



WaveSuite Network Insight

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

Application note

Abstract

As an optical network operator, your challenge is to stay competitive by turning your optical network into a CAPEX- and OPEX-friendly platform that can create value by enabling new service innovation, accelerating service deployment and improving the customer experience.

Nokia WaveSuite applications help you achieve success by building industry-leading innovation into open applications that help monetize the network. At the same time, machine learning-driven automation lowers network TCO. Our global ecosystem program brings diverse innovators together to create value, and our professional services rapidly deploy automation innovation.

To learn how the WaveSuite applications accomplish all of these things, read this application note.

Contents

Abstract	2
Introduction	4
A new era of AI and machine learning automation	4
Applying machine learning automation to optical networks	5
Getting quality optical network data	5
WS-HA data lake	5
Built-in Nokia Bell Labs innovation and expertise	6
Knowing your optical network fiber types through Nokia Bell Labs algorithm	7
Rapidly deploying automation	7
Interactions with other WaveSuite applications	9
WaveSuite Service Enablement	9
WaveSuite Optimizer	9
Interactions with the Nokia NSP	11
Nokia WaveHub	11
Nokia WavePrime professional services	12
Example use case: WaveSuite customized automation	13
Summary	13
Abbreviations	14

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 more difficult for businesses to get more value from the network in isolation.

The Nokia WaveSuite Health and Analytics (WS-HA) application provides tools that make it easier for network operators to gain valuable network insights from their data, to automate their networks. This automation helps operators optimize their networks so they can extract more capacity to grow revenue, protect service-level agreements (SLAs), enhance network awareness of external factors that can impact the network, and lower network total cost of ownership (TCO).

WS-HA leverages Nokia Bell Labs optical network insight and data science algorithms to provide user-friendly ways to automate and simplify network operations. The application also facilitates optical network service troubleshooting by streamlining the association between services and the underlying physical network key performance indicators (KPIs), to help identify potential issues before they impact IP or optical services.

WavePrime professional services provide 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 to realize their business outcomes. Predefined WavePrime use case workflows and multivendor network adapters accelerate the deployment of automation.

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.

These approaches can be validated using WaveHub Labs – a preconfigured virtual labs environment.

A new era of AI and machine learning automation

Artificial intelligence (AI) and machine learning are foundational capabilities of the modern world. They have 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, intent-driven and instrumented with streaming telemetry, the time is right to use data science capabilities such as machine learning to apply automation to network operation tasks to reduce network complexity. 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 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 data science to automate optical networks. Nokia has combined this industry-leading research with our unmatched technical expertise in optical networking to develop foundational elements for applying data science to optical networks. These elements focus on:

- Creating reliable optical network KPIs from which optical networks can be safely automated
- Visualizing KPIs with at-a-glance user interfaces that depict information with the clarity required to automate and monitor network health
- Quickly analyzing data using built-in Nokia Bell Labs data science algorithms and optical network expertise that enables efficient and safe automation
- Matching tailored Nokia Bell Labs data science algorithms with key optical network performance features to automate optical networks and identify optical network fiber types
- Optimizing network element data models for more efficient streaming telemetry
- Minimizing the impact of network data collection on the optical data communications network (DCN).

The Nokia WS-HA application and data lake environment use these innovations to provide the tools and environment that operators need to automate optical networks and lower network TCO. Nokia WavePrime predefined use case workflows also accelerate the deployment of WS-HA and automation.

Getting quality optical network data

Accurate machine learning algorithm prediction largely depends on gathering reliable KPIs for 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 together with the impact to terabytes of customer traffic if optical network automation goes wrong.

One key to successful machine learning for optical networks is to gather large amounts of training data from diverse optical network environments.

WS-HA data lake

The WS-HA data lake environment is designed to facilitate intelligent data capture. It uses advanced streaming telemetry to collect equipment information, network topology, and analog and digital KPIs. The WS-HA application also collects environment telemetry, contextual information (e.g., environmental data) and data from other applications to create a comprehensive data lake from which data science algorithms can be built.

The data lake environment allows for continuous learning to optimize network performance and operations in changing physical and business conditions.

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

In addition to a dynamic repository for data, the WS-HA data lake environment provides tools that enable network operators to work with the KPIs, including:

- KPI visualization
- Creation of historical records
- File export using standardized formats
- A real-time, customizable KPI dashboard with related KPI threshold-crossing alarms and KPI threshold-crossing notifications via a REST API
- Reports on specific KPI data set features
- Network topology views to associate KPIs with the physical optical network.

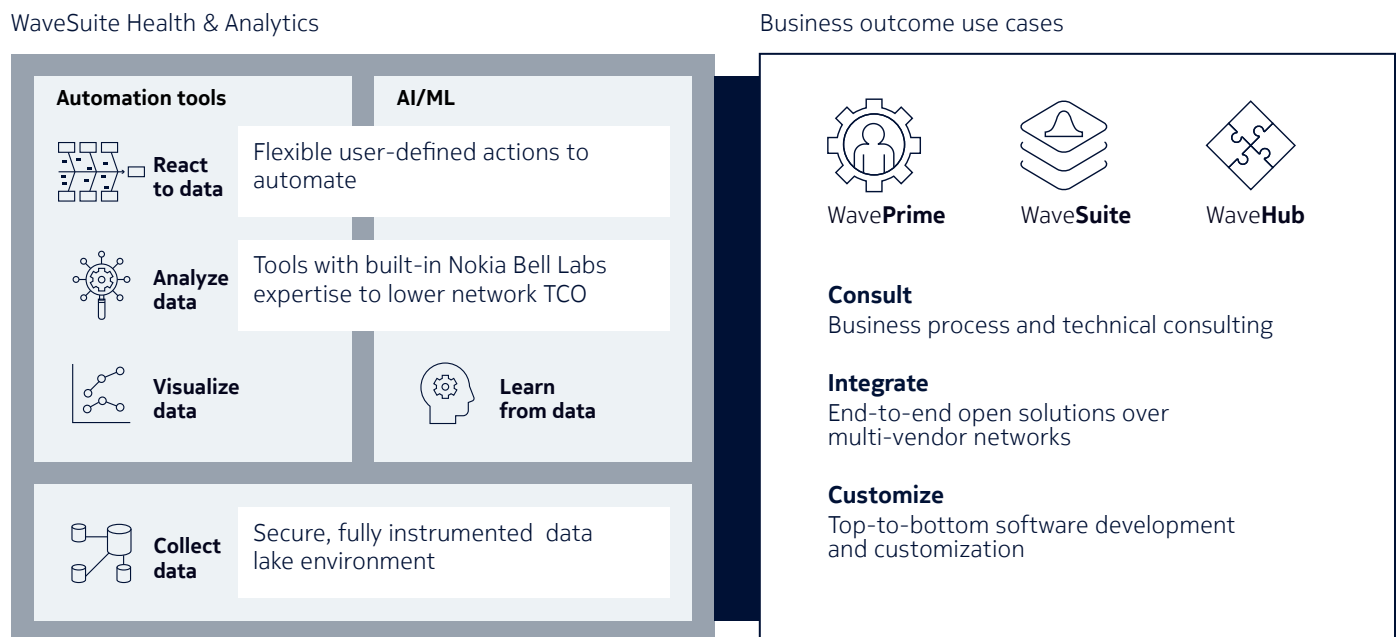
The data lake environment can be actively monitored and analyzed to understand the history and impact of network configuration and topology changes over time. By analyzing network behavior between snapshots, the data lake environment can isolate network modifications that triggered changes in network performance. It can also visualize and monitor network KPIs from past and current values. Users can determine which data feature subsets to monitor.

The visualization tool can monitor and illustrate the impact of real-time streaming telemetry on the optical 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.

Built-in Nokia Bell Labs innovation and expertise

The WS-HA application (see Figure 1) puts data science algorithms in a user-friendly, open wrapper to make them easier to deploy and operate.

Figure 1. Key to optical network automation success



With built-in Nokia Bell Labs data science innovation and expertise, WS-HA helps optical network operators to:

- Securely and efficiently collect data from a variety of sources from which to train AI and machine learning algorithms to better automate the network.
- Intuitively visualize network KPIs with at-a-glance user interfaces that depict information with the clarity required to automate.
- Quickly analyze data using built-in Nokia Bell Labs data science algorithms and optical network expertise that enables efficient and safe automation.
- Intelligently react to the network insights hidden in network data.

Operators can use these insights to drive business outcomes via automation, including automation to:

- Maximize network performance
- Detect and classify anomalies to quickly diagnose issues in the network and protect SLAs
- Detect environmental signatures that threaten the network
- Perform proactive maintenance
- Predict future network capacity needs
- Create greener networks by facilitating the analysis of network power consumption
- Safely drive closed-loop automation.

Knowing your optical network fiber types through Nokia Bell Labs algorithm

It's common for optical network operators to lose track of their optical network fiber types. Contributing factors include the use of outdated records or erroneous fiber connections during network repair or growth. An operator can also get erroneous information about fiber types when it buys or rents part of its network infrastructure from another operator.

Having complete knowledge of optical network fiber types allows operators to increase the capacity or availability of the network wavelengths. It also eliminates the need to underestimate wavelength signal performance and to over-dimension the network with additional CAPEX.

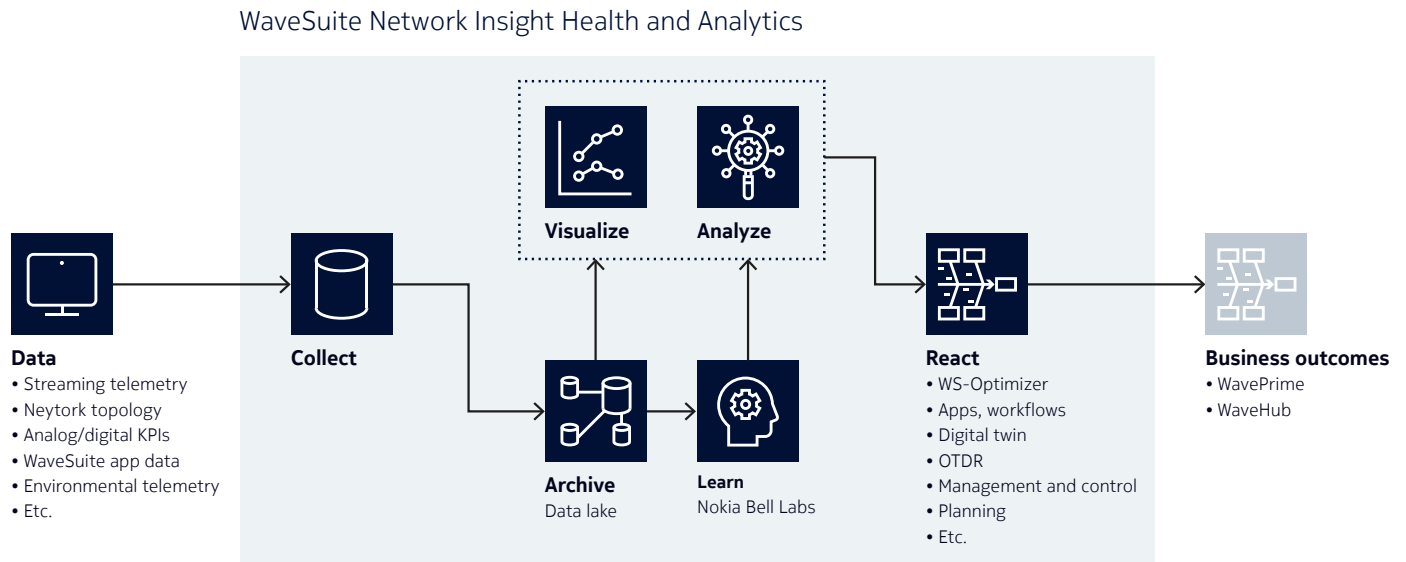
The WS-HA application uses a Nokia Bell Labs algorithm to determine fiber types by leveraging the chromatic dispersion over all established network wavelength light paths measured by all deployed coherent receivers in the optical network.

Using this approach, optical network operators can avoid a slow, manual fiber optic characterization (FOC) test that involves sending technicians to each fiber span site. They can also reduce design margins when they deploy optical wavelengths. These capabilities lead to maximum network performance and reduced network TCO.

Rapidly deploying automation

The Nokia WavePrime Digital Process Automation (DPA) practice (see Figure 2) enables the rapid deployment of WaveSuite applications via predefined use case workflows. Use case workflows are tailored to solve network operator-specific business outcomes.

Figure 2. WaveSuite applications: Collect, visualize, analyze and react to data with in-depth network insight



Use case workflows can also be customized to integrate:

- Other WaveSuite applications, including the Nokia WaveSuite Planner application that enables rapid network expansion to support services
- Nokia Network Services Platform (NSP) management and software-defined networking (SDN) control for IP/optical networks
- Third-party software or customer operations support systems/business support systems (OSS/BSS).

Network operators can also leverage the WavePrime Digital Twin as a Service offer 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.

Nokia WaveHub can be used to accelerate the deployment of network automation and innovation. Nokia WaveHub offers:

- A preconfigured **Labs** cloud-hosted environment for developers and partners
- A **Communities** secure digital collaboration environment that fosters information exchange and access to tools and resources. (The Communities environment is implemented using Nokia's purpose-built collaboration environment called Open Ecosystem Network (OpEN)).

Interactions with other WaveSuite applications

WaveSuite applications can be deployed independently or together to create more network value and lower network TCO.

WaveSuite Service Enablement

The Nokia WaveSuite Service Enablement (WS-SE) application allows optical network operators to increase revenue without making a large CAPEX and OPEX investment. This open application enables operators to create more consumable networks that support more customers and new go-to-market channels. WS-SE expands 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 WS-SE application and associated customer tenant portals help automate the sale of optical network services by supporting all aspects of the optical service life cycle throughout the business hierarchy involved in selling the services.

WS-SE also contributes service-related data to the WaveSuite data lake. WaveSuite Health and Analytics-based workflows can use this data to troubleshoot the underlying physical network, to identify potential issues before they impact services.

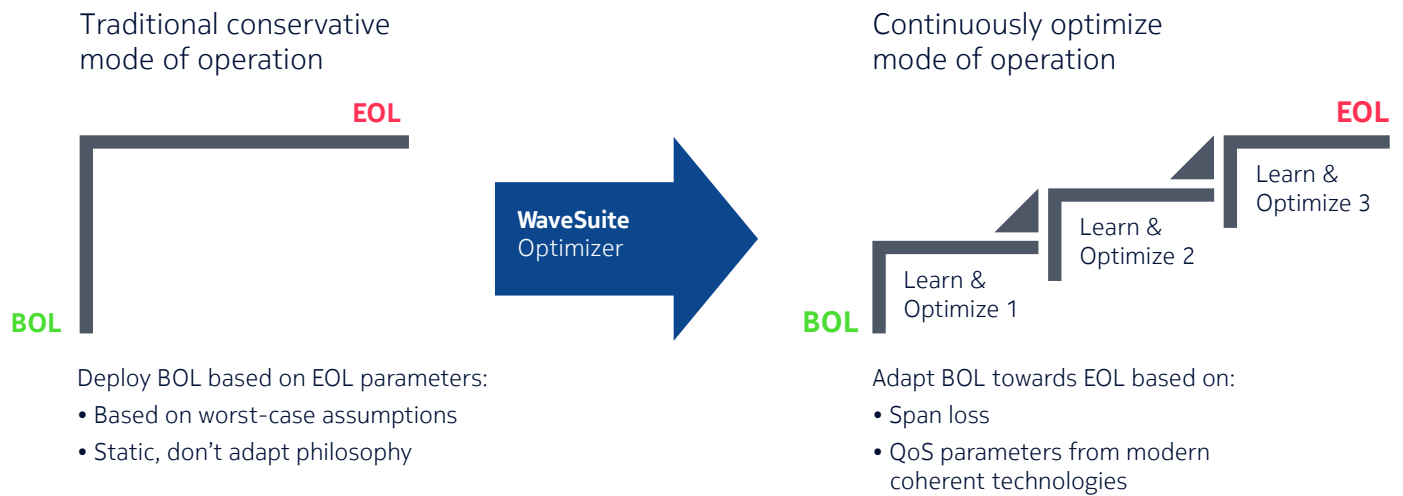
WaveSuite Optimizer

Optical network operators face growing capacity demand, and the cost of addressing these requirements can significantly impact their bottom line. With the introduction of 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 real-time network data within a continuous “learn and optimize” approach that adapts to approaching EOL conditions (see Figure 3).

With the WaveSuite Optimizer application, 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 reoptimization 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 Optimizer: Evolving to a network learn-and-optimize approach



The WaveSuite Optimizer application also ensures that network performance matches initial business objectives defined by the Nokia WaveSuite Planner network planning software. WaveSuite Optimizer helps operators extract more network capacity and value by enabling them to migrate from their current, static, optical networks and operations to more innovative and automated networks and operations.

The WaveSuite Optimizer tools use a proven Nokia network management and control software base to reduce the risk involved in migrating to open SDNs and intent-driven networks.

- **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 WS-HA application to create customized workflow automation that supports wavelength performance tuning with closed-loop operation. This automation allows 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 the Nokia NSP

The Nokia 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 WS-HA to trigger NSP management and control capabilities. For example, workflows can use WS-HA 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
- Communications service providers (CSPs), other network operators and enterprises.

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.

The 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, pre-configured virtual labs plus information about Nokia APIs and use cases.

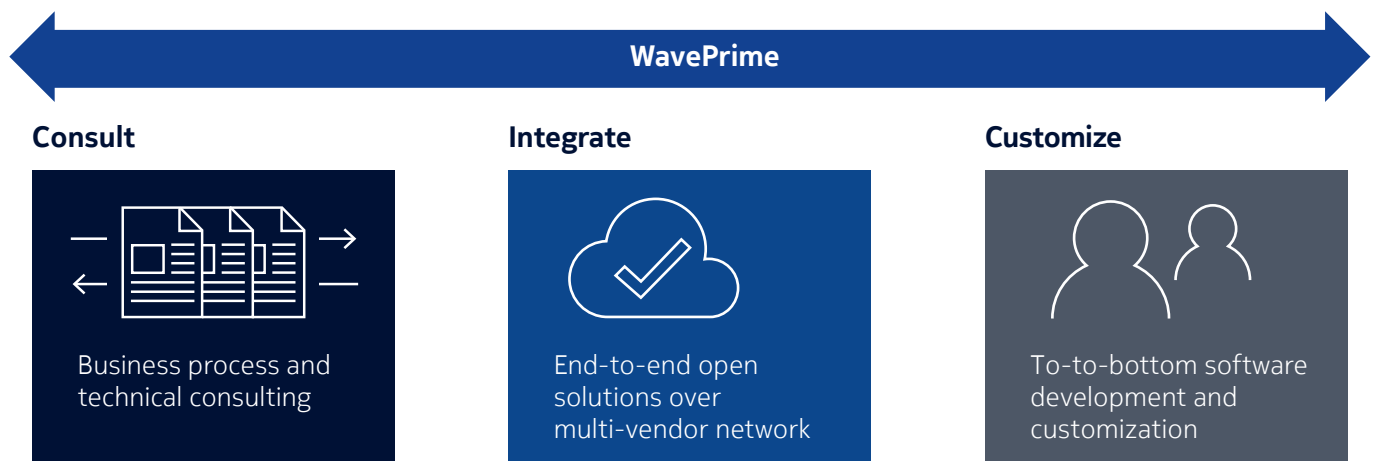
Nokia WavePrime professional services

The Nokia WavePrime professional services team provides expertise, toolsets 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 (see Figure 4). These services include:

- Network modernization and transformation services
- Network operations, administration, maintenance and provisioning (OAM&P) and SDN controller systems integration of optical products and northbound OSS/BSS software
- Network consultation and design
- Business process automation and closed-loop workflow optimization
- Network data intelligence extraction and reporting.

Figure 4. WavePrime: Accelerating automation deployment for business success



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, automation workflows, multivendor equipment adaptors, testing and integration.

The WavePrime services team can create a digital twin of an operator's current or planned physical 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.

Example use case: WaveSuite customized automation

A tier-1 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 wavelengths and act on their deployment.

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

- Nokia WS-HA to intelligently capture data to learn from and proactively monitor wavelength performance. The CSP uses the WaveSuite Optimizer application to explore wavelength optimization and/or rerouting options.
- Nokia NSP: The workflows use the NSP IP/optical cross-domain coordination capabilities to coordinate tasks and network resources across the IP and optical layers.

The use case-based workflows provided the automation environment that the CSP required. They enabled the CSP to:

- Validate its SDN intent-driven architecture and infrastructure
- Increase real-time visibility of its network
- Use predictive algorithms to proactively resolve potential service-impacting issues
- Reduce 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.

Abbreviations

AI	artificial intelligence
API	application programming interface
BOL	beginning of life
CAPEX	capital expenditures
CDC-F	Colorless Directionless Contentionless – Flexgrid
CPU	central processing unit
CSP	communications service provider
DCN	data communications network
EOL	end of life
IoT	Internet of Things
IP	Internet Protocol
KPI	key performance indicator
ML	machine learning
NSP	Nokia Network Services Platform
OPEX	operating expenditures
OTDR	optical time-domain reflectometer
SDN	software-defined networking
TCO	total cost of ownership

About Nokia

At Nokia, we create technology that helps the world act together.

As a trusted partner for critical networks, we are committed to innovation and technology leadership across mobile, fixed and cloud networks. We create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

Adhering to the highest standards of integrity and security, we help build the capabilities needed for a more productive, sustainable and inclusive world..

Nokia is a registered trademark of Nokia Corporation. Other product and company names mentioned herein may be trademarks or trade names of their respective owners.

© 2022 Nokia

Nokia OYJ
Karakaari 7
02610 Espoo
Finland
Tel. +358 (0) 10 44 88 000

Document code: 214964 (June) CID207466