabilities include:

- Automatically discovering topology at all network layers and cross-domain interconnect information to allow effective engineering planning
- Ensuring that true path diversity is present to support service availability
- Supporting bottom-up and top-down navigation and visualization across domains and layers
- Efficiently identifying root causes of service-affecting issues without complex inter-organization dynamics

Automated workflows can use WaveSuite Network Insight machine learning results to trigger NSP management and control capabilities. For example, workflows can use WaveSuite Network Insight machine learning results to automate the coordination and control of IP and optical network activities such as restoration and network maintenance to prevent impacts on services. Coordinated restoration simplifies network operations and eliminates the cost of duplicated restoration and protection resources between IP and optical layers.

Nokia WaveHub

To survive and thrive, optical network operators need continuous innovation that can enable them to extract more network value and lower operating costs. Nokia WaveHub is a market-oriented ecosystem program that brings Nokia customers and partners together to develop new ways to create value. The program is designed to:

- Accelerate business growth
- Help members become more successful by leveraging innovations from a diverse ecosystem
- Remove barriers to collaboration to make innovating easier

WaveHub provides a platform that enables optical network operators to work with a global ecosystem of innovators to automate and unlock the value in their networks and stay ahead of the competition. Through WaveHub, network operators can connect with:

- Independent software and hardware vendors, including startups
- Research institutions and academia
- System integration partners
- Technology partners
- Communication service providers, other network operators and enterprises
WaveHub Labs

An alternative to in-house physical labs, WaveHub Labs can help optical network operators reduce cost and complexity while enabling faster integration testing of automated workflow development.

Optical network operators with their own expertise or workforce can use the WaveHub DevOps environment to implement a digital twin of their network and use it to test and validate workflow automation. They can also collaborate with other members of the WaveHub community to develop new machine learning algorithms. These algorithms can be shared or placed in secure, private sections of the WaveSuite Network Insight data lake environment.

WaveHub Developer Portal is a cloud-hosted environment that Nokia customers and partners can use to facilitate and accelerate the creation of new solutions. It includes resources such as a catalog of ready-to-go, on-demand virtual labs, information about Nokia APIs and use cases.

Nokia WavePrime professional services

The Nokia WavePrime services team provides expertise, tool sets and best practices to help network operators deploy workflow automation that protects and grows their businesses.

With WavePrime, operators can access a wide range of services that help them accelerate automation and extract maximum tactical and strategic value from their optical networks. These services include:

- Network modernization and transformation services
- Systems integration of optical products and software
- Network consultation and design
- Business process automation and workflow optimization
- Network data intelligence extraction and reporting

The WavePrime services team can help optical network operators develop and deploy customized software and workflows to automate networks and services. The services offer includes top-to-bottom open software stack development, testing and integration.

Figure 4. WavePrime: Accelerating automation deployment for business success
Optimizing performance with digital twins

The WavePrime services team can create a digital twin of an operator’s current or planned network in a secure private cloud environment. This digital twin allows the operator to simulate and benchmark a comprehensive set of business process activities in a virtual environment. The operator can use the insights gained from these simulations to automate and optimize its physical production network.

Operators can efficiently perform a variety of activities in the digital twin environment, including:

- Business and network modeling
- Design and integration
- Training
- Testing and homologation
- Assessments and audits
- Simulation and what-if analysis
- Disaster recovery
- Application development

Nokia WaveFabric equipment

It is easy to overlook innovation leadership in an era of SDN and white boxes. Embracing open networking should not mean compromising on innovation that could maximize network potential. This is especially true for optical networks given the continuous scaling demands placed on them. Nokia WaveFabric equipment delivers world-class optical networking innovation with open, programmable interfaces to address the network scaling and performance needs of all optical network deployments and applications.

WaveFabric equipment supports open interfaces that bridge the gap between traditional optical networks and SDN. Nokia recognizes the importance of open agent flexibility to network automation, so it supports OpenConfig and NETCONF options across most of the WaveFabric portfolio. WaveFabric also supports gRPC streaming telemetry innovation to maximize machine learning algorithm learning and automation accuracy while minimizing the impact on the DCN. The WaveSuite applications and WaveHub environment leverage these open interfaces interact with live networks and network digital twins.

PSE network insight

Nokia Photonic Service Engine (PSE) is the industry’s most advanced family of coherent digital signal processors (DSPs). It provides the DSP component of the WaveFabric Elements portfolio of application-optimized optical subsystems and powers WaveFabric equipment by supporting advanced probabilistic constellation shaping (PCS), enhanced forward error correction (FEC), fine-granularity baud rates and reduced power consumption. These capabilities enable WaveFabric equipment to set new industry benchmarks for optical performance, capacity and flexibility.

The PSE DSPs are instrumented with DCN-efficient streaming telemetry interfaces to collect key wavelength performance indicators that machine learning algorithms can use to can learn. This in-depth network insight allows WaveSuite applications to maximize wavelength capacity and reach, especially over regional, long-haul and ultra-long-haul routes.
Use case: Pulling it altogether with customized automation

A tier 1 communication service provider (CSP) wanted to streamline operations between its SDN-ready IP and optical networks. The CSP’s key requirements included enabling automation to proactively react to the following events:

• If congestion is predicted in the IP network, automatically explore options to extract more optical network capacity to support the IP network and deploy the best option.
• If wavelength performance degradation is predicted, explore options to reroute or optimize the wavelength and act on their deployment.

Nokia used its unique IP and optical network experience and expertise to help the CSP develop workflows that use open APIs to WaveFabric equipment and the following tools to automate the network:

• Nokia WaveSuite Network Insight: The workflows use the data lake and Health & Analytics application to intelligently capture data to learn from and proactively monitor wavelength performance. They use the Optimizer application to explore wavelength optimization and/or rerouting options.
• Nokia Network Services Platform (NSP): The workflows use the capabilities of three NSP modules. The Network Resource Controller – Transport (NRC-T) module provides optical connection path computation. The Network Resource Controller – Packet (NRC-P) module provides MPLS path computation. The NRC Cross Domain Coordination (NRC-X) module coordinates tasks and network resources across the IP and optical layers.

The workflows provided the automation environment that the CSP required. They enabled the CSP to:

• Validate its SDN architecture and infrastructure
• Increased real-time visibility of its network
• Use predictive algorithms to proactively resolve potential service-impacting issues
• Reduced network TCO for its IP and optical networks by having them work together as one to ensure service quality and availability

Summary

A successful optical network provides its operator with a foundation for lowering operating costs and generating new revenue to fuel innovation for future growth. Nokia WaveSuite applications help operators achieve this success by building industry-leading innovation into open applications that help monetize the network, machine learning-driven automation that lowers network TCO, a global ecosystem program that brings diverse innovators together to create value, and professional services that rapidly deploy automation innovation.
About Nokia

We create the technology to connect the world. Only Nokia offers a comprehensive portfolio of network equipment, software, services and licensing opportunities across the globe. With our commitment to innovation, driven by the award-winning Nokia Bell Labs, we are a leader in the development and deployment of 5G networks.

Our communications service provider customers support more than 6.4 billion subscriptions with our radio networks, and our enterprise customers have deployed over 1,300 industrial networks worldwide. Adhering to the highest ethical standards, we transform how people live, work and communicate. For our latest updates, please visit us online www.nokia.com and follow us on Twitter @nokia.

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Abbreviations

API application programming interface
BOL beginning of life
CDC-F Colorless Directionless Contentionless – Flexgrid
CPU central processing unit
DCI data center interconnect
DCN data communications network
DSP digital signal processors
EOL end of life
FEC forward error correction
IoT Internet of Things
KPI key performance indicator
NSP Network Services Platform
OTN optical transport network
SDN software-defined networking
TCO total cost of ownership
ZTP zero-touch provisioning