Insight-driven optical networks

Automating networks with innovative business and network insights

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.

To stay competitive, these businesses are looking to turn 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’s becoming tougher for businesses to get more value from the network in isolation.

Nokia is addressing this challenge with an insight-driven approach to optical networking. This approach combines unique optical service delivery insights, advanced network telemetry and machine learning-based automation to support programmable actions that meet business, service and network operation needs. Together with professional services that enable rapid automation, it enables optical network operators to build a smart, scalable, automated and secure optical network foundation that can create more value and lower total cost of ownership (TCO).

Building an optical foundation for business success

A successful network can provide the foundation for lowering operational costs and generating new revenue to help fuel innovation for future growth. To create this foundation, optical network operators need:

- Business insight that will help them streamline the optical service lifecycle and create a differentiated customer experience
- Network insight that will enable them to use machine learning-based automation to make network optimization simpler, streamline operations and predict network-impacting failures
- The ability to link network and business insights so they can keep customers throughout the optical service value chain informed of service-impacting network events and their resolution
- The ability to rapidly deploy automation

Addressing new customer expectations

Many optical network operators support internal and external customers. Increasingly, external customers expect network connectivity services to be as consumable and instrumented as cloud services. They want to accelerate the delivery and activation of service-supporting equipment and get improved notifications and tracking for service-related issues. Internal customers want to streamline the consumption, delivery and instrumentation of their partition, or slice, of the optical network.
Customers of both types may also want the ability to deliver the same consumption, delivery and instrumentation capabilities to their customers in cases where optical connectivity is passed up a hierarchical service value chain.

Figure 1. Optical services must become as consumable as cloud services

Figure 2. Hierarchical optical service value chain
Meeting new network performance demands

To build a successful services business, optical network operators need a programable, high performance, scalable and secure network that keeps TCO low. High-performance networks maximize network capacity, minimize latency and detect network issues proactively, before they impact service-level agreements. When failures do occur, high-performance networks are faster to repair, and keep customers throughout the optical service value chain up to date on service status.

Nokia Insight-driven optical networks

Nokia insight-driven solutions help give network operators the control they need to turn their networks into open, consumable platforms that create value with automation that optimizes network performance, simplifies operations and accelerates network monetization and service deployment. This automation reduces TCO, improves ROI and streamlines the delivery of differentiated revenue-generating services.

Nokia supports these insight-driven solutions with four key initiatives:

• WaveFabric, a portfolio of high-performance, application-optimized equipment that provides the network scale and programmability that network operators need to keep up with growing bandwidth and service demands.

• WaveSuite, a set of open applications and network management and control options that help operators get more value from the network. These applications enable rapid network monetization and enhance the customer experience throughout the optical service value chain. They can also help optical network operators use machine learning to automate and optimize their networks.

• WaveHub, a market-oriented ecosystem program that enables operators to collaborate with a global community of partners to accelerate new network value creation and minimize network TCO. The ecosystem is supported by a remotely accessible lab environment that enables members to model and experiment with a network digital twin.

• WavePrime, a professional services offer designed to help all optical network operators create SDN-ready optical networks and achieve their automation business goals.
Together, these initiatives enable network operators to support new approaches that further improve business outcomes and rapidly deploy automation for network expansion, optimization and monetization.
A model that understands the optical service value chain

The foundation for the insight-driven optical networking approach is a patented software model that understands the business of delivering and selling optical services. The model covers the hierarchical optical service business value chain that extends from the physical network operator to its customers and its customers’ customers. For example, a physical network operator can use software modeled around this hierarchy to quickly advertise and distribute capacity to internal business units and/or external partners. These entities can then quickly distribute this capacity to regional sales forces to monetize it.

This hierarchical model is a foundational pillar of the WaveSuite applications, which enable optical service automation, deployment and troubleshooting. Together, these open applications provide tools that facilitate new service innovation, service lifecycle automation and service differentiation throughout the optical service value chain. Nokia can also provide underlying foundation for these applications with WaveSuite network management and SDN control options.

Figure 5. Nokia WaveSuite - an insightful optical services value chain model
WaveSuite: Automation that creates value for operators and customers

By leveraging this hierarchical value chain model, the WaveSuite Service Enablement applications provide the tools that optical network operators need to improve service monetization, instrumentation and quality of experience for internal and external customers, as well as their respective customers.

Automated service monetization

WaveSuite Service Enablement applications help optical network operators 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 revenue potential by using the hierarchical value chain 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. When the partner sells services to its customers, the physical network operator gets revenue without having to be involved in the partner’s business transactions. The WaveSuite Service Enablement software and associated end-customer web portals help streamline the sale of optical services by supporting all aspects of the optical service lifecycle throughout the business hierarchy.

Machine learning and network automation

The WaveSuite Network Insight applications and data lake environment help optical network operators accelerate the use of machine learning to automate their networks. Operators can use the capabilities of the data lake environment to securely gather network data and explore new ways to apply machine learning to a broad range of optical networking topics. Data related to equipment streaming telemetry, network topology, analog and digital KPIs, environment telemetry and other WaveSuite applications is used to create a comprehensive data lake from which machine learning models can learn. Operators can also consult with experts from Nokia Bell Labs, who can help match algorithms with data to maximize the accuracy of machine learning prediction, classification and detection.

The WaveSuite Network Insight Health & Analytics application wraps machine learnings in a user-friendly, open, wrapper to facilitate their deployment and operation. To support the creation of workflow automation, interfaces to the following capabilities can be used to trigger desired outcomes:

- other Nokia WaveSuite apps
- Nokia management and control software, including Network Services Platform (NSP) IP/Optical multi-layer, cross-domain and end-to-end coordinated management of IP routing and optical transport assets
- Nokia WavePrime networking planning software
- third-party software

The Nokia WaveHub labs environment can be used to create an optical network digital twin to test the impact of workflow automation and machine learning outcomes on a virtual network before they are deployed live. Nokia WavePrime professional services can also be called on to help develop and customize workflow automation for unique network environments.
WaveFabric: Programmable equipment that transforms optical networks

In an era of SDN and white boxes it’s easy to overlook innovation leadership. Embracing open networking shouldn’t 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.

Figure 7. WaveFabric characteristics and components

Massively Scalable
Photonic scale
Electro-optic scale
Switching scale

Openly Programmable
Hardware & services
Zero-touch operations
Automation-ready

Better Wavelengths
More Wavelengths
Efficient Wavelengths

High Performance
Spectral efficiency
Deterministic
Application-optimized

Secure
Encrypted
Intrusion detection
Resilient
**Massive scalability and high performance**

WaveFabric provides the three key elements that operators need to scale their optical networks: better wavelengths to optimize capacity and reach, more wavelengths per physical fiber, and efficient wavelengths that are optimally packed with traffic and can be dynamically routed throughout the network.

**Better wavelengths**

Wavelengths powered by a coherent digital signal processor (DSP) are at the heart of every optical network. The 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 effort correction (FEC), fine-granularity baud rates and reduced power consumption. These capabilities enable operators to address their capacity needs in an optimal way.

**More high-performance wavelengths**

The C-band (1530 nm to 1565 nm) of optical frequencies has traditionally been used for WDM fiber optic systems because of the combination of low fiber loss and the availability of efficient, cost-effective erbium-doped fiber amplifiers (EDFAs) in this band. It supports up to 96 channels with standard 50 GHz spacing for each channel.

One option for operators seeking additional capacity is to use flexible grid WDM systems, which support flexible channel sizes as small as 37.5 GHz. The smaller channel sizes enable operators to provide up to 120 channels in the C-band, but with some trade-offs. As the channel spacing decreases, so does the optical reach, which results in a better fit for the smaller-sized channels on metro networks than on long-haul routes.

An alternative approach that provides additional capacity at all optical reaches is the use of L-band (1565 nm to 1625 nm) optical frequencies. The L-band shares many characteristics with the C-band, including low fiber loss and availability of EDFA technology for amplification. The Nokia Ultra-Wideband Wavelength Routing solution allows operators to double available network capacity on the same fiber pair. It enables the use of both C-band and L-band optical frequencies, providing up to 192 channels. The flexible pay-as-you-go modular C+L architecture allows operationally simple upgrades. And, Nokia automated, self-tuning networks ensure simple, worry-free upgrades and operations. Support for SDN and/or GMPLS wavelength control options also enables the solution to deliver more wavelengths with more agility to rapidly deploy, protect and restore services.

**Efficient wavelengths**

New packet and OTN initiatives such as Flex Ethernet (Flex-E) and Flex OTN (Flex-O) are redefining the way client services are mapped to transport DWDM wavelengths. 5G cell site aggregation requires Time Sensitive Networking (TSN), a new low-latency Ethernet networking approach to fronthaul and midhaul. Many network operators need to prepare their networks to support these initiatives.

The WaveFabric equipment portfolio uses card-, shelf interconnect- and fabric-based packet networking capabilities to achieve the right level of performance for a variety of deployment options. This wide-ranging equipment portfolio leverages the same Service Router Operating System (SR OS) as the Nokia IP/MPLS portfolio and common open interfaces to reduce the operational complexity of service deployment from end to end.

Operators can generate significant CAPEX savings by efficiently packing wavelengths with client services, and then optimizing the networking of client services through ROADM, OTN and/or Ethernet switching. However, this approach requires equipment that can provide the right mix and scale of ROADM, OTN...
and packet switching for each specific deployment application. The WaveFabric portfolio addresses this requirement for fronthaul, midhaul, backhaul, metro/regional aggregation, long-haul core and submarine line terminal equipment (SLTE) applications.

Nokia also provides GMPLS extensions for wavelength and OTN multilayer networking. These extensions make service transport more efficient by streamlining the interaction between network layers to reduce service delivery times and operational costs. They also support tiered service availability levels using wavelength, OTN and/or multilayer restoration capabilities, which enable more service options and optimal use of network resources.

**Open programmability**

WaveFabric equipment supports open interfaces that bridge the gap between traditional optical networks and SDN. Nokia recognizes the need for open agent flexibility to support 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 optical data communications network (DCN).

Optical network environments require application-specific equipment form factors and interfaces. The WaveFabric portfolio packages innovative technology in several different form factors to minimize network total cost of ownership. It also supports common open interfaces across these form factors. This helps operators minimize the complexity associated with operations and integration planning and evolve between different form factors if required.

**Strong security**

Confidential data generated and transmitted across networks is becoming increasingly attractive to thieves and intruders. The Nokia Secure Optical Transport solution protect the network's fiber infrastructure from attack by implementing transport wavelength encryption. It ensures that strong, quality keys are used in encryption generation by using the Nokia 1830 Security Management Server to provide centralized key management for the entire cryptographic lifecycle of each encrypted service.

**WaveHub: An ecosystem program that accelerates innovation**

To survive and thrive, optical network operators need continuous innovation that will enable them to extract more value from the network and lower operating costs. Nokia WaveHub is a market-oriented ecosystem program that brings network operators together with hardware and software vendors, research institutions, system integrators and other innovators develop new ways to create value. This global 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

Nokia manages WaveHub using the Nokia Open Ecosystem Platform, or OpEN, a purpose-built collaboration environment. WaveHub encourages an agile, mock-up driven, iterative, fail-fast experimentation process. It also supports traditional and DevOps delivery models.
Virtual lab environment
WaveHub Labs provides an alternative to in-house development labs. It focuses on reducing time to revenue by helping network operators reduce cost and complexity while enabling more rapid integration testing and solution development.

Developer portal
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, on-demand virtual labs, information about Nokia APIs, and use cases.

Innovation marketplace
The WaveHub Innovation Marketplace is a digital storefront for solutions created through the WaveHub ecosystem. It enables new value chains and go-to-market opportunities.

WavePrime: Professional services that enable rapid automation
The Nokia WavePrime services team provides expertise, tool sets and best practices to help network operators build insight-driven communications networks that protect and grow 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

WavePrime services enable operators to turn their networks into secure, efficient and resilient infrastructures with open interfaces and multivendor support. The services use a business outcome-focused methodology to ensure 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 optimize its physical production network.

Activities that can be efficiently carried out in the digital twin environment include:
- Business and network modeling
- Design and Integration
- Training
- Testing and homologation
- Assessments and audits
- Simulation and what-if analysis
- Disaster recovery
- Application development

A complete network services portfolio
In addition to WavePrime professional services, Nokia offers a comprehensive suite of network lifecycle services that features:
- Maintenance and care services, including troubleshooting, repair or exchange, and issue resolution
- Learning services, including training and certification for our IP and optical products and solutions
- Deployment services, including site selection, installation, commissioning and decommissioning
Summary

A successful network provides its operator with a foundation for lowering operating costs and generating new revenue to fuel innovation for future growth. Nokia insight-driven optical networking helps operators achieve this success with an industry leading innovation and portfolio, open applications that 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 fuel new automation innovation.