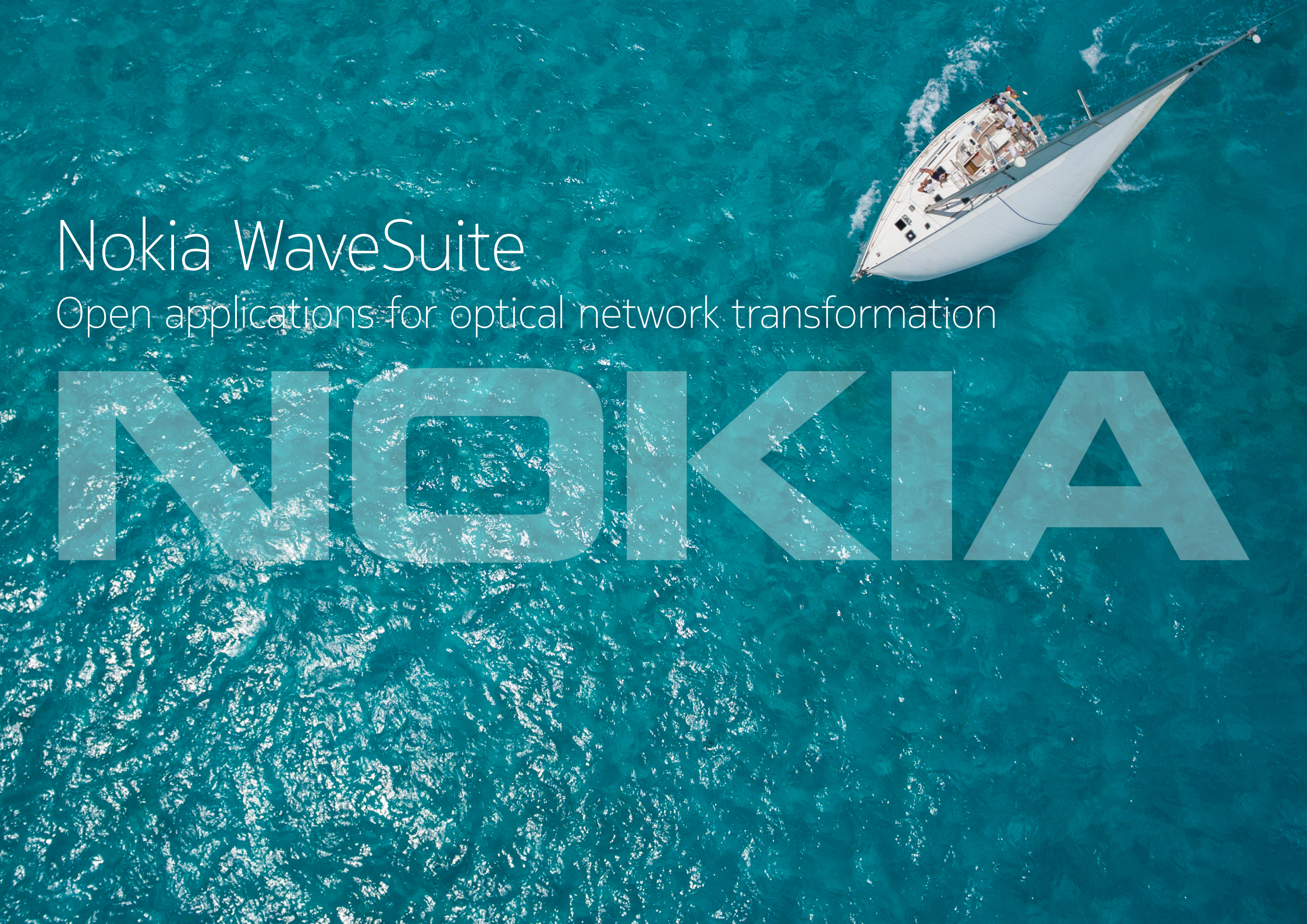


Nokia WaveSuite

Open applications for optical network transformation

NOKIA

As a network leader, you know that your optical network needs to adapt to a new communications era driven by bandwidth-intensive applications. Communications that link people, machines and things are introducing new requirements for network scale, agility and connectivity. Nokia WaveSuite lets you address these requirements with a simplified, network that increases operational efficiency, optimizes CAPEX and generates new revenue.

Transforming networks for success

The rise of digital technologies is creating unprecedented opportunities for optical network operators. By intelligently connecting people, machines and data, you can enrich the customer experience, generate new revenue, control CAPEX growth and make your operations ultra-efficient. But you need the right tools.

Nokia WaveSuite applications enable you to use automation to monetize your optical network, operate it more efficiently and optimize its performance. Based on open networking initiatives, our WaveSuite applications jump-start your digital transformation by enabling you to move to a more scalable, agile, deterministic and secure network. They provide focused, lightweight tools and success-based economics, all driven by a business-optimized user experience.

WaveSuite Service Enablement helps you increase revenue without making a large CAPEX investment. This open application lets you create a more consumable network that supports more customers and new go-to-market channels. It expands your revenue potential by using our patented B2B2X business relationship-aware software models to virtualize the network and support new services and business partnerships based on the optical network as a service (NaaS) shared economy business model. Our optical NaaS implementation goes beyond traditional VPN service models by adding hierarchy to enable virtual network operators at each level to define and independently sell a wide range of optical network services.

WaveSuite Service Enablement can also support optical network services based on packet utilization. These services are ideal for addressing the connectivity demands of the cloud era. WaveSuite Service Enablement also simplifies your operations by automating service fulfillment to establish optical network service connectivity, even for enhanced service types that demand low latency and high availability. For high-availability services, your optical network service customers can use the application to get an abstract map view of the primary and protection routes.

WaveSuite Health and Analytics uses real-time network intelligence to help you make smarter decisions about your business, operations and infrastructure. They combine Nokia

Bell Labs optical network and data science expertise and automation algorithms to maximize the performance of fiber optic links and wavelengths and protect service-level agreements (SLAs) by predicting issues before they happen. They also help you monitor and reduce network power consumption. You can select different levels of automation to suit your operational environment.

WaveSuite applications for network design, operations and control help you respond quickly to fast-changing optical network demands, simplify your network management, get the most from optical network resources and ensure maximum service performance and availability. They build on our open, modular and proven network management and control software base to reduce the risk of migrating to open software-defined networking (SDN) and automation.

These applications address your need for more responsive, efficient and reliable networks by providing:

- An open programmable management platform that enables your engineers and developers to automate network operations and ease integration with orchestrators and operations support systems (OSS)
- Resource control capabilities that let your network engineering and operations teams visualize network topology, support multivendor network initiatives, control the network and discover optimal network service paths in real time
- A complete suite of ready-to-use applications that help your network operations teams cover automation use cases for network management, optimization, capacity reservation and calendaring, equipment integration, provisioning and planning

You can deploy WaveSuite applications alone or together. When deployed together, the applications enable you to extract more capacity from the network, monetize this capacity instantly and increase operational efficiency. Nokia WavePrime professional services offers customization, workflow adaptation and consulting expertise that can help you deploy WaveSuite applications and quickly realize your automation goals.

WaveSuite applications support open northbound and southbound interfaces. They can run in multi-vendor environments or Nokia environments, which support some of the industry's most advanced networking capabilities.

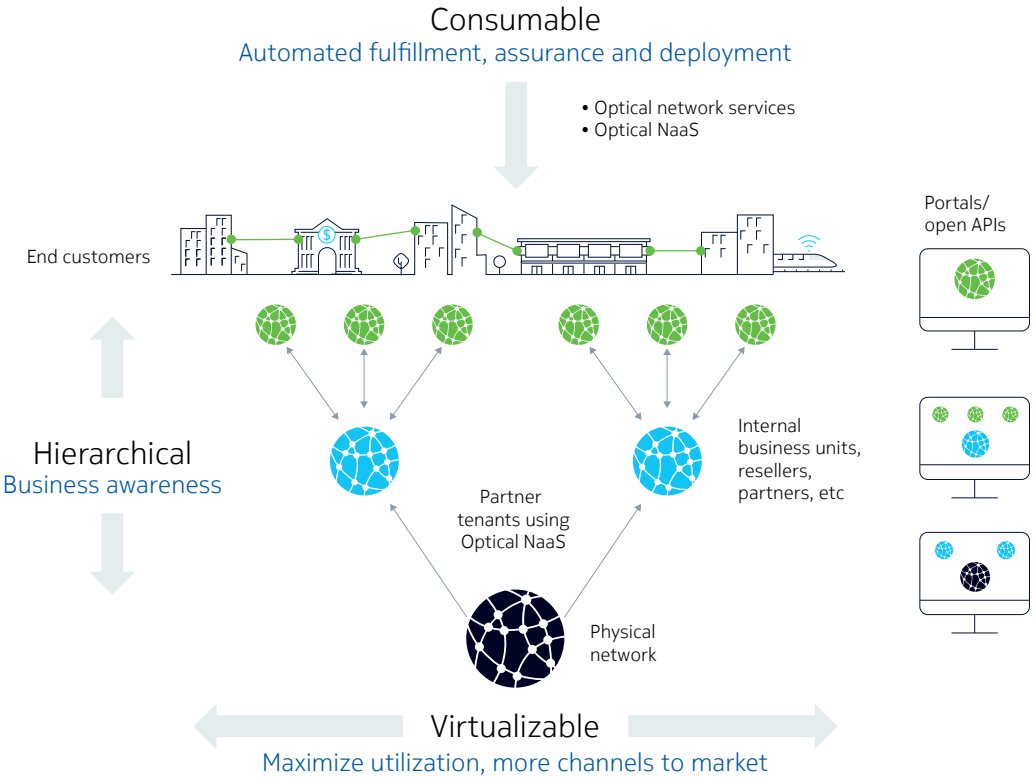
Service enablement with business awareness: Creating a more consumable network

A communications innovation explosion has transformed business interactions. Connectivity is now essential for business success. Network wholesalers need to get bandwidth into the hands of their customers quickly to extend their retail reach and empower the middle layer of wholesale network consumers that depend on connectivity for their business success. In an increasingly competitive world, many enterprises can't afford the cost and complexity involved in running an optical network. Enterprise applications represent new optical NaaS opportunities for optical network operators.

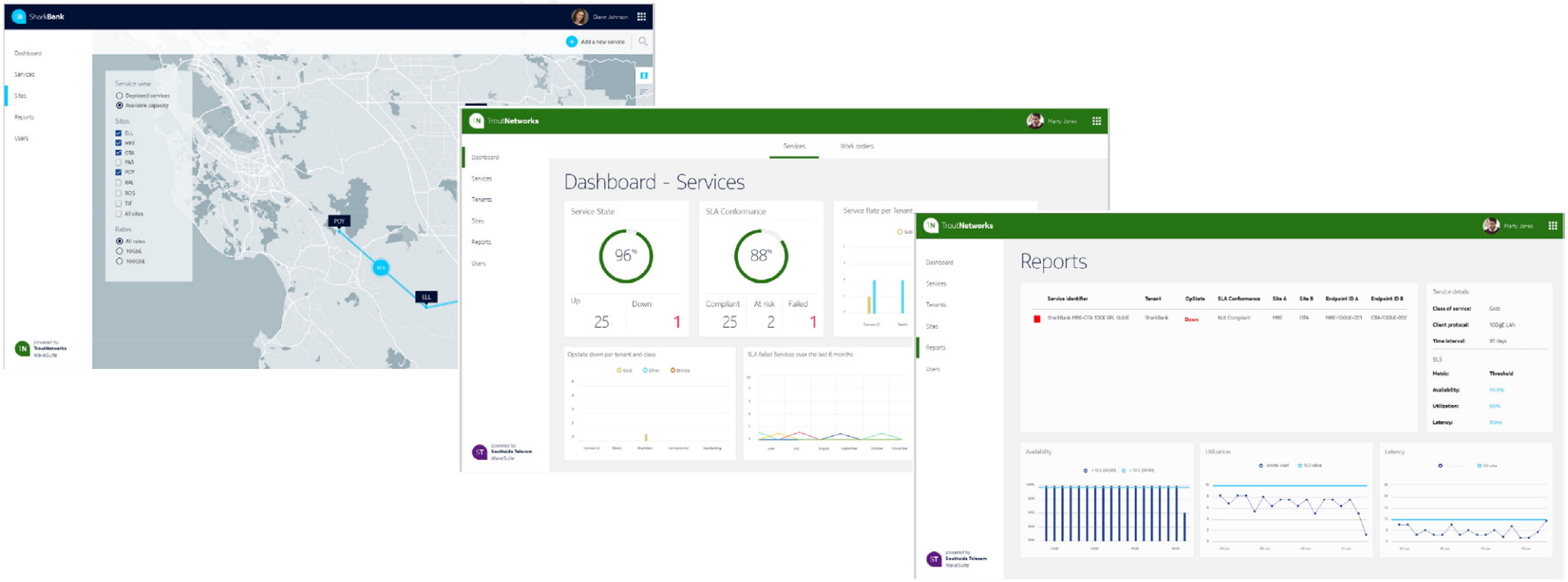
WaveSuite Service Enablement uses hierarchical relationship-aware B2B2X business models that allow each business layer to focus on what it does best. As an optical network operator, you can use this software to run a massive network, sell wholesale and retail services, or operate a cloud network that requires scalable and flexible customer connectivity. It enables you to partner more easily with IT systems integrators, cloud operators and carrier-neutral providers that have their own unique and varied end customer channels.

You can also use WaveSuite Service Enablement automation to get optical network services into the hands of your internal organizations. This reduces optical network service delivery time from weeks to minutes. As an owner and operator of physical optical network infrastructure, you are at the root of the tenancy hierarchy. At the hierarchy's intermediate levels, the service providers are virtual network providers that resell virtual connectivity to other virtual network providers or end subscribers using independent and secure hierarchical user views for service fulfillment, assurance and inventory.

Business relationship-aware hierarchy and portals



Views of partitioned virtual slices of optical connectivity using WaveSuite fulfillment, dashboard and assurance portals



You can also use WaveSuite Service Enablement to support new optical network services based on packet utilization. These services are ideal for subscribers who periodically have high packet utilization requirements and provide opportunities to upsell service capacity as the need for bandwidth grows. They are also ideal for high-capacity subscriber traffic with low packet statistical multiplexing gains (e.g., video, voice). You can use them to complement Carrier Ethernet and IP VPN packet services to keep your network scaling costs low.

The combination of WaveSuite Service Enablement and Nokia WavePrime service-led automation expertise can allow you to bypass the massive effort and complexity involved in adapting back-office systems to support new services. A lightweight and extremely focused solution for optical services, WaveSuite can drive transformation in this area and keep you from having to take on a much larger and more expensive project.

Ultimately, WaveSuite Service Enablement allows you to increase revenue by evolving to a more consumable and cost-effective network that supports more customers and channels to market. Customer service portals and open APIs for fulfillment, assurance and inventory functions facilitate the automation of service lifecycles at all levels of the service enablement network hierarchy.

Health and Analytics: Maximize your network's potential

In an environment of intensely scrutinized budgets, many optical network operators are looking for economical ways to address the growing bandwidth demands of an increasing connected world. They want a safe and agile approach that can run the network at maximum potential, enable automation and learn intelligently.

The WaveSuite Health and Analytics application puts Nokia Bell Labs artificial intelligence and machine learning algorithms and advanced analytics in an open wrapper that makes it safe and easy to automate optical networks and maximize their efficiency and potential. Together with WaveSuite Optimizer, it can intelligently and automatically shape wavelengths or optimize optical links to ensure the best possible network performance and availability.

WaveSuite Health and Analytics is supported by pre-integrated use case workflows that ease its introduction into operational environments. It uses streaming telemetry, historical big data records, performance monitoring, trending analysis, prediction and machine learning to proactively analyze, classify and predict network behavior and monitor network health.

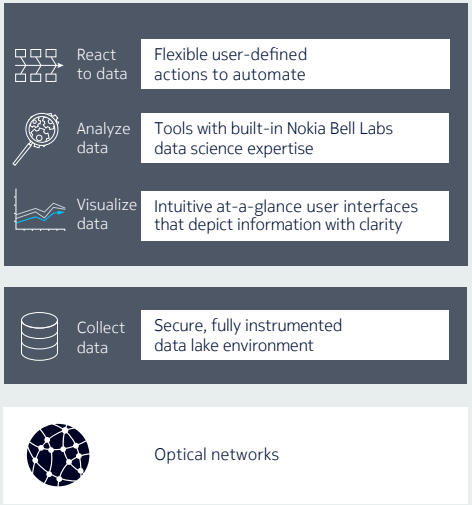
With WaveSuite Health and Analytics, you can:

- Securely and efficiently collect data from a variety of sources and use it to train machine learning-driven algorithms to automate your network more effectively
- Intuitively visualize network key performance indicator (KPI) data with at-a-glance user interfaces that provide the clarity required for automation
- Quickly analyze data to identify network fiber types and enable efficient, safe automation
- Intelligently react to the network insights hidden in optical network data

You can use these insights to drive business outcomes though automation that:

- Maximizes network performance to reduce overall total cost of ownership (TCO)
- Detects and classifies anomalies to quickly diagnose issues in the network and protect SLAs
- Detects environmental signatures that threaten the network
- Proactively maintains the network based on degraded optical link KPIs
- Predicts future network capacity needs
- Predicts and lowers network power over-consumption (hotspots)

WaveSuite Health and Analytics: Intuitive expert tools for optical network insight



Extract valuable network data insights

- Create reliable performance indicators to drive automation
- Visualize and analyze data with easy-to-use tools
- Benefit from comprehensive KPI support

Maximize network performance

- Reclaim margins to maximize network performance
- Monitor power consumption
- Enable network optimization automation to reduce network TCO

Protect SLAs

- Avoid service delays, outages, and loss of data
- Automatically forecast and orchestrate maintenance
- Proactively keep network infrastructure safe

Network design, operations and control automation: Maximize operational efficiency and network resources

The WaveSuite network design, operations and control applications combine a proven software base with our decades of optical networking experience and expertise. The result is a suite of open applications that automate operations tasks to reduce network TCO.

WaveSuite Network Operations Center

As a network operator, you want to minimize network TCO and differentiate your optical network services by accelerating service deployment, improving SLA compliance and ensuring a superior customer experience. To speed up service deployment, you need automation that can realize connection establishment for SLA attributes such as low latency and high availability. To keep your costs low, you need open interfaces that can make it easier to manage and operate your network and realize your open networking initiatives.

The WaveSuite Network Operations Center (WS-NOC) application addresses these needs by adding more openness and functionality to the Nokia optical network management software. Designed for integration with the Nokia Network Services Platform (NSP), also a modular microservice software framework, it provides optical network OAM, assurance, optimization, path computation and service protection and restoration capabilities that can help you manage your optical network more efficiently.

Deliver optical network services faster

WS-NOC lets you rapidly provision services and connectivity without requiring in-depth knowledge of optical networks. It eases service delivery by providing easy-to-use templates, service profile cloning, rules-based configuration for all service types and bulk operations capabilities.

Automated service connection establishment removes the difficulties associated with implementing service route constraints. These include bandwidth reservation, latency guarantees and disjoint or diverse protection types such as node diversity, port diversity or Shared Risk Group (SRG) diversity.

Service templates simplify and streamline service creation by providing default values for common parameters and allowing for the specification of unique naming and key attributes. Service infrastructure and connection deployment rules enable you to influence automated service creation and path computation processes. You can do this by applying behavioral requirements and constraints to service lifecycle control using policies such as the signal rate, connection shapes of the service infrastructure, protection connection characteristics, deployment node/port terminations and routing rules.

You can also use the WS-NOC open and standard interfaces and data models to communicate with orchestration systems, multivendor network controllers, and the Nokia Network Services Platform (NSP) to simplify the delivery of IP/optical network services.

Protect and restore services

Working together with WaveSuite Planner, WS-NOC lets you differentiate

your optical network services with superior protection and restoration capabilities. WS-NOC supports service protection with a comprehensive GMPLS path computation and restoration functionality based on our industry leading Generalized MPLS Routing Engine (GMRE).

The GMPLS implementation coordinates and optimizes multilayer service connectivity when it establishes, protects and restores L0 and L1 optical transport network (OTN) services. It then reverts to the nominal service route when service connectivity on that route is repaired. The results are faster optical network service restoration and optimal use of network resources. With our GMPLS implementation, you can offer customers different levels of service protection and restoration to grow revenue and get maximum value from your network investments.

Visualize the network with clarity

WS-NOC saves you time with network health and state visualization tools that help you assess your network and accelerate all network management tasks, including:

- Customizable network summary dashboards
- End-to-end service and routing topology views with SLA insights
- Context-sensitive equipment displays that show service and customer inventories
- Intuitive graphical user interfaces (GUIs) that let you monitor, filter and analyze a comprehensive set of performance management (PM) and KPI data at a glance

The alarm surveillance functionality lets you configure, supervise and manage alarm events raised by the network equipment because of hardware failures or mismatches, cabling errors or disconnects, or equipment or service misconfiguration. It manages the storage, listing, acknowledgment and clearing of the current and historical alarms, which are timestamped and grouped according to severity levels. An alarm correlation framework discovers the root causes of the service alarms and allows you to navigate to the network elements with the root faults.

The PM functionality enables the collection and monitoring of statistics and events for network nodes, cards, ports and services. WS-NOC uses this PM data for network analysis and planning, and to implement proactive, forward-looking network optimization and service resizing procedures based on traffic trends and usage patterns. You can configure it to collect PM data at time intervals between five minutes and 24 hours. You can also manage the configuration and monitoring of PM information using PM templates that can be applied to network components, connections and services.

Rapidly integrate equipment

WS-NOC makes it easy to onboard network resources and align them with your network design and physical network. It also lets you perform equipment integration provisioning using classic, REST and model-driven interfaces. It gives all network additions a configuration birth certificate to simplify baseline comparisons as the network ages.

WaveSuite Resource Controller

Evolving to open network initiatives can help you accelerate service deployment and reduce network TCO. To succeed with this evolution, you need an open network resource controller that enables you to make the best use of your network assets and support multivendor and multi-domain networks.

The WaveSuite Resource Controller (WS-RC) application performs multi-domain and multivendor SDN controller functions, and computes paths across optical network domains. It fulfills path connection requests from OSSs and orchestration systems by implementing the required connectivity over physical and virtual network elements. WS-RC helps you prepare for open network initiatives and make your network more flexible and productive by providing open and programmable management that enhances workflows and external business processes through standardized interfaces.

Make the best use of network assets in real time

WS-RC is based on a stateful Path Computation Engine (PCE) architecture and uses various path optimization algorithms to ensure optimal path placement across the optical network. It manages the creation of transport path connections for L1 OTN and L0 wavelength connections. Its topology and path databases are synchronized with the network to enable the connection of transport paths on demand.

WS-RC provides an efficient centralized PCE that supports connection and service parameters such as latency, shared risk link groups (SRLG), cost and impairments of the physical layer. It also supports a time-specific Path Computation Reservation Engine (PCRE) that can keep track of scheduled and calendared events (e.g., maintenance intervals, network upgrades) and enable calendared services with service guarantees.

Leverage full-featured standardized interfaces

WS-RC supports full-featured standardized interfaces that:

- Simplify BSS/OSS integration
- Enable customized workflows
- Enable automation of bulk operations
- Foster common data model communication within the physical network

By supporting T-API, model-driven and intent-based standardized APIs, WS-RC gives you the tools you need to realize your open network initiatives and intended business outcomes.

Enable multivendor networks

WS-RC lets you take full control of open multivendor optical network infrastructure and enable pluggable ZR+ technologies using standardized model-driven southbound interfaces such as NETCONF and RESTConf.

WaveSuite Advanced Diagnostics

The WaveSuite Advanced Diagnostics (WS-AD) application enables you to diagnose and resolve network issues quickly, reduce time to repair and minimize network TCO with a powerful troubleshooting automation engine that integrates diagnostics tools from WS-NOC.

WS-AD enhances the WS-NOC diagnostic tools by automating the anomaly detection process to speed up fault isolation. Users can click once to access the root alarm and click again to locate the fault and see the recommended repair steps.

WS-AD continuously analyses and verifies the dynamic state of the network against intent and policy to ensure connectivity and prevent potential network outages and vulnerabilities before they impact your business. It enforces network security policies and checks for compliance against business rules to reduce security risk and achieve provable continuous compliance. In addition, WS-AD can proactively verify corrective actions to reduce the risk of network failures caused by human error.

Identify and resolve potential network issues quickly with enhanced assurance

WS-AD alarm correlation filters and analysis capabilities help you quickly identify the alarm source, provide a detailed report on all the impacted services, and identify the equipment you need to replace. Workflow troubleshooting capabilities address the alarm lifecycle with:

- Alarm diagnostics
- Visual network failure identification
- Automatic collection of supporting diagnostics
- Recommendations for repair, including policy-driven verification checks to ensure the alarm source is repaired successfully

Precisely locate fiber impairments with integrated OTDR support

WS-AD launches bi-directional OTDR scans for specified alarms and span loss KPI threshold crossings. It uses the OTDR information history to facilitate optical connection trouble-shooting when network issues arise.

Resolve connection issues fast with integrated maintenance and supervision

To help you diagnose optical connection issues, WS-AD automatically creates connection birth certificates and subsequently tracks and timestamps all connection-related events (e.g., connection creation and modifications, alarms raised, failures identified, repairs and re-routing). With WS-AD, you can define maintenance intervals for equipment and fiber spans, along with conditions to be met for the duration of the maintenance interval. WS-AD also provides a sliding time window frame that allows you to coordinate maintenance intervals, calendared connections and network upgrades.

WaveSuite Synchronizer

5G mobile transport networks have stringent frequency and phase/time synchronization requirements. The WaveSuite Synchronizer (WS-S) application provides intuitive tools that let you take control of your entire network synchronization infrastructure and monetize it.

With WS-S, you can address the challenges involved in planning, provisioning, operating, maintaining and providing service assurance for robust and resilient synchronization distribution networks. You can also automate these functions, simplify network operations and ultimately improve synchronization performance.

Easily distribute frequency synchronization and phase/time-of-day synchronization

Effective synchronization management is critical for network synchronization. When something goes wrong in the synchronization chain, it is not humanly possible to sift through the logs – node by node, clock by clock – to identify the root cause, or to inspect the performance monitoring counters on each node to detect a time error degradation. Troubleshooting to identify the downstream impact and other correlated issues is difficult for those who are not SyncE/PTP experts.

WS-S lets you easily distribute IEEE 1588 PTP and ITU-T SyncE frequency synchronization and IEEE PTP phase/time-of-day synchronization. It provides a network-wide view of the synchronization layer and delivers real-time intelligence on the various synchronization elements, KPIs and fault conditions. This allows you to act proactively to avoid synchronization distribution errors in the network, or to quickly localize failures and take corrective actions.

Monetize network synchronization

WS-S helps you monetize your network synchronization infrastructure by providing support for Synchronization as a Service (SyncaaS). Built on a standardizable set of services and service attributes, SyncaaS supports a pure synchronization service that is delivered independently from MEF L1/L2/L3 services. With SyncaaS, you can offer your customers three synchronization service types:

- Frequency/SyncE
- Phase/Time PTP with Full Timing Support (FTS)
- Phase/Time PTP with Partial Timing Support (PTS)

This comprehensive support lets you address all the synchronization requirements of mobile operators. You can grow revenue by offering SyncaaS on its own or by combining it with your mobile fronthaul, midhaul and backhaul services.

WaveSuite Optimizer

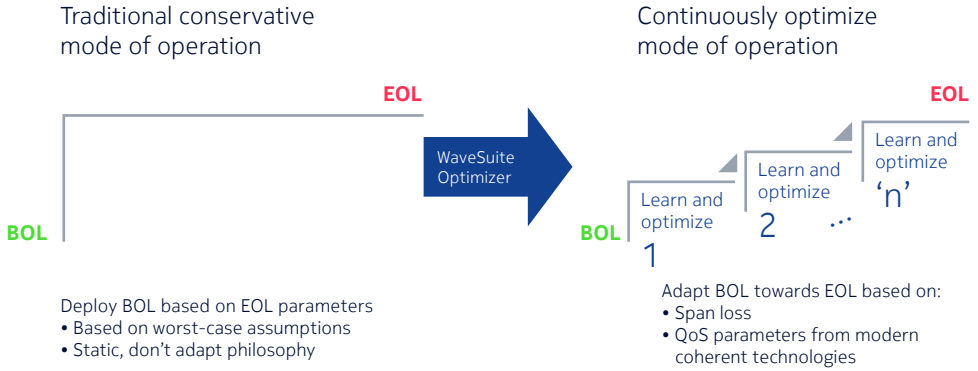
The cost of keeping pace with growing capacity demand can have a big impact on your bottom line. With the introduction of SDN, optical networks will see increased client port speeds and more dynamic service requests. As a network operator, your challenges are to extract maximum efficiency from your network and bridge the gap between where your network is today and where it needs to be in the future.

The WaveSuite Optimizer (WS-O) application helps you use automation to extract more capacity and value from your optical network. It leverages advances in coherent wavelength modulation formats, together with Colorless Directionless Contentionless – Flexgrid (CDC-F) wavelength routing, to enable new approaches to optical network optimization. Instead of defining beginning-of-life (BOL) network infrastructure based on worst-case, end-of-life (EOL) fiber infrastructure parameters, you can now use real-time network data within a continuous “learn and optimize” approach that adapts to approaching EOL conditions.

With the WS-O application, you can use this approach to periodically tune the network to maintain optimal performance and stay ahead of deteriorating network conditions. When EOL conditions eventually threaten network performance, the application can make proactive network re-optimization recommendations that will keep these conditions from impacting service deployment velocity. The result is a more robust and adaptable network that is ready to face the unpredictable nature of SDN service dynamism.

WS-O ensures that network performance matches initial business objectives defined by the Nokia WaveSuite Planner network planning application. Together, these applications help you use network automation extract more network capacity and value.

WaveSuite Optimizer: evolving to a network learn and optimize approach



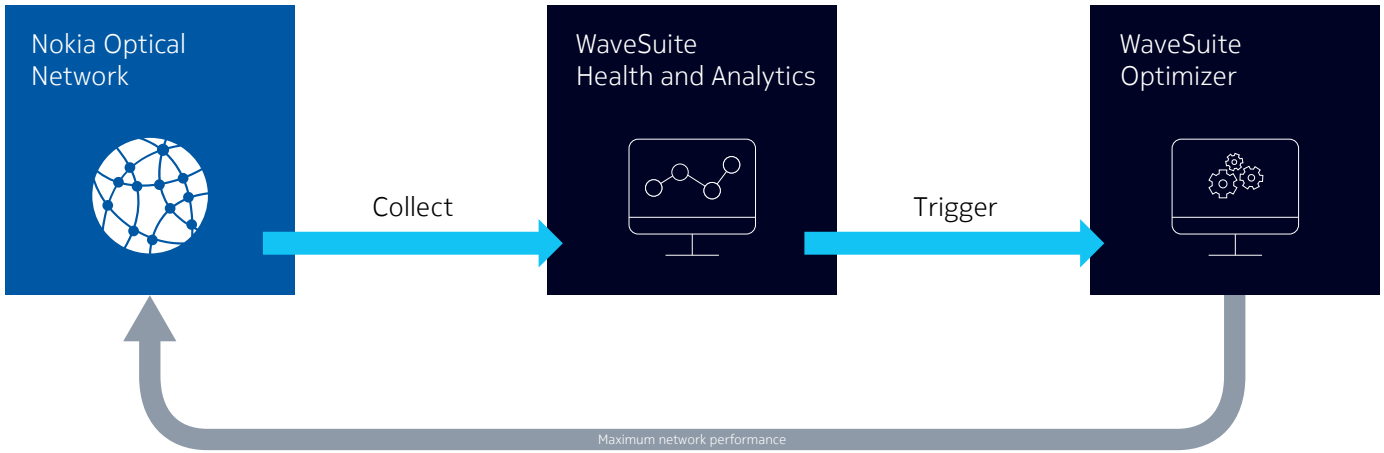
WS-O uses a proven Nokia network management and control software base to reduce the risk involved in migrating to intent-driven SDN. It maximizes network performance with a suite of tools that use automation to free up spectrum, simulate and prepare for the unexpected:

- **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. You can manually adjust these formats if needed.

- **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 wavelength routing based on CDC-F 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 L0 and/or OTN L1 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 your own criteria.
- **Scenario Analysis** performs what-if analysis of current network consumption, extracts key statistics, extrapolates growth trends, identifies bottlenecks and recommends the most appropriate mitigation activities.

You can use these tools with the WaveSuite Health and Analytics application to create customized workflow automation that supports

WaveSuite Health and Analytics and Optimizer



wavelength performance tuning with closed-loop operation. This automation will allow you 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.

WaveSuite Planner

The WaveSuite Planner (WS-P) application helps you extract maximum value from your network investments with intuitive tools that simplify and accelerate multi-phase network design and ensure accuracy with your existing physical network. The application supports all common optical termination points, including card-based interfaces, 400ZR/ZR+ pluggables, foreign wavelengths and multivendor open photonic networks. It is built on a carrier-grade client/server, multiuser planning platform that provides enhanced performance, scalability and usability.

Accelerate network design

WS-P makes it simple to develop multiple network evolution plans and share them among engineers so that they can work together to achieve the best network design. It also identifies the network materials, installation descriptions and cabling you need to expand your network quickly.

Advanced network analysis and optimization capabilities seamlessly interoperate with other WaveSuite applications. This allows you to optimize your network in real time. You can also customize your planning environment by using open APIs to create workflows for your photonic infrastructure and OTN service layers. User administration features let you securely perform system administration tasks such as managing users, user roles and privileges and displaying lists of system notifications, system events and running processes.

Make network design easy

Our ready-to-go customizable templates allow you to use WS-P to quickly create and evolve your network architecture and run feasibility analysis. WS-P also provides a

complete set of features that enable you to quickly and properly plan your network evolution and design your network equipment types, connection topology, traffic engineering parameters, traffic flow routes and traffic protection and restoration mechanisms based on the accurate physical description of the network infrastructure. It automatically generates bill of materials orders and equipment provisioning files to help streamline the network production and operation processes.

Get the ultimate in optical network service protection and restoration

Advanced optical network service protection and restoration can help you stand out from the competition. WS-P protects services with a comprehensive GMPLS path computation and restoration functionality based on Nokia GMRE. It enables you to grow your revenue and maximize your network investments by offering different levels of service protection and restoration.

WS-P emulates network routes according to the network design and verifies the availability of each data connection's main (nominal) and restoration paths based on the defined traffic demand parameters. GMPLS restoration combines path routing and optical layer protection mechanisms such as Sub-Network Connection Protection (SNCP) to enable multilayer resiliency for network services. It is used only for traffic flow requests with the Automatic routing option.

Support multivendor networks

You can extend WS-P to support all common types of optical termination points, including ZR/ZR+ pluggables and foreign wavelengths. You can also plan multivendor networks across open photonic networks by leveraging open planning initiatives that support TIP GNPy models.

We make optical network automation easy

WaveSuite applications use automation to turn your optical network into an open, efficient, consumable platform that creates value for you and your customers. This automation simplifies optical network management and control, reduces network TCO, improves ROI and streamlines the delivery of differentiated, revenue-generating optical network services.

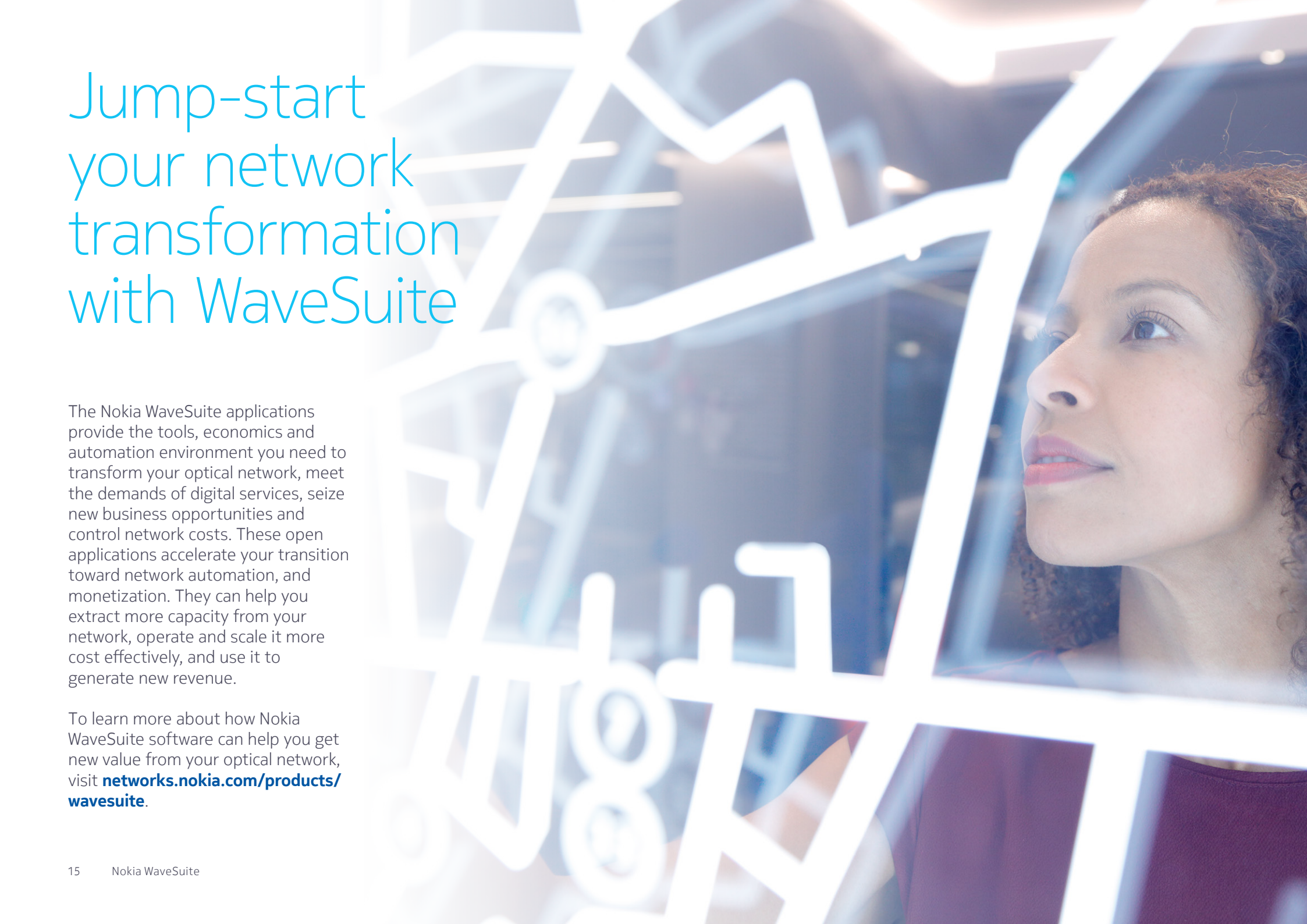
We complement WaveSuite with three initiatives to create an optical network automation environment that supports new approaches and better business outcomes for network expansion, optimization and monetization.

Nokia optical systems
Our portfolio of high-performance, deployment environment-optimized optical network equipment provides the scale and programmability you need to keep pace with growing bandwidth and service demands.

Nokia WavePrime
WavePrime is a professional service offer that can help you achieve your automation business goals and unique customization requirements. The WavePrime team has built predefined workflows and multivendor network adapters that let you connect and use WaveSuite applications to realize and get the most from your automation strategy. WavePrime also offers Digital Twin as a Service, which allows you to use a digital replica of your optical network to train your operational teams, execute project-specific scenario analysis, and accelerate time to revenue for your automation initiatives.

Nokia WaveHub
WaveHub is a market-oriented ecosystem program that enables you to collaborate with a global community of partners to accelerate new network value creation. It is supported by a remotely accessible lab environment that you can use to model and experiment with a pre-configured network digital twin. Ecosystem members also have access to documented APIs, code snippets and tutorials that can be trialed within the lab environment.

Jump-start your network transformation with WaveSuite



The Nokia WaveSuite applications provide the tools, economics and automation environment you need to transform your optical network, meet the demands of digital services, seize new business opportunities and control network costs. These open applications accelerate your transition toward network automation, and monetization. They can help you extract more capacity from your network, operate and scale it more cost effectively, and use it to generate new revenue.

To learn more about how Nokia WaveSuite software can help you get new value from your optical network, visit **networks.nokia.com/products/wavesuite**.

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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.