



NOKIA

Nokia WaveSuite

Optimize, scale and monetize
your optical network

As a network leader, you know 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 platform of applications and resources that make it easy to increase network operational efficiency, scale your network to address changing market conditions and generate new revenue.

Transforming networks for success

The optical transport network forms the backbone of our modern communications infrastructure. But we're asking more and more from it. Increasing demand is driving new transport requirements from the access, edge and core, connecting data centers and both private and public clouds. All sorts of new devices and applications require access, and each has its own specific requirements.

Optical networks are capable of meeting all these new demands. The networking technology is evolving with new capabilities to accommodate these new requirements but it's becoming more complex as a result. Software automation is critical for managing such complex networks, operating them efficiently, growing them seamlessly and using them to generate new revenue.

By adopting the Nokia WaveSuite platform, you can use automation to optimize your network to make it operate more

efficiently, scale it to meet changing demand and monetize it to quickly offer new services and address new customers with new business models. Based on open networking initiatives, WaveSuite applications jump-start your network transformation by enabling you to move to a more scalable, agile, deterministic and secure network. They provide state-of-the-art tools driven by business-driven use case outcomes.

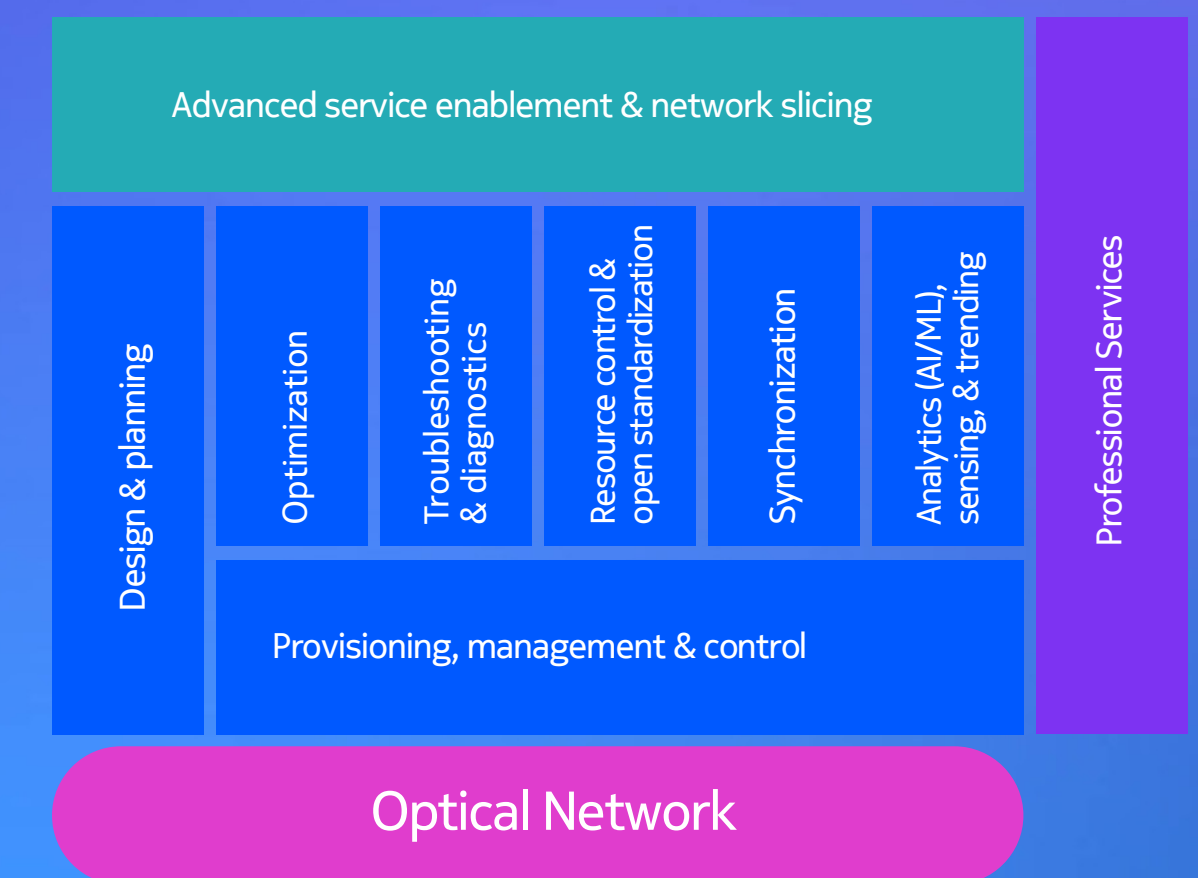
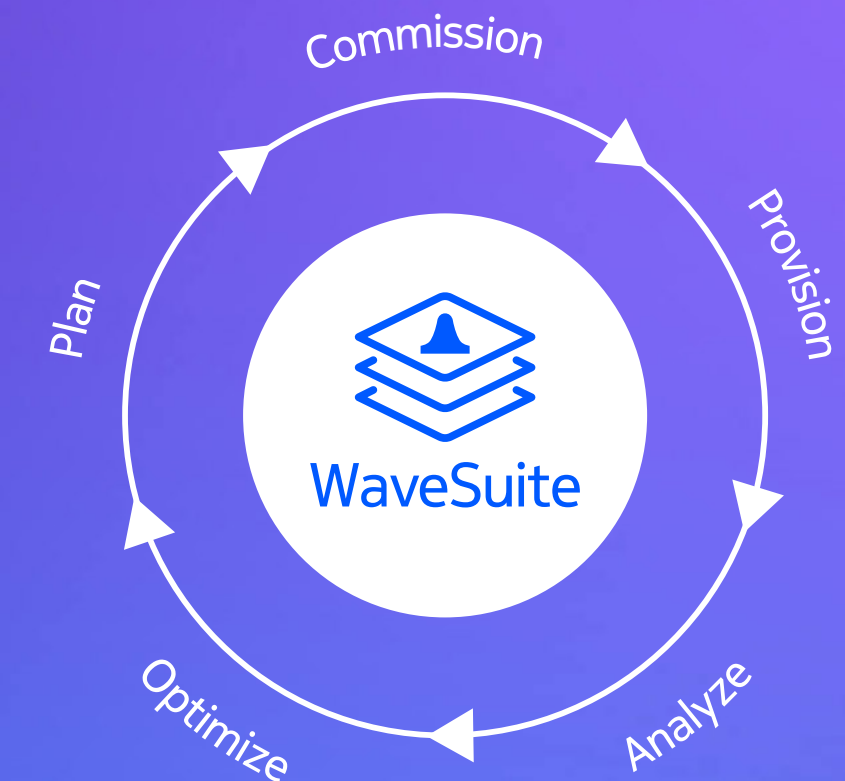


Figure 1 - WaveSuite platform to grow revenue and reduce network TCO

Optimize network performance and operations

Use WaveSuite to deliver the performance, reliability and assurance your customers demand from optical networks. WaveSuite helps you to minimize human error and ensure that your network is set up, monitored and managed for peak capacity and efficiency. This reduces your CAPEX and OPEX.

WaveSuite also helps you improve fault diagnosis and mean time-to-repair to further reduce your OPEX. It provides accurate and streamlined problem resolution so you can deliver on service-level agreements (SLAs) and protect your revenue.

Scale network capacity

WaveSuite ensures that you always have real-time information about network performance and demand trends, and can seamlessly add new hardware and applications. Insights on trends will help you optimize your network and identify potential issues before they occur so you can protect your SLAs. You can also use WaveSuite to protect your network, services and customers from unauthorized access.

When it’s time to scale up, WaveSuite provides a complete status of your network inventory and topology for optical open line systems and coherent terminal end points. You can import this information directly into the WaveSuite planning application, which will help you design, plan and lay out your network more efficiently while ensuring that it makes better use of available resources. WaveSuite can then deploy your chosen configuration directly to the network, streamlining the process and avoiding errors. When new capacity is available, WaveSuite helps you accelerate service order delivery to increase customer satisfaction and shorten time to revenue.

Monetize network assets

WaveSuite can make sure that you get maximum value from your network. It helps you automate service order fulfillment and expose new service types for new or existing subscribers. It also helps you generate new revenue by extending premium value-added services to existing customers.

WaveSuite makes service slicing, spectrum sharing and virtual private network slicing easy and delivers all the assurance you need so you can offer and adhere to strict SLAs. You can also use WaveSuite to monetize your network synchronization capabilities.

Use the Nokia WaveSuite platform to strategically optimize, scale and monetize your network by building tailored network automation solutions for your day-to-day network operations, capacity planning and management processes, as well as automation solutions to rapidly deliver services and maximize revenue.

WaveSuite applications have the network and service automation capabilities you need to address your optimization, scale and monetization business outcomes, while maximizing efficiency, reducing TCO and growing revenue.

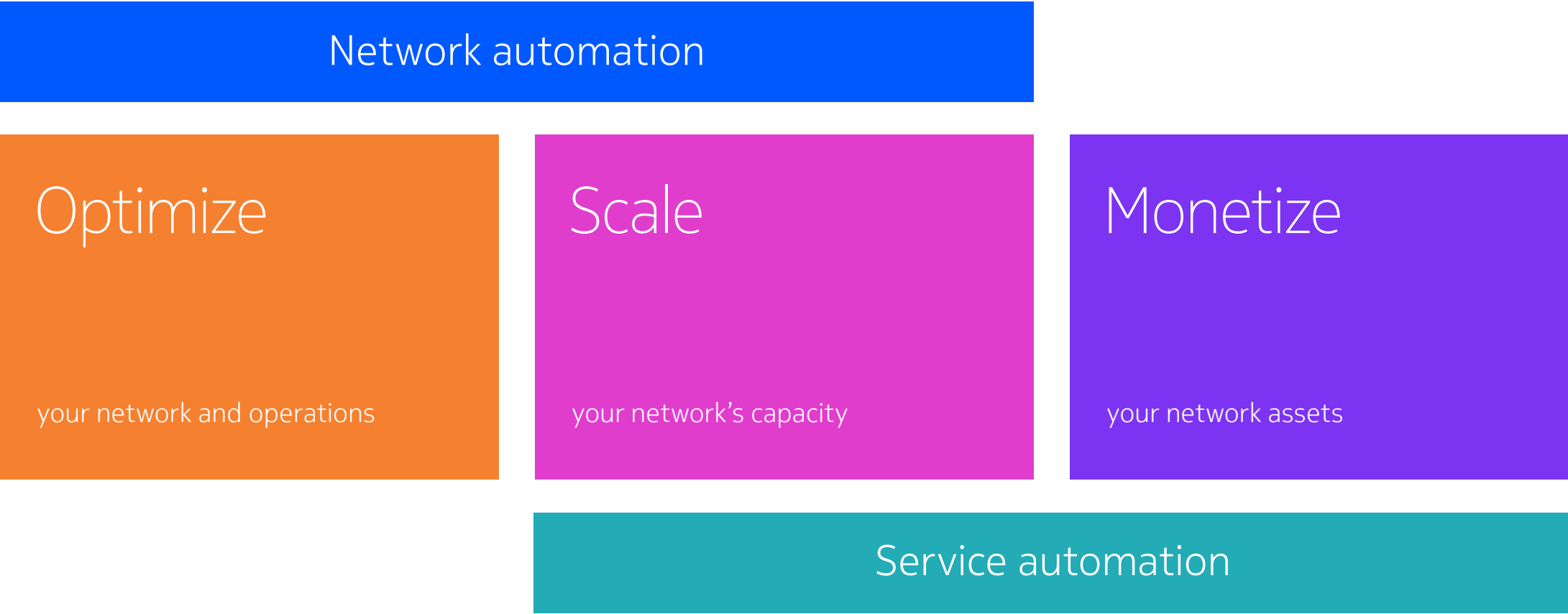


Figure 2: - The benefits of automation for optical networks and services

WaveSuite applications for network automation help you respond quickly to fast-changing optical network demands and simplify day-to-day operations, maintenance and provisioning tasks. They are built on a modular platform using virtualization technology that factors security into its workspace as well as performance as the network grows. The applications adopt many widely used open standards and architectures to accelerate the deployment of your software-defined (SDN) or intent-based networking automation use cases.

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 (OSSs)
- Resource control capabilities that let your network engineering and operations teams visualize network topology, support multivendor and multi-domain network initiatives, control the network and discover optimal network service paths in real time
- Real-time intelligence that helps you make more informed decisions, maximize fiber optic link performance, predict network issues and reduce network disruptions
- A troubleshooting automation engine you can use to rapidly identify and resolve issues before they impact SLAs, and to precisely locate and isolate fiber impairments
- The ability to easily distribute precise frequency, phase and time synchronization information, and to monetize your network synchronization capabilities
- Multilayer “what-if” scenario analysis so you can efficiently manage your optical network to get maximum capacity and value from it, even when unexpected events occur
- Efficient optical network design, planning, layout and analysis so you can simplify the design process across multiple teams, ensure synchronization between network designs and the physical network, and accommodate multiple types of optical termination points

WaveSuite applications for service automation help you increase revenue by exposing differentiated network services to your subscribers and by providing automated service order fulfillment to accelerate service delivery. These open applications let you create a more consumable network that supports more customers and new go-to-market channels. They expand your revenue potential by using patented software models that virtualize connectivity in the network and enable new Network-as-a-Service (NaaS) shared economy business models.

You can deploy WaveSuite applications alone or together. Once deployed, the applications enable you to create automation solutions to optimize the network for optimal performance and efficiency, scale the network to match capacity to market demands and monetize capacity instantly. Nokia Professional Services offers customization, digital process automation using workflows, network emulation environments and automation consulting expertise that can help you realize your automation solutions and quickly achieve your desired business outcomes.

WaveSuite applications support open interfaces, so you can run them in IP/optical environments or with multivendor hierarchical controllers and integrate them seamlessly with OSS/BSS platforms.



WaveSuite applications for network automation:

Maximize operational efficiency and scale with ease

WaveSuite combines a proven software base with our decades of optical networking experience and expertise. The result is a set of powerful, open applications that automate operational tasks to reduce your network's total cost of ownership (TCO).



WaveSuite Network Operations Center

As a network operator, you want to minimize network TCO and differentiate your optical network service delivery by accelerating service deployment, improving SLA compliance and ensuring superior customer experience. To speed up service deployment, you need automation that can provision connections for specific SLA attributes, such as low latency and high availability.

The WaveSuite Network Operations Center (WS-NOC) application addresses these needs by adding more functionality to the Nokia optical network management software. WS-NOC is designed for integration with the Nokia Network Services Platform (NSP), a suite of applications you can use to automate, manage and control IP and optical networks to boost operational efficiency and service velocity. NSP helps your network operations teams to cover all network management, orchestration and control use cases. It also provides SDN control to optimize traffic and an open programmable platform to ease integration with orchestrators and OSSs.

The WS-NOC application functionality provides optical network OAM, assurance, fault management, path computation, and salient reporting and visualization capabilities that can help you maintain your optical network infrastructure and resources efficiently while keeping them secure.



Deliver optical network services faster

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

WS-NOC adheres to the template-based design, deploy, operate and administration (DDOA) provisioning model. This model enables users to execute specific network provisioning tasks to customize the infrastructure and service connection requirements of a particular network site. You can use DDOA to get status updates on the deployment state of the intended connection, along with the necessary views of your network map, equipment and alarms. The DDOA model puts all administrative functions at your fingertips so you can seamlessly perform backups, monitor your systems and manage user profiles.

Enhanced service offers

WS-NOC helps differentiate your optical network services with superior protection and restoration capabilities, and by providing diverse, disjoint and latency-aware service capabilities. It supports service restoration with a comprehensive GMPLS path computation functionality based on our industry-leading generalized MPLS routing engine (GMRE). When combined with optical switching capabilities on the line system, WS-NOC also supports a mix of protection and restoration to ensure SLA adherence.

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.

WS-NOC also provides provisioning templates to support a mix of network domain types. Whether your network adopts a full GMPLS control plane, a managed plane or a mix of both domains, WS-NOC creates end-to-end services to ensure that traffic seamlessly passes between them.

New services that have strict SLAs or demand very low latency will require routes in the optical network that meet those specific requirements. WS-NOC supports these service intents and offers easy-to-use service templates to help you provision and deliver services faster. It enables you to offer your customers different levels of enhanced services so you can grow revenue and get maximum value from your network investments.



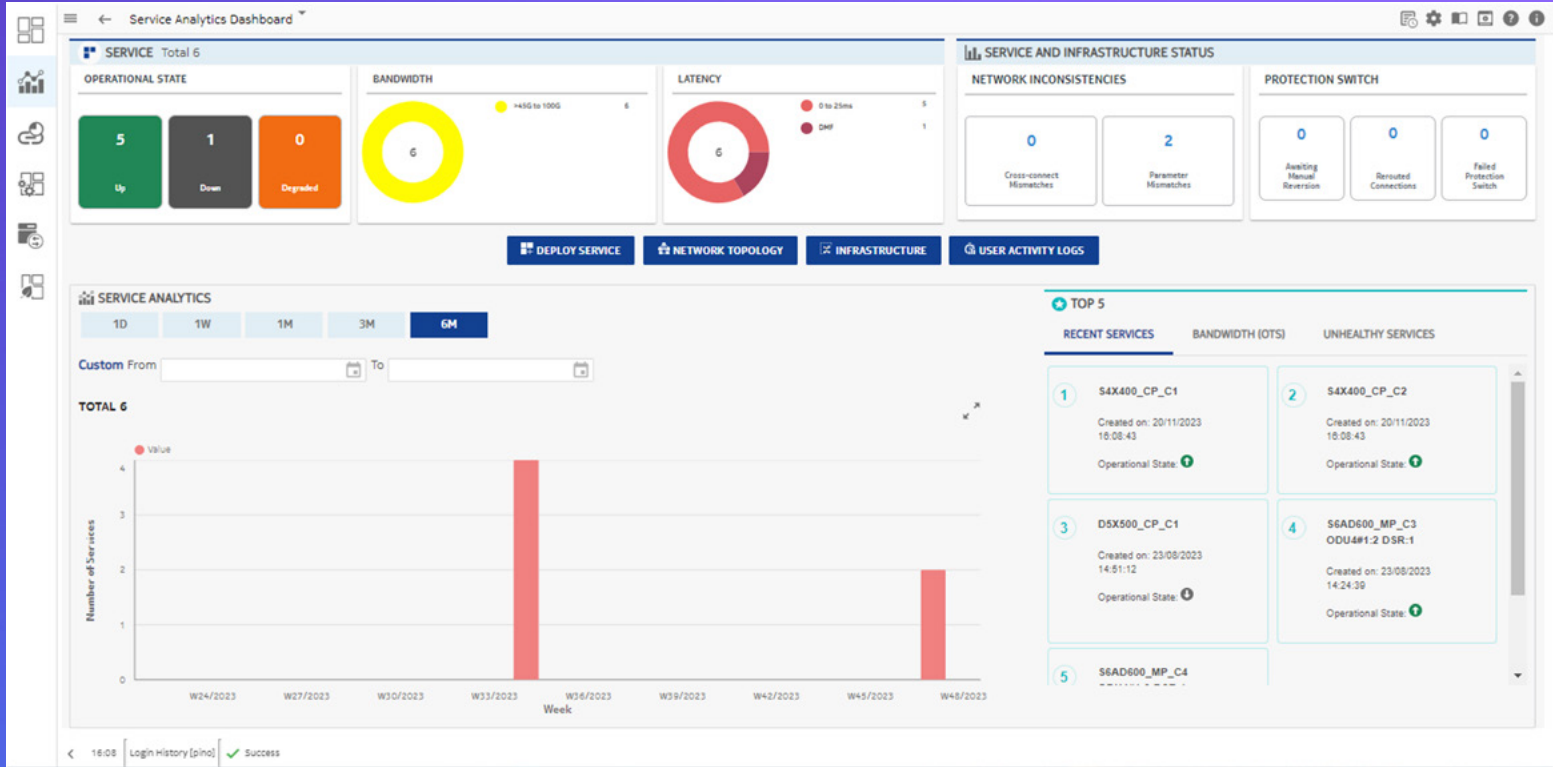


Figure 3 - WaveSuite Network Operations Center Service Analytics Dashboard

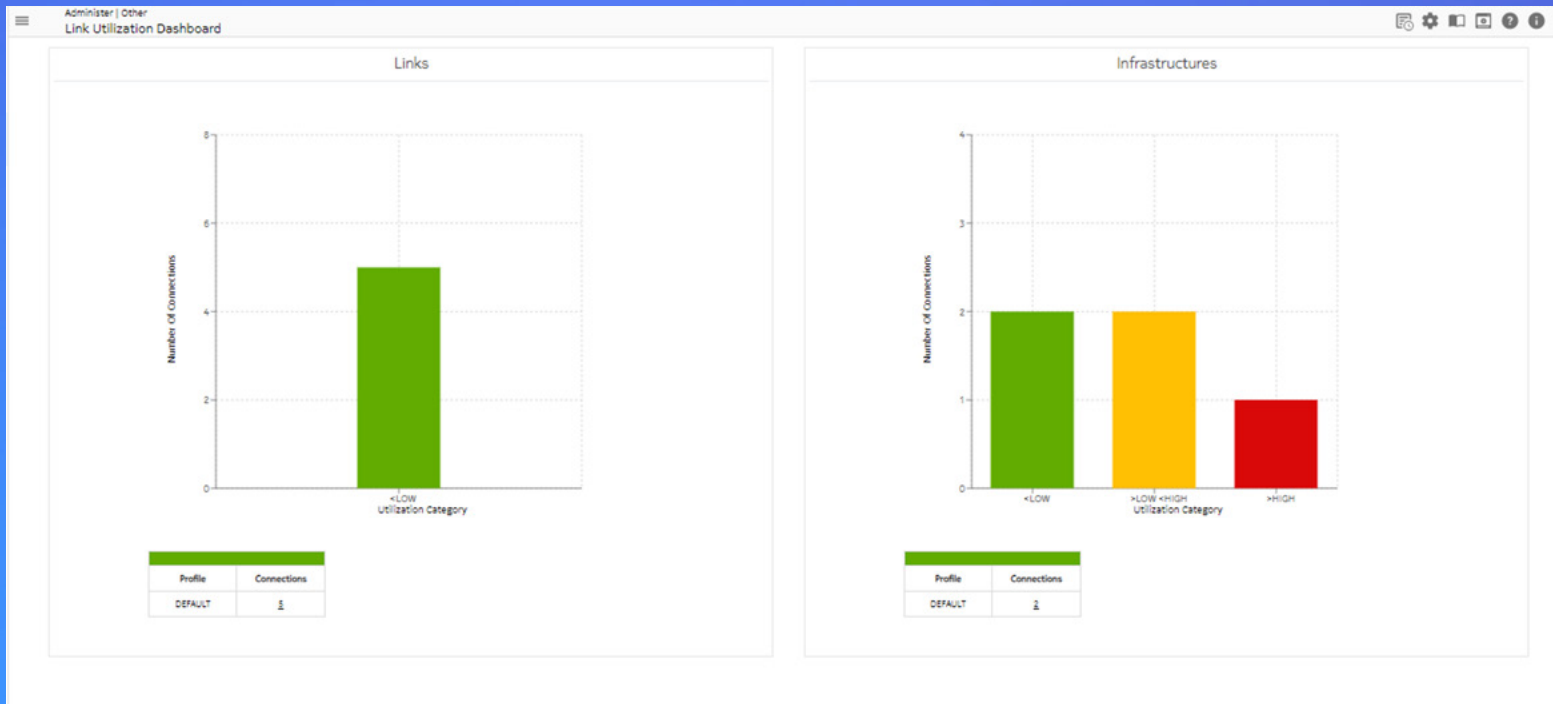


Figure 4 - WaveSuite Network Operations Center Link Utilization Dashboard

Visualize the network with clarity

Save time by using the WS-NOC application’s network health and state visualization tools to assess your network and accelerate all network management tasks.

These tools include:

- 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 key performance indicator (KPI) data at a glance
- Utilization reports for physical and transport objects

Use the alarm surveillance functionality of WS-NOC to 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. This functionality manages the storage, listing, acknowledgment and clearing of 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 so you can navigate to the network elements with the root faults.

Use the PM functionality to collect and monitor 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. PM counters can be automatically enabled within the system, so you don’t need to perform any configuration for PM activation. You can also manage the configuration and monitoring of PM information using customizable PM report templates that can be applied to network components, connections and services.

Rapidly integrate equipment

With WS-NOC, it’s easy to onboard network resources and align them with your network design. You can also provision and integrate equipment using classic, REST and model-driven interfaces. All network additions receive a configuration birth certificate that helps simplify baseline comparisons as the network ages.

WaveSuite Resource Controller

Evolving to open network initiatives such as the Optical Networking Forum (ONF) Transport API (T-API) can help you accelerate service deployment and reduce network TCO. To succeed with this evolution, you need a network resource controller that supports these initiatives and uses T-API (v2.1.3 or later) to ensure your network assets benefit from operations, administration, maintenance and provisioning (OAM&P) and streaming telemetry capabilities, and to support multivendor and multi-domain networks.

To keep costs low, you need open interfaces that can make it easier to manage, operate and sustain your network across release cycles for continuous integration and continuous deployments (CI/CD) for your future network evolution.

You can also use these open standard interfaces and data models to communicate with orchestration systems, multivendor network controllers or the NSP to build and simplify the delivery of IP/optical network services.

The WaveSuite Resource Controller (WS-RC) application performs SDN controller functions such as computing routed paths across optical network domain layers. It helps facilitate business process automation into northbound OSS/BSS systems using standardized interfaces while providing programmable management to seamlessly build customized workflows that address your specific network or service automation use case.

Enable interoperable software-defined optical network domain management

There's no need to limit your optical network management capabilities to proprietary single-vendor solutions. With WS-RC, you can simplify your end-to-end management and service orchestration if parts of your network are from different vendors.

WS-RC interconnects with other network vendors' open standard optical domain SDN controllers to ensure that traffic flows are routed appropriately and adhere to your end-subscriber SLAs. It supports a stateful path computation engine (PCE) that delivers optimal path placement across the optical network. WS-RC also manages the creation of transport path connections for L1 OTN and L0 wavelength connections and enables you to export a full topology of the network traffic routes and the resources consumed along the path.

Connect to your orchestrator platforms or other open SDN hierarchical network controllers

Make the best use of the WS-RC open interfaces to ensure you are synchronized to the deployed optical network inventory and source the most up-to-date insights on your transport path connections and topology. Enhance your network automation functionality by using WS-RC to import bulk connection requests directly into your optical network to rapidly deliver services and increase revenue.

You can also use WS-RC to support service connection parameters such as latency and shared risk link groups (SRLGs) at the physical layer, while also enabling time-specific reservations for calendared services with service guarantees. With its T-API support, WS-RC includes the common model- and intent-based data models to communicate with the physical network. You can use the NSP to create business process automation functions in your northbound applications and enable pluggable ZR+ technologies within IP routers to unlock your desired business outcomes.





WaveSuite Health and Analytics

In an environment of intensely scrutinized budgets, many optical network operators are looking for economical ways to address the growing bandwidth demands of an increasingly connected world. This calls for safe and agile solutions that can run the network at maximum potential, enable automation and learn effectively.

The WaveSuite Health and Analytics (WS-H&A) 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 capabilities. Together with WaveSuite Optimizer, it can intelligently and automatically shape wavelengths or optimize optical links to ensure the best possible network performance and availability.

WS-H&A is equipped with a programmable API layer to support the development of customized workflows that target your operational use cases to lower TCO. It uses streaming telemetry, historical big data records, performance monitoring, trending analysis, prediction and machine learning to proactively analyze, classify and predict and monitor your network’s behavior.

With WaveSuite H&A, you can:

- Intelligently sense, identify and react to events to gain network insights about factors that impact the optical network
- 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 KPI data with at-a-glance user interfaces that provide the clarity required for targeted automation workflows
- Sense small or large perturbations and use built-in machine learning on ingested enhanced performance monitoring data to classify and localize events when they occur, or proactively schedule maintenance to better prepare your network and minimize impacts to your SLAs

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

- Maximizes network performance to reduce overall 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



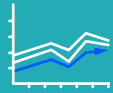
React to data

Flexible user-defined actions to trigger automation



Analyze data

Tools with built-in Nokia Bell Labs data science expertise



Visualize data

Intuitive at-a-glance user interfaces that depict information with clarity



Collect data

Secure, fully instrumented data environment



Optical network

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 forecasting and data science support

Maximize network performance

- Provide early detection of link degradation (aging) to avoid service disruption and data loss
- Improve equipment failure detection by using data science techniques to better manage equipment replacements

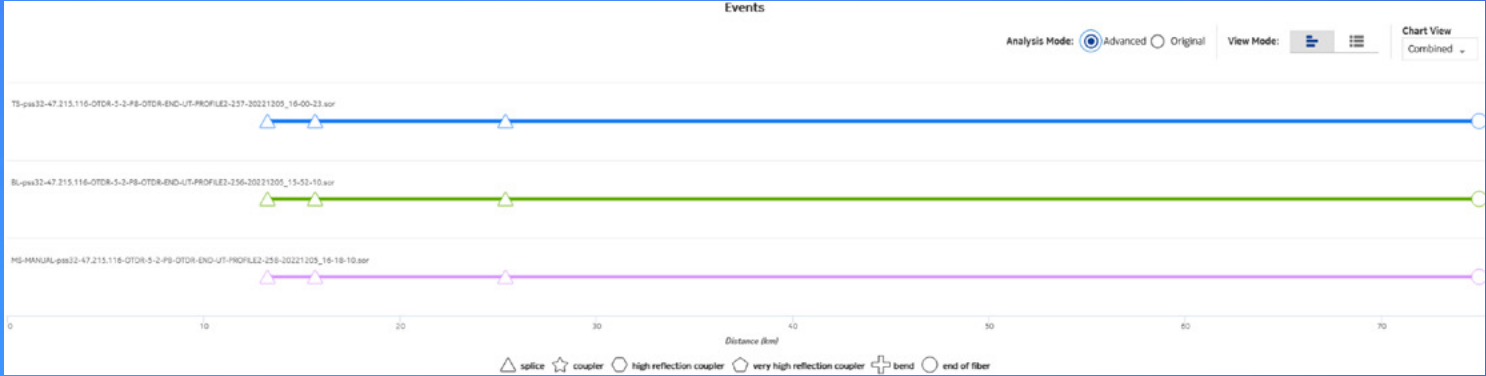
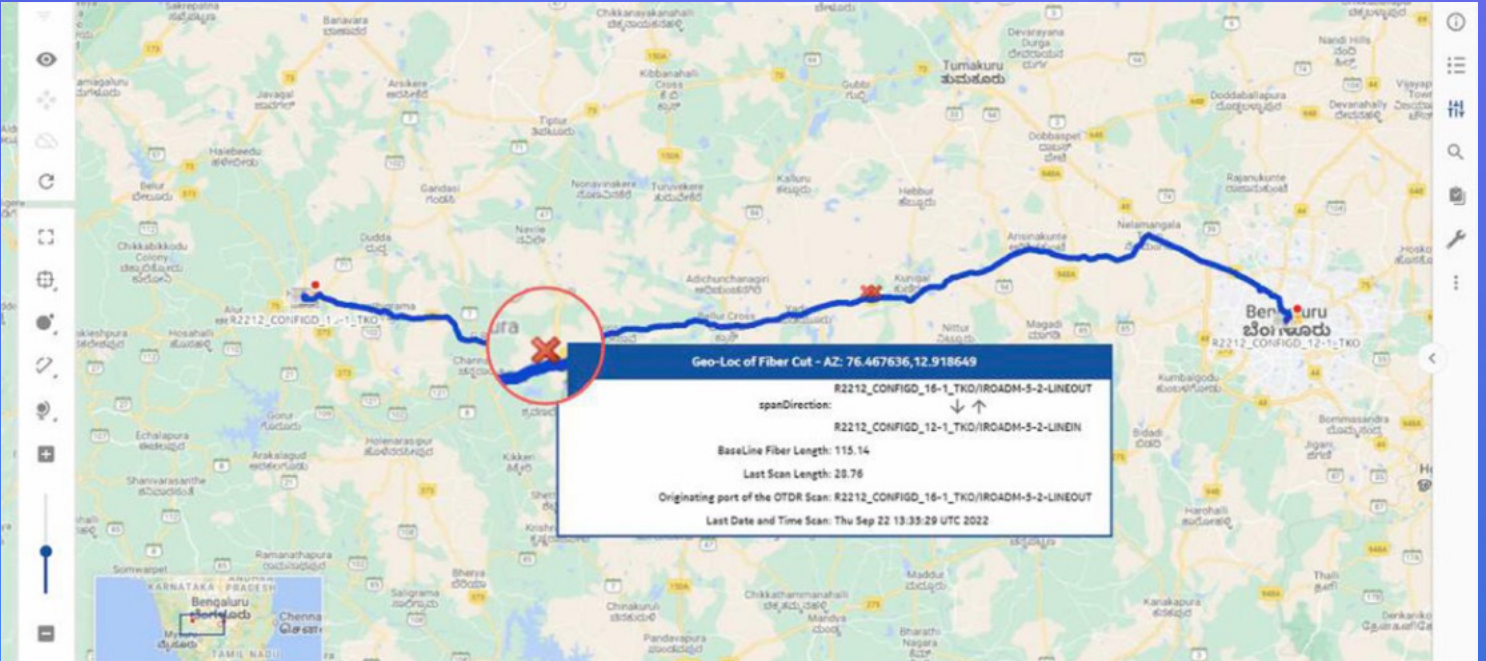
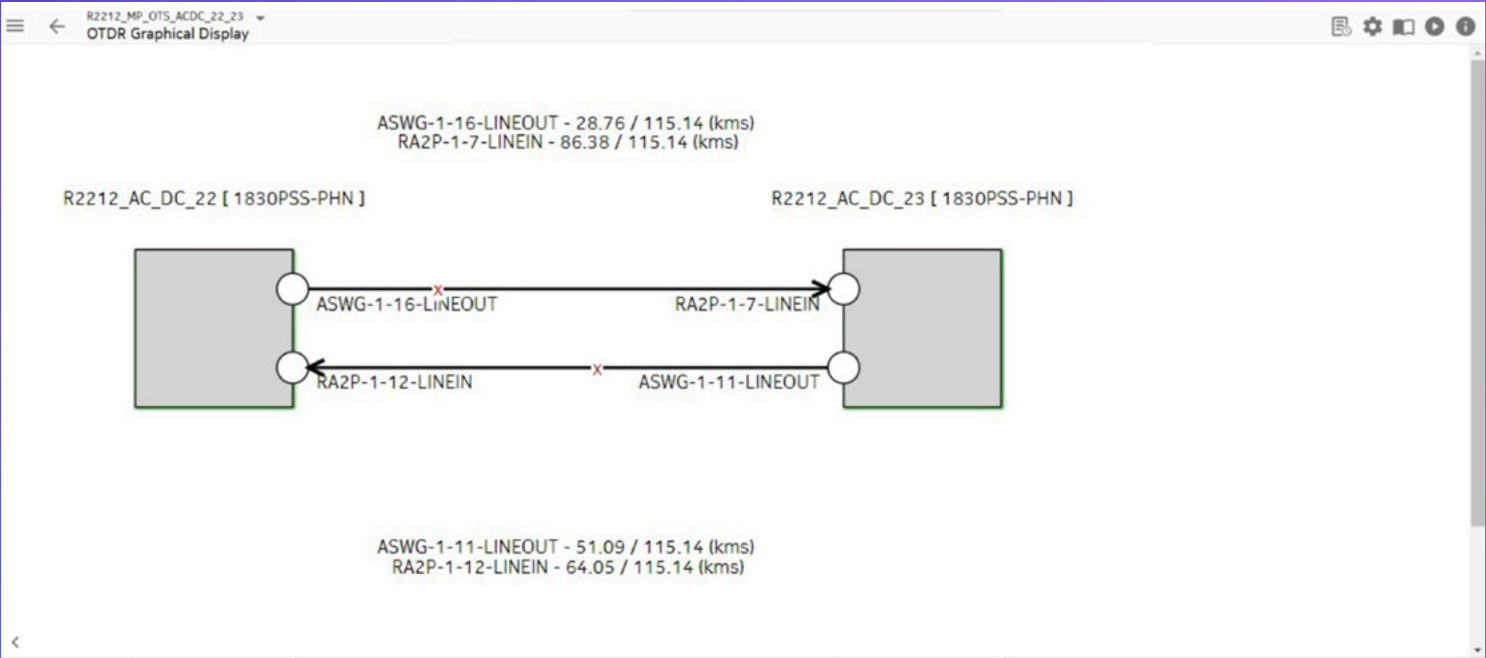


Figure 5 - OTDR scans showing the graphical display, the routing view and the combined view of multiple scans

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 expands the diagnostic capabilities of WS-NOC.

WS-AD enhances the WS-NOC application’s diagnostic tools by automating the anomaly detection process to speed up fault isolation. You can use WS-AD to simplify fault location detection once an alarm is raised and summarize the recommendation actions for repair.

WS-AD is triggered by and reacts to events in the network to troubleshoot impairments on the physical connection and provides visualization capabilities to help summarize the root cause. It can automatically trigger email notifications with reports to your operations teams when your network experiences significant span loss degradations or fiber cuts.

Identify and resolve potential network issues quickly with enhanced assurance

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

Its intelligent troubleshooting capabilities further streamline the alarm lifecycle with:

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

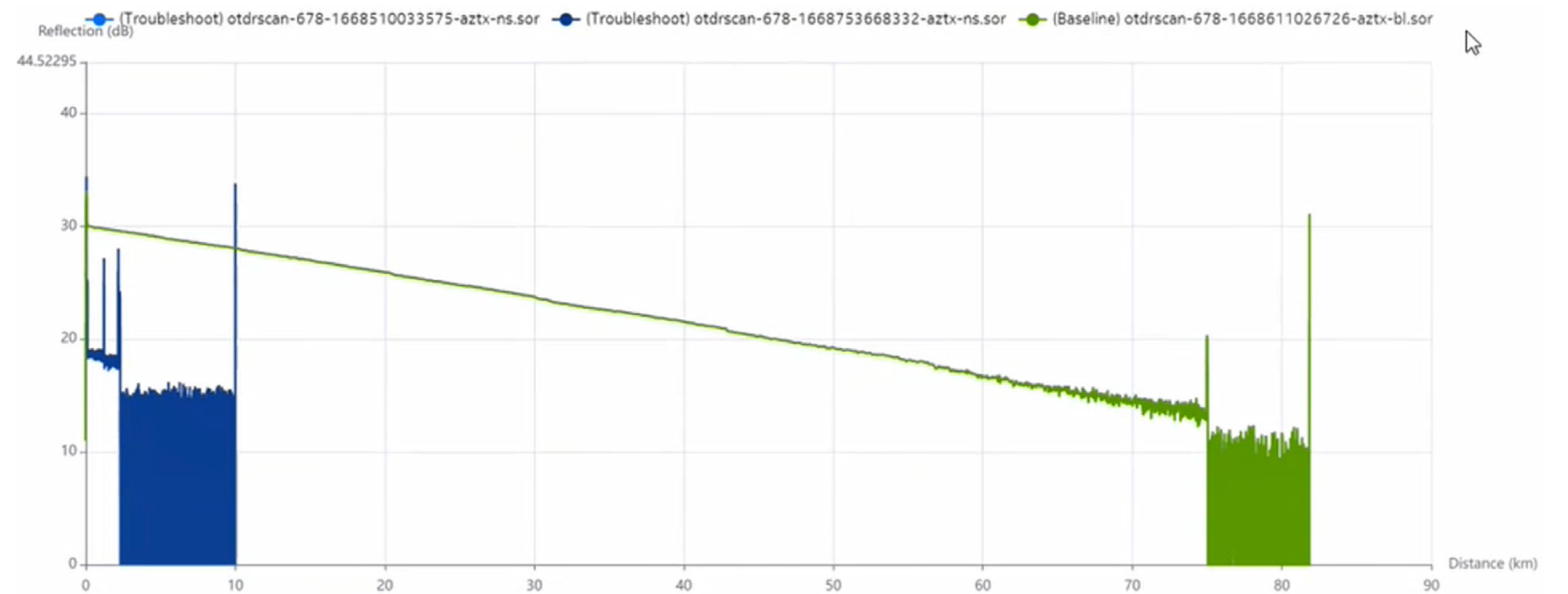
Precisely locate fiber impairments with integrated OTDR support

WS-AD launches optical time-domain reflectometer (OTDR) scans for specified alarms and span loss KPI threshold crossings. It uses the OTDR information history to facilitate optical connection troubleshooting when network issues arise.

Resolve connection issues fast with integrated maintenance and supervision

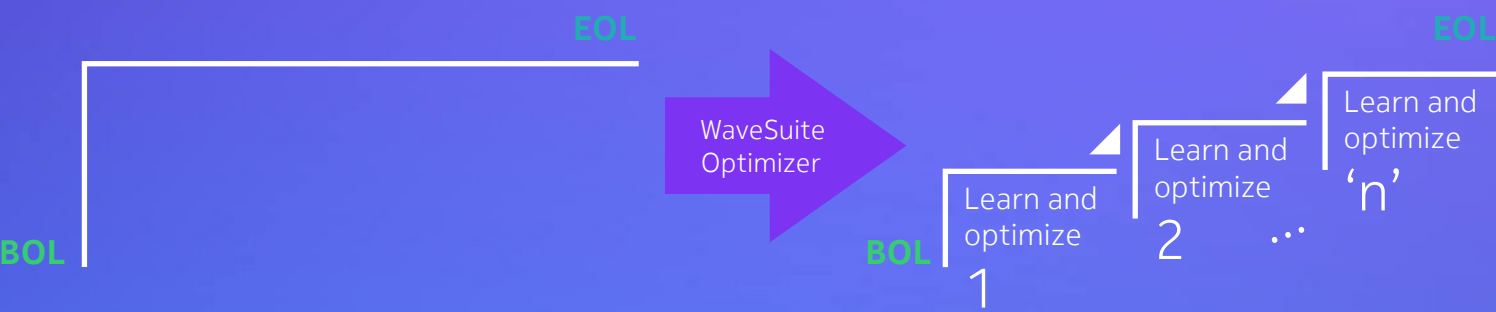
To help you diagnose optical connection issues, WS-AD automatically creates connection birth certificates and subsequently tracks and timestamps all connection-related events (e.g., connection creation and modifications, alarms raised, failures identified, repairs and re-routing).

With WS-AD, you can define maintenance intervals for equipment and fiber spans, along with conditions that need to be met for the duration of the maintenance interval.



Traditional conservative mode of operation

Continuously conservative mode of operation



Deploy BOL based on EOL parameters

- Based on worst-case assumptions
- Static, don't adapt philosophy

Adapt BOL towards EOL based on:

- Span loss
- QoS parameters from modern coherent technologies

Figure 6 - WaveSuite Optimizer: Evolving to a network “learn and optimize” approach

WaveSuite Optimizer

The cost of keeping pace with growing capacity demand can have a big impact on your bottom line. The introduction of SDN brings increased client port speeds and more dynamic service requests to optical networks. 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 lets you use automation to extract more capacity and value from your optical network. Combining advances in coherent wavelength modulation formats with colorless directionless contentionless-flexgrid (CDC-F) wavelength routing, WS-O enables new approaches to optical network optimization. Instead of defining a 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, WS-O uses coherent and line system technologies to make re-optimization recommendations

that will keep these conditions from slowing down service deployment. The result is a more robust and adaptable network that is ready to face the unpredictable and dynamic nature of SDN services.

WS-O ensures that network performance matches the optical network design requirements defined by the Nokia WaveSuite Planner application. Together, these applications help you use network automation to adhere to your SLAs and ensure you can optimize network capacity when required.

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 streamline spectrum utilization and analyze real network resilience and maintenance scenarios.



Link Optimizer

Ensures optimal optical link performance based on the available BOL to EOL optical link performance margin (figure 7).

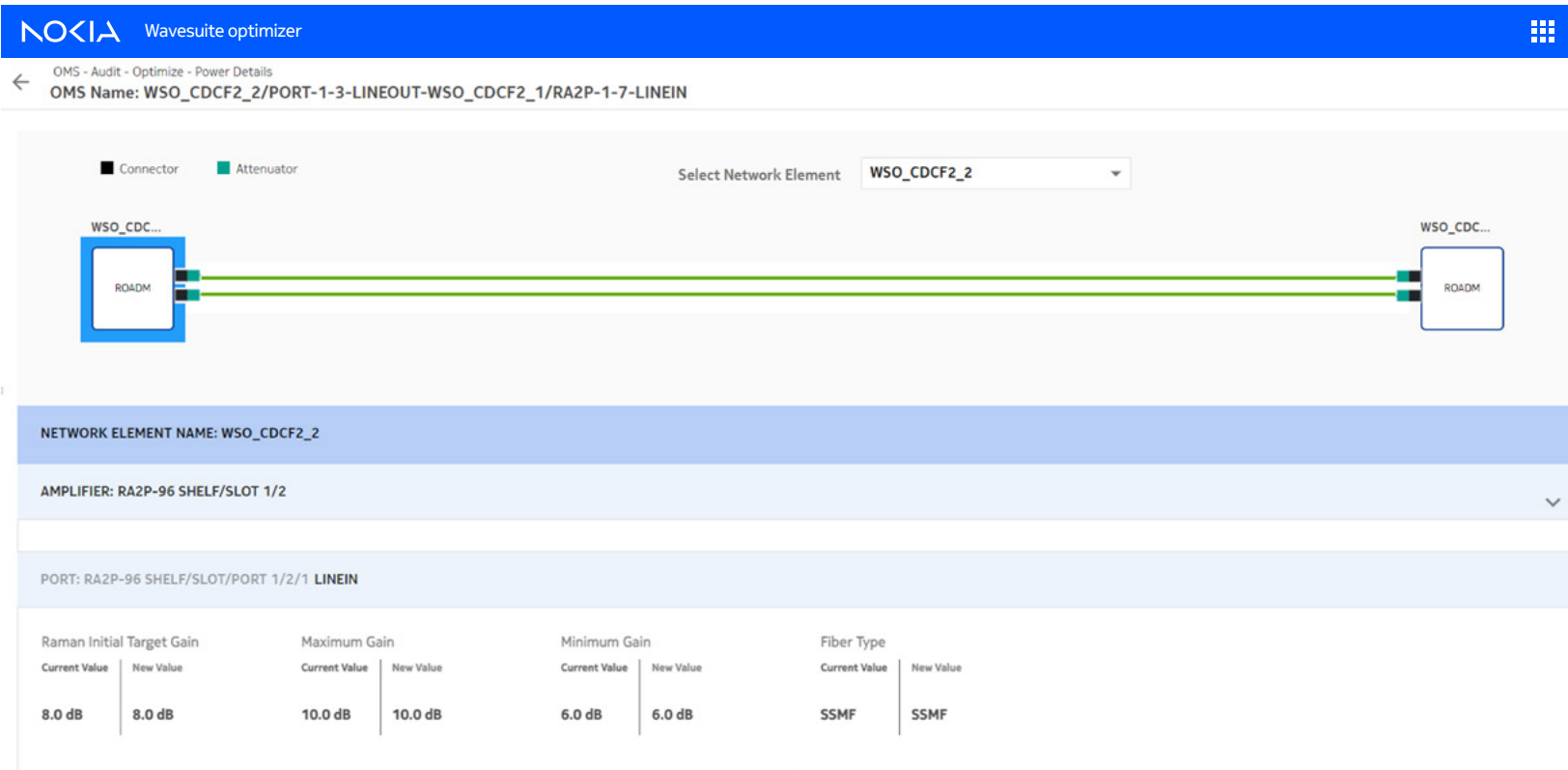
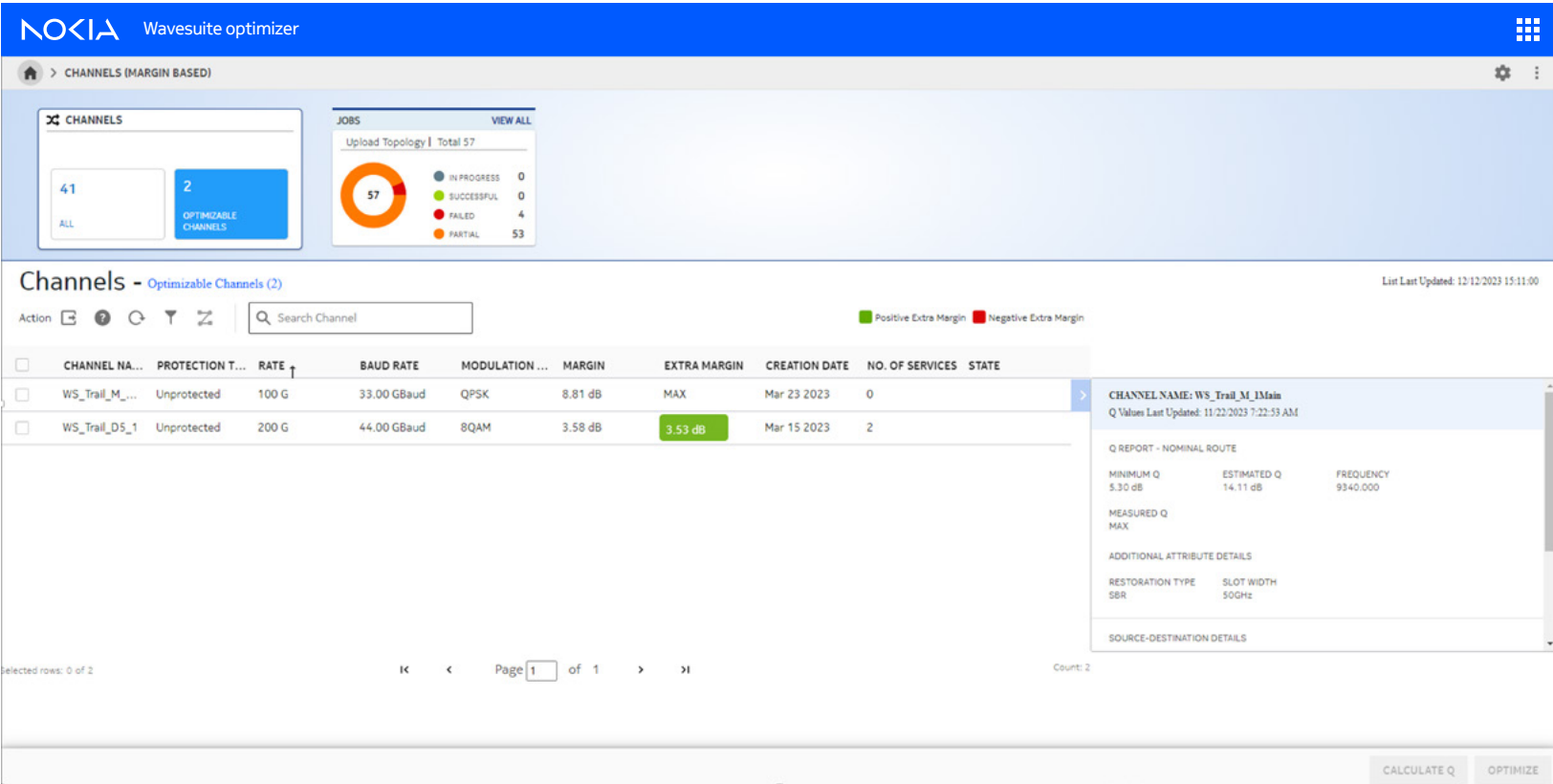


Figure 7 - (above three images) Link optimization with WaveSuite Optimizer

Channel Optimize

Ensures optimal link performance based on programmable optical channel rate profiles from the Nokia Photonic Service Engine (PSE), which can be selected according to the quality of transmission KPIs for your network links (figure 8).

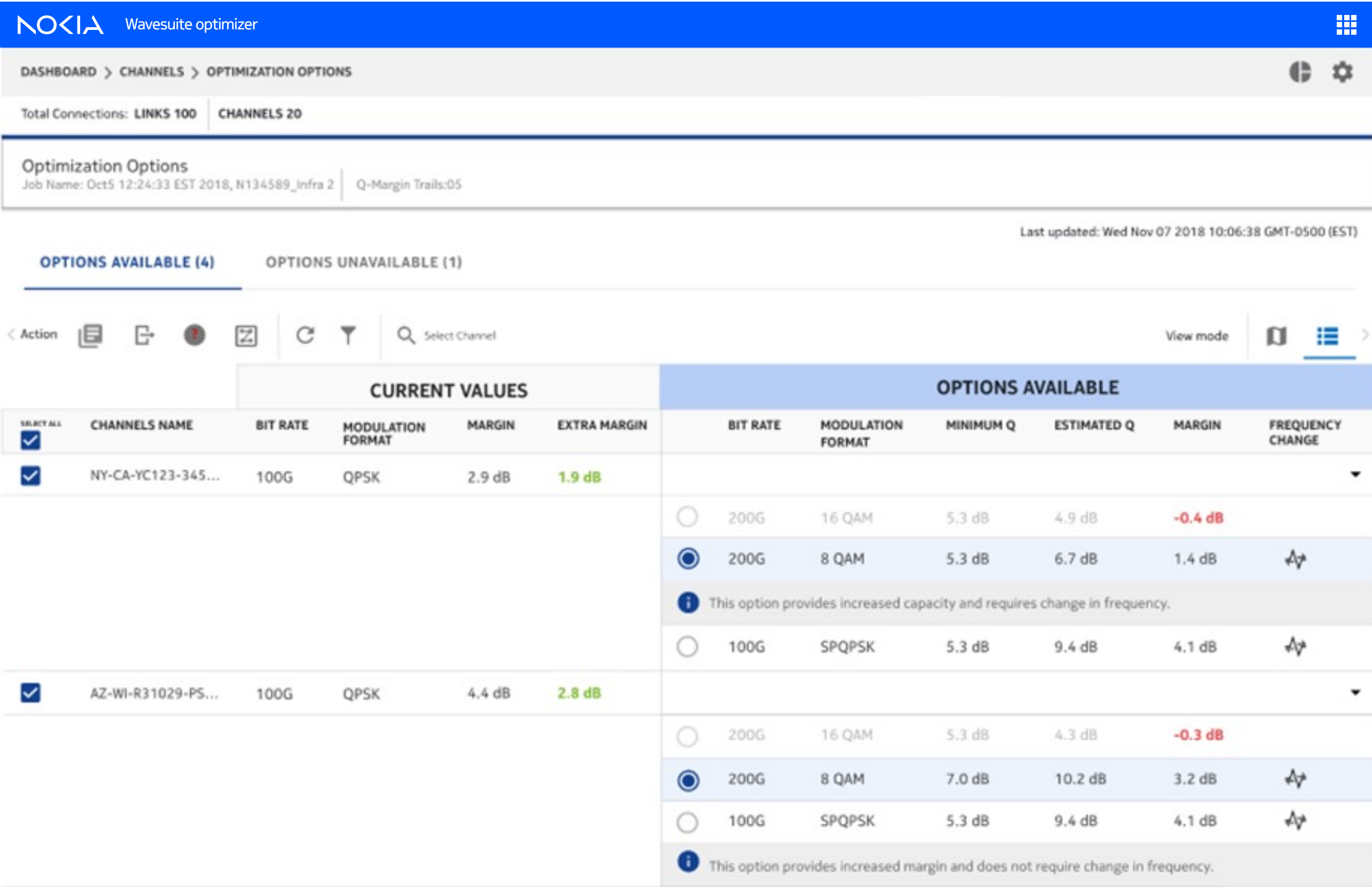


Figure 8 - Channel optimization with WaveSuite Optimizer

Maximize operational efficiency and scale



Spectrum Streamline

Rearranges optical wavelength assignments throughout the network to maximize spectrum occupancy (figure 9). It can prevent network bottlenecks by enabling you to monitor the current link state to make the most efficient use of the spectrum. The pace of migration to wavelength re-coloring is based on analyzing optical link spectrum fragmentation and its impact on associated deployment inefficiencies. By extending spectrum occupancy, you can deploy new services on your network that would have been unavailable otherwise.

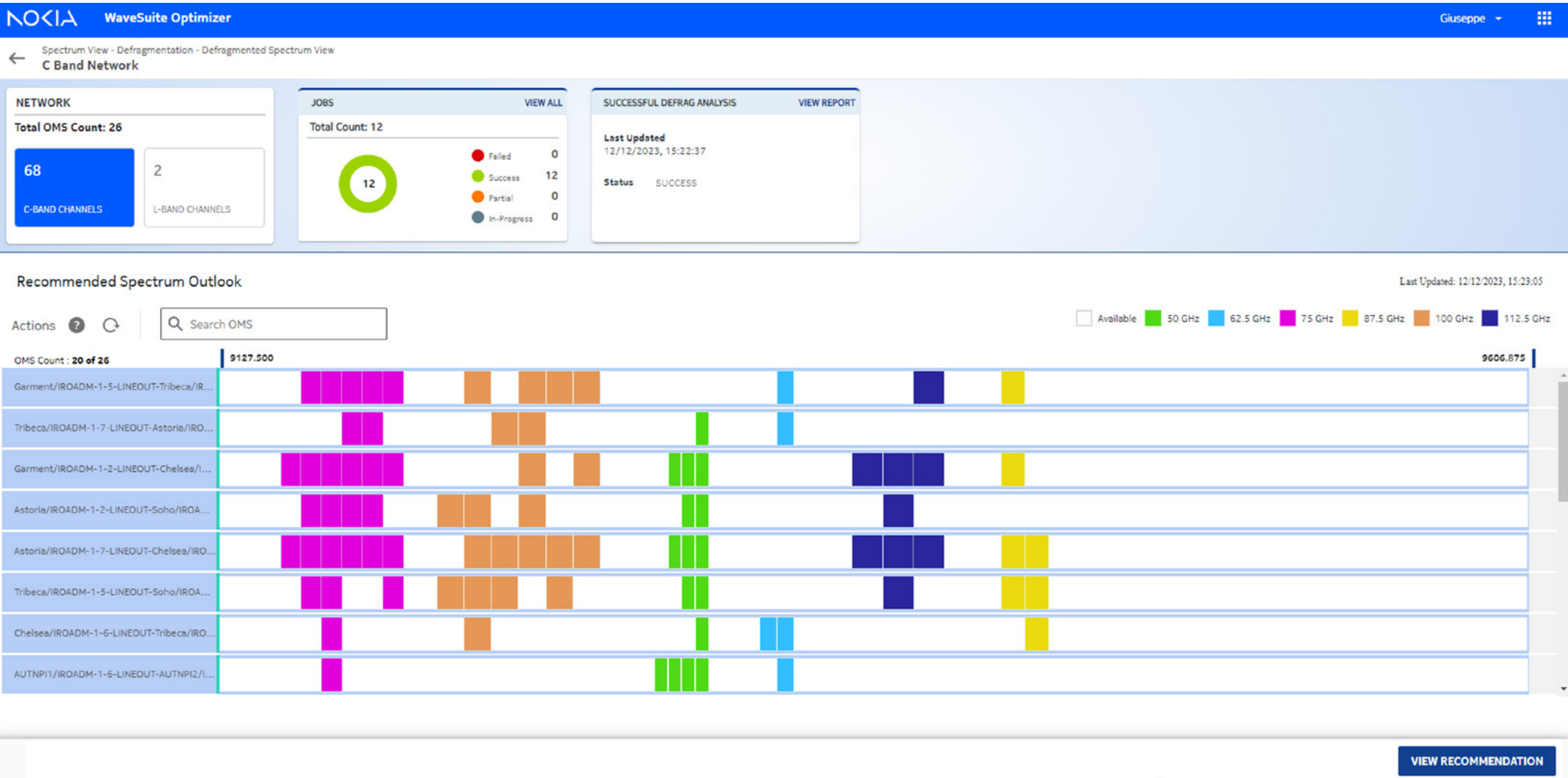
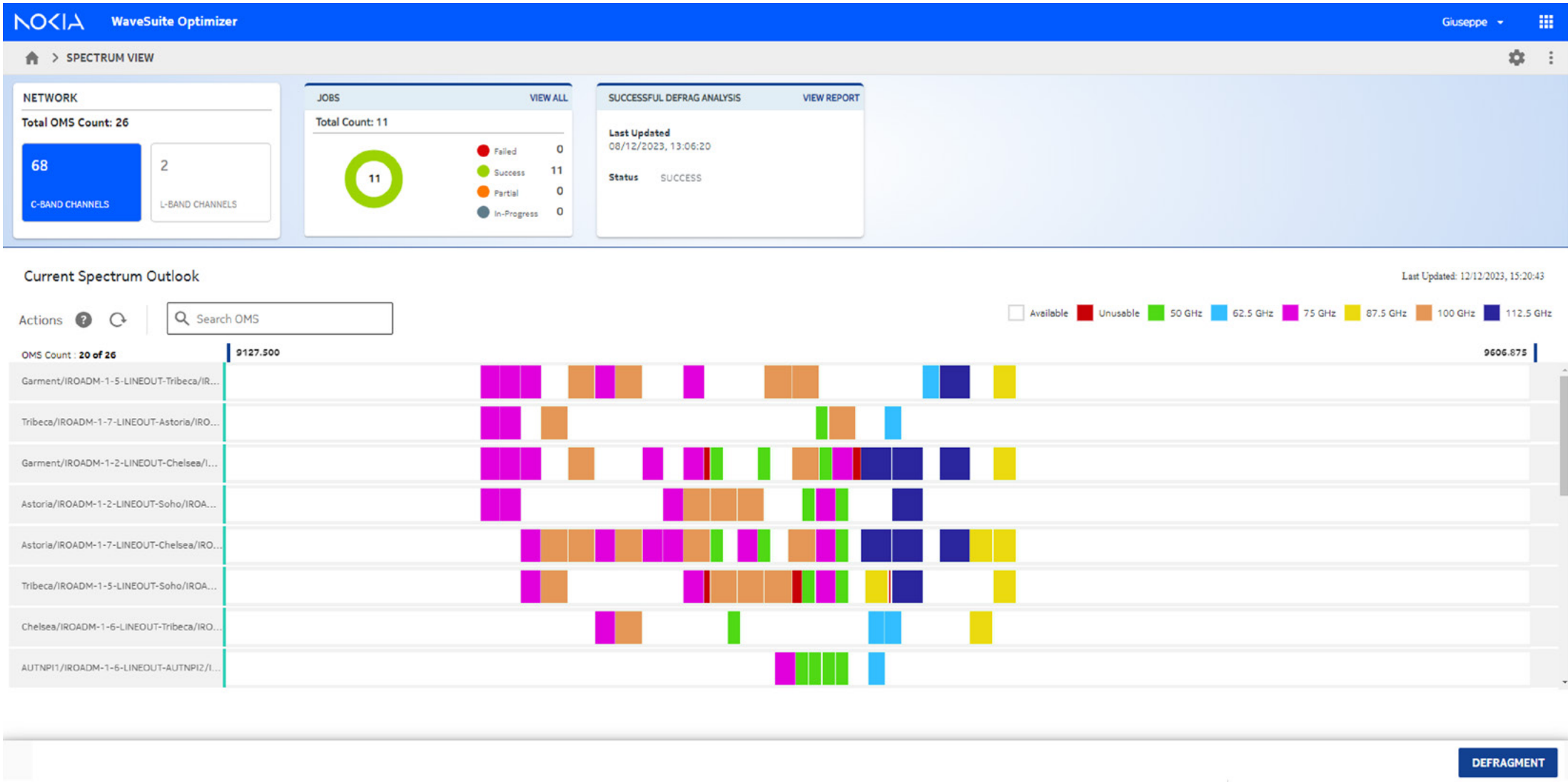


Figure 9 - Before and after spectrum streamlining with WaveSuite Optimizer



Multilayer Restoration Analysis

Lets you simulate L0 wavelength failures (figure 10). It offers network assessment and resilience verification capabilities that can identify these critical failure scenarios (nodes or links) and provide visibility of exposed areas in your network where more appropriate strategies may be needed to increase network robustness for specific outage scenarios. It also allows you to analyze the effects of simultaneous link maintenance actions in your networks, which improves your ability to plan your network and minimize these traffic-impacting scenarios.

You can use these tools with the WaveSuite Health and Analytics application to create customized workflow automation that supports 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 digitalize some of your operational processes and lower TCO.

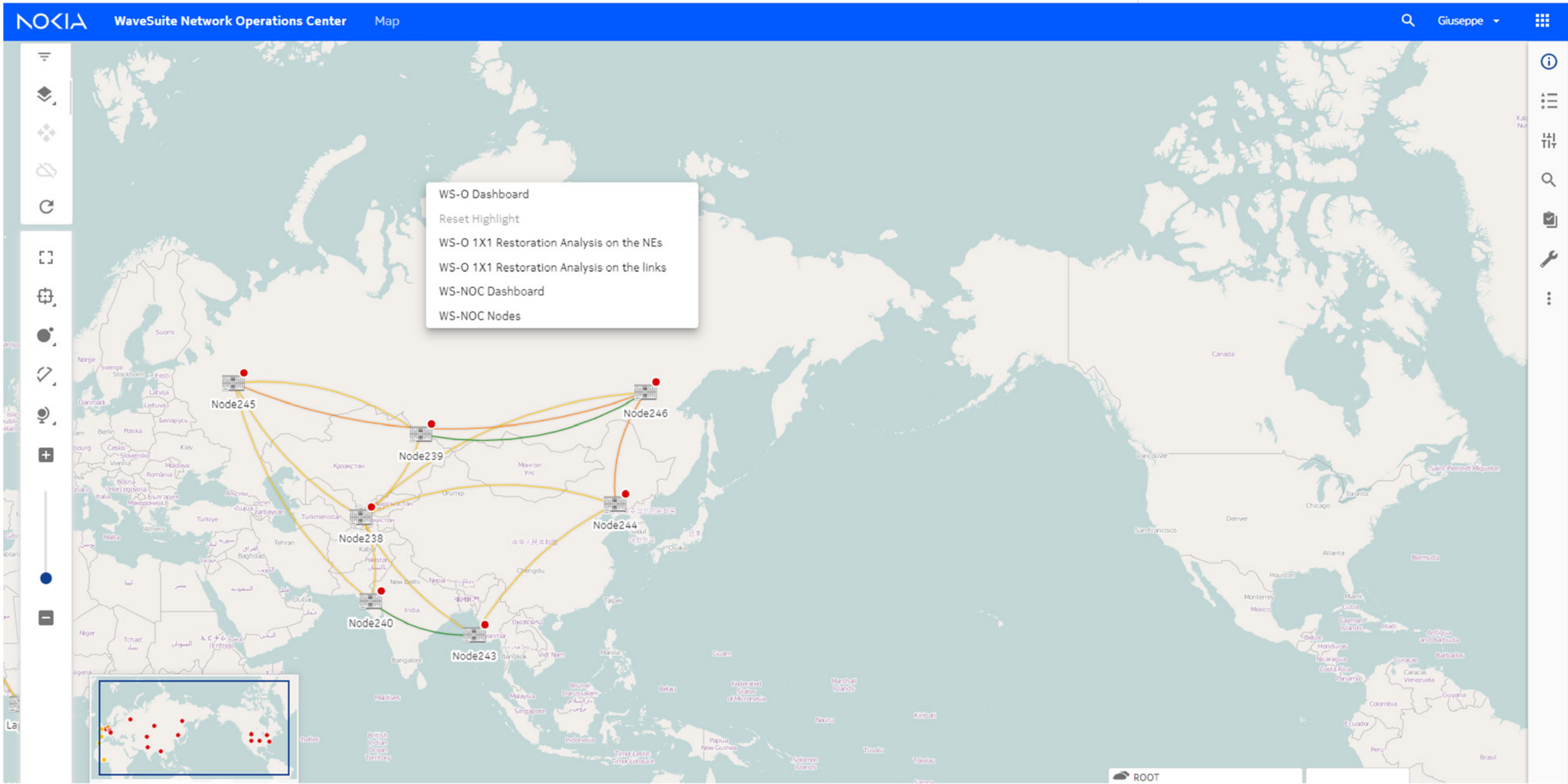


Figure 10 - Multilayer restoration analysis with WaveSuite Optimizer

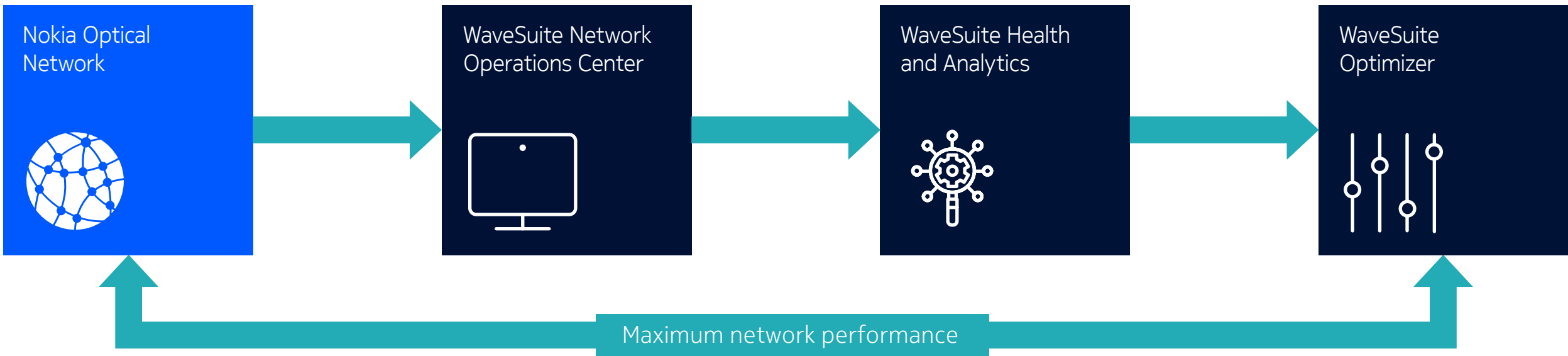


Figure 11 - Automation flow between the network, WaveSuite Network Operations Center, Health and Analytics and Optimizer



WaveSuite Planner

You can extract maximum value from your network investments by using the WaveSuite Planner (WS-P) application's intuitive tools to simplify and accelerate multi-phase network design and ensure your design accurately reflects your existing network. WS-P supports the 1830 PSS, OTN Switching and PSI-M based optical transponder family, and provides additional support for digital coherent pluggable technologies from Nokia IP routers. It is built on a multiuser planning platform that provides enhanced performance, scalability and usability.

Accelerate network design

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

You can use the WS-P API to build workflows to expand network analysis and optimization use cases for your photonic infrastructure and OTN service layers. These workflows can include other WaveSuite applications.

Make network design easy

Use our customizable, ready-to-go network parameter and nodal templates in WS-P to quickly create and evolve your network architecture and validate it by executing a 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 intuitively provides an up-to-date design status to confirm whether design component objects are complete or incomplete. This ensures all design rules are in place to fully route services and create spans with the appropriate parameters.

WS-P automatically generates bills of material 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 comprehensive GMPLS path computation and restoration analysis functionality based on Nokia GMRE. Restoration analysis lets you augment your design to build resiliency and adhere to critical services that demand stricter SLAs. You can grow your revenue and maximize your network investments by offering different levels of service protection and restoration to your enterprise customers.

WS-P emulates network routes according to the network design and verifies the availability of each infrastructure connection's (trail'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. Once this is enabled, WS-P incorporates resiliency checks to allow your teams to review potential service connection routes that contain limited resources to expose potential route disruptions.

Seamlessly sync planned and upload deployed networks

Mirroring what is in the field for planning teams to use in their designs and, in reverse, provisioning traffic according to plans developed in the operator's network operation center can help you speed the planning process and avoid errors.

You can use WS-P to auto-discover your actual deployed design and the entirety of your traffic demands. You can also compare your planned design with your deployed live network using a full report that keeps track of your network activity changes or growth. Your network operations team can provision the connections planned in WS-P into the deployed network through the WS-NOC application to ensure consistency with the intended design.





WaveSuite Synchronizer

The WaveSuite Synchronizer (WS-S) application helps you to provision and configure clock distribution throughout your network so you can rapidly deliver time-sensitive services, reduce error-prone tasks and improve your network operations team's productivity.

5G mobile transport networks have stringent frequency and phase/time synchronization requirements. The innovative tools provided in the WS-S application let you take control of your entire network infrastructure with automation that rapidly reduces the time to configure, visualize and monetize your clock distribution capabilities.

With WS-S, you can address the complex and time-consuming 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 boost 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 makes it easy to 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. Use WS-S to proactively avoid synchronization distribution errors in the network, or to quickly localize failures and take corrective action.



Monetize network synchronization

You can monetize your network synchronization infrastructure using the WS-S application's 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 applications for service automation:

Creating a more consumable network

WaveSuite Service Enablement

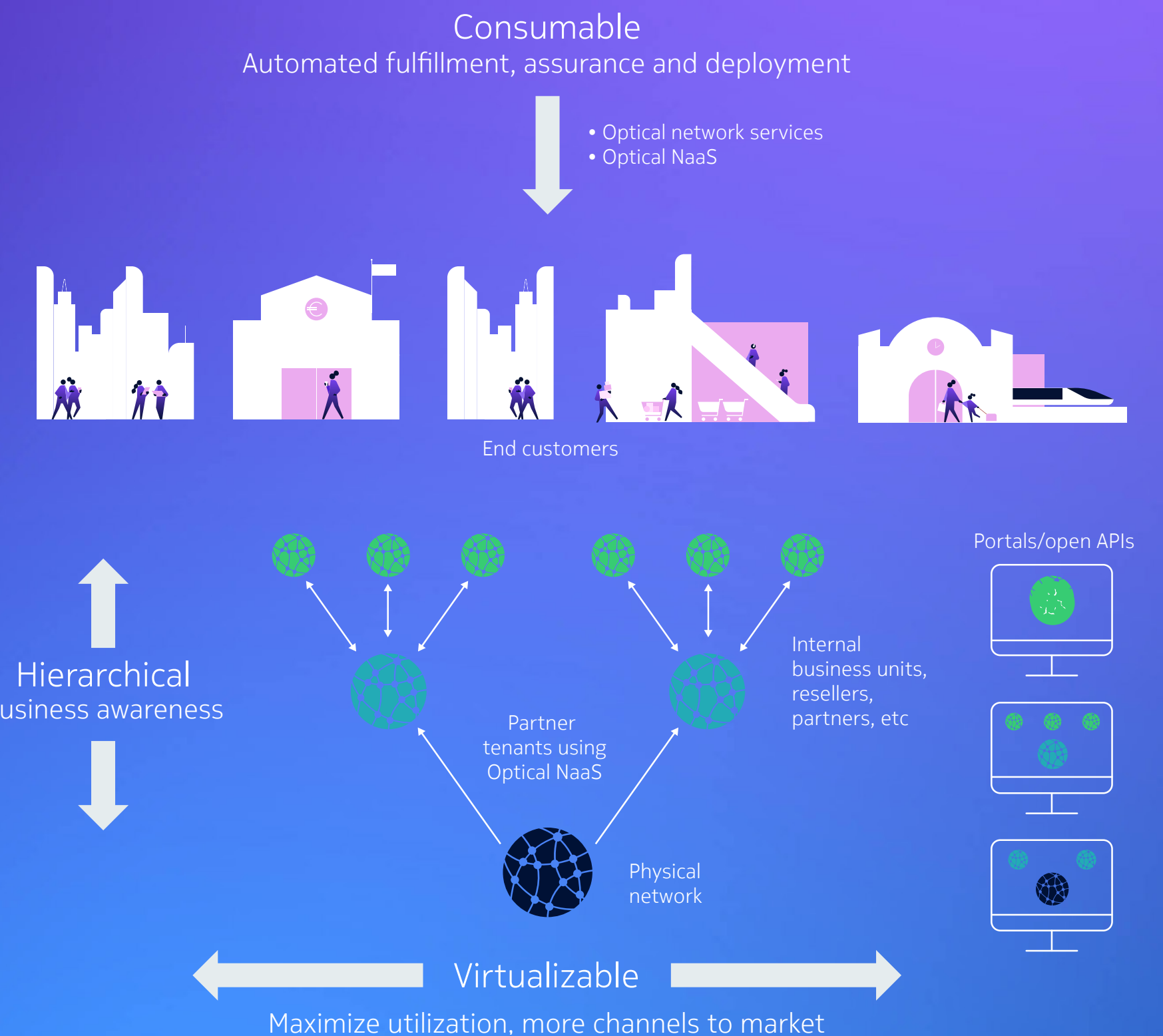
A communications innovation explosion has transformed business interactions. Connectivity is now essential for business success. Network wholesalers need to get bandwidth into the hands of their customers quickly to extend their retail reach and empower the middle layer of wholesale network consumers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

WaveSuite Service Enablement (WS-SE) uses hierarchical relationship-aware 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:

- Dynamically fulfill services with various service characteristics
- Advertise these services throughout the business hierarchy
- Automate service order fulfillment for wholesale and retail services
- Allow your cloud-based subscribers on-demand, scalable and flexible connectivity with unique SLAs
- 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 WS-SE automation to put 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. WS-SE helps all stakeholders get more value from optical network services.



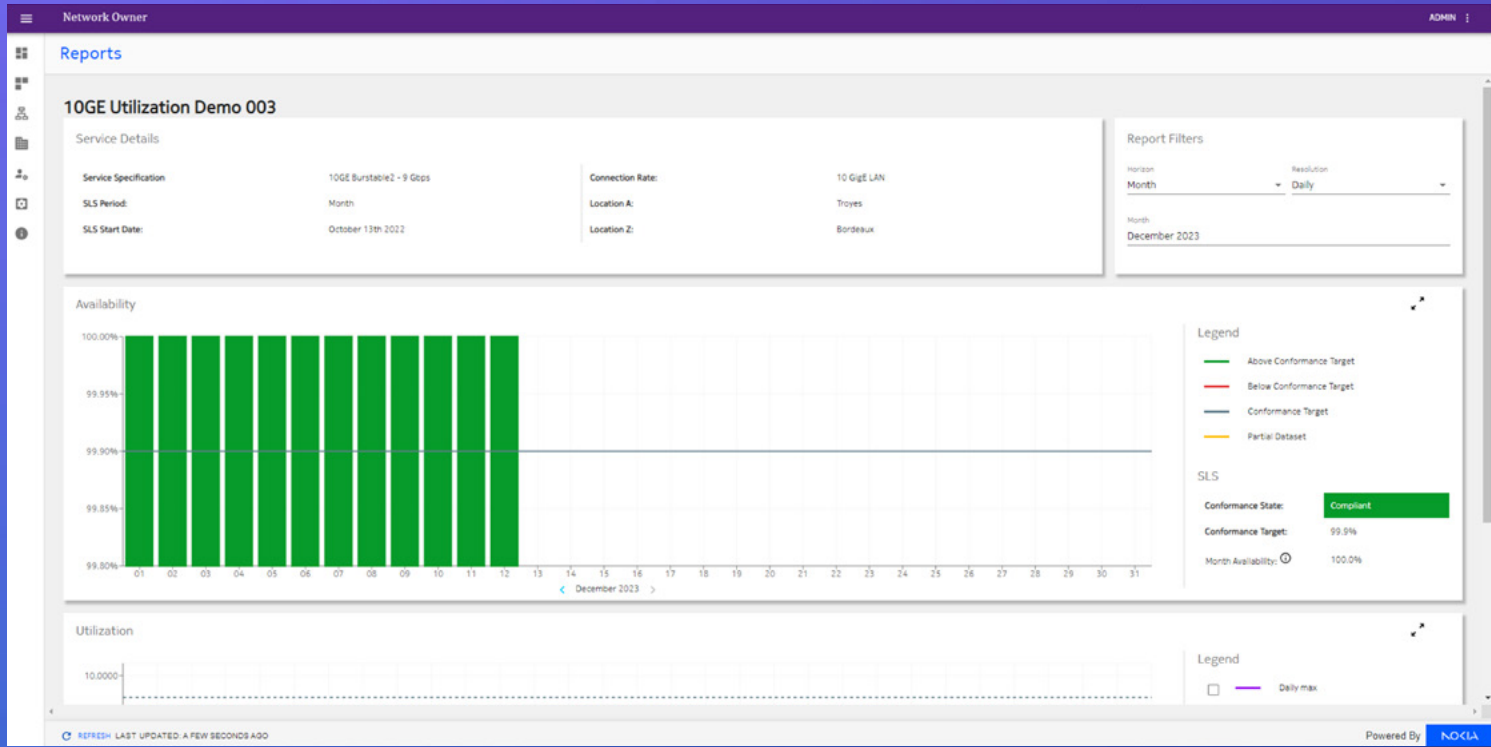
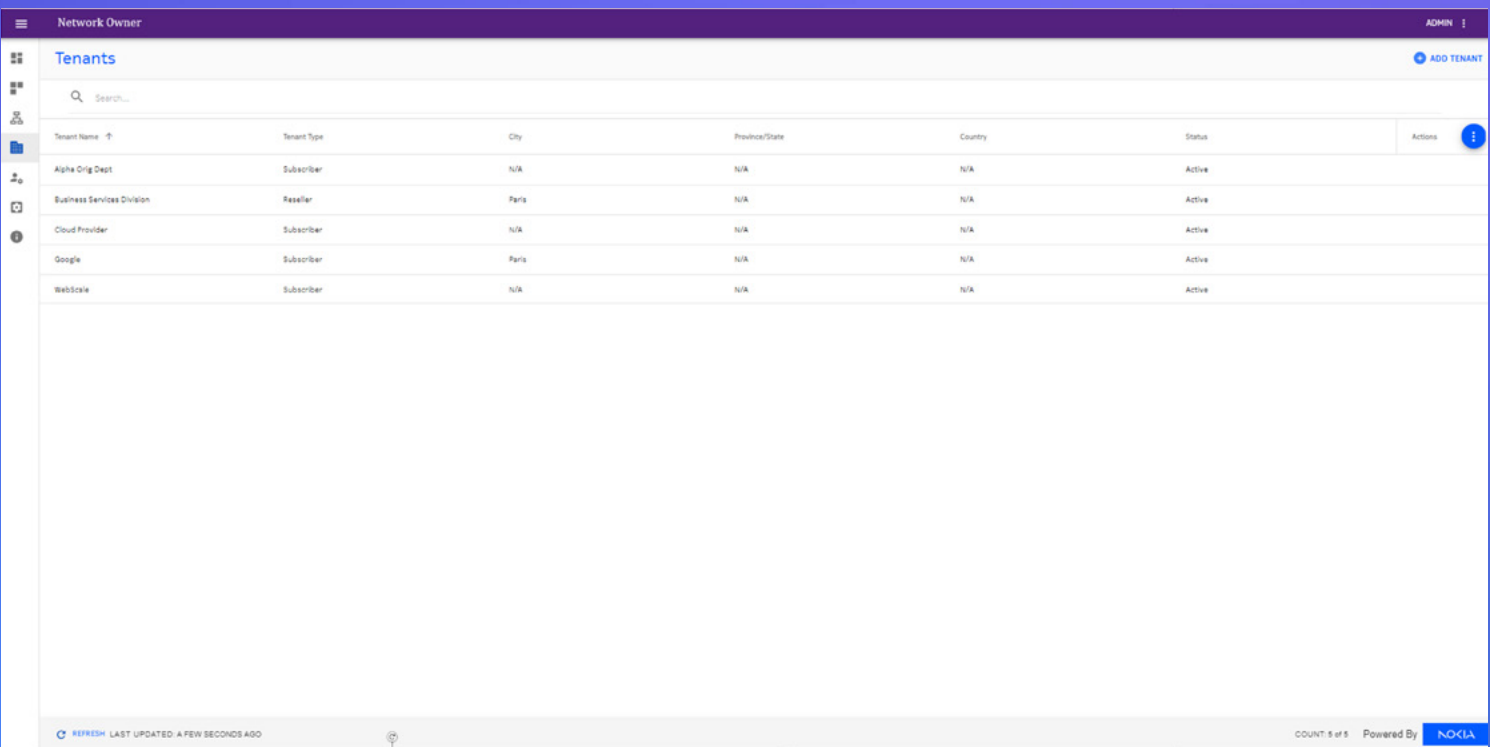
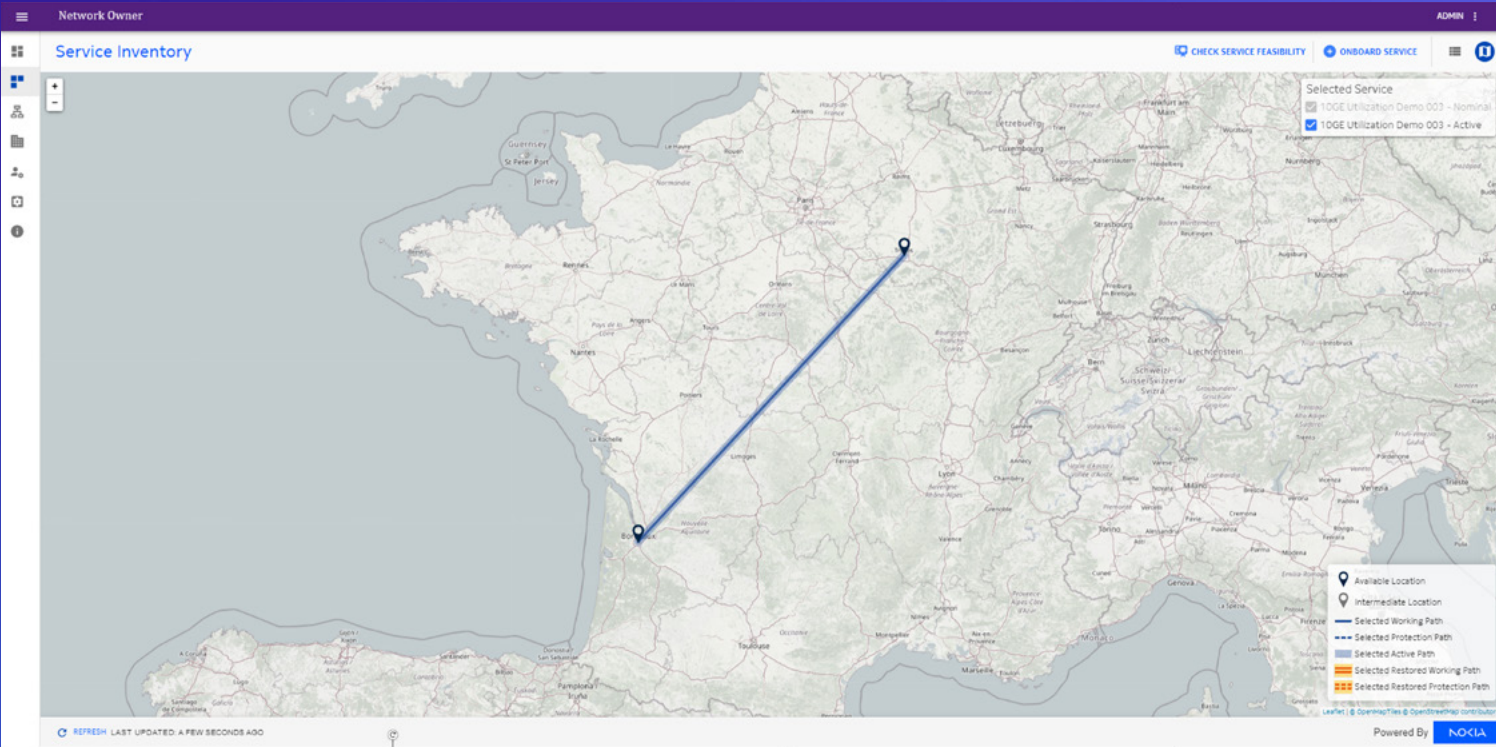


Figure 14 - Views of partitioned virtual slices of optical connectivity using WaveSuite fulfillment, dashboard and assurance portals

You can also use WS-SE 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 these services to complement Carrier Ethernet and IP VPN packet services to keep your network scaling costs low.

Combining WS-SE with Nokia Professional Services-led automation expertise lets you bypass the massive effort and complexity involved in adapting back-office ordering systems to support new services and monetize new business opportunities. The combination of expertise and a lightweight and extremely focused solution for optical services can help drive transformation in this area and keep you from having to take on a much larger and more expensive project.

Ultimately, WS-SE 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 service automation at all levels of the service enablement network hierarchy.

Accelerate your automation initiatives

Use WaveSuite to turn your optical network into an open, efficient, consumable platform that creates value for you and your customers. WaveSuite gives you applications that make it simple to automate task-driven processes and reduce repetitive actions. You also get resources and expertise that help you overcome internal limitations and rapidly deploy automation projects.

With WaveSuite, you can streamline your operations, rapidly homologate new technologies, or de-risk your project timelines with a differentiated set of capabilities—network emulation, consultancy or full turnkey development.

Optical Professional Services

Our dedicated optical professional services team can help you achieve your automation business goals and meet your unique customization requirements. The team has proven expertise in

workflow development and digital process automation. They can work with you to connect and use WaveSuite applications so that you get the most from your automation strategy.

The optical professional services team can also provide Digital Twin as a Service, which allows you to build a digital replica of your optical network, or a subset of your optical network. You can use this digital twin to train your operations teams, execute project-specific scenario analysis, accelerate time to revenue and continuously validate your automation initiatives.

Jump-start your network transformation with WaveSuite

Use the tools, economics and automation environment within WaveSuite to transform and scale your optical network, meet the demands of digital services, seize new business opportunities and optimize your network operations and optical performance. These open applications accelerate your transition toward network and service automation, helping 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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