Nokia Transcend Open Wave Explorer Analytics and Automation

Proactive Network Planning and Operation

Transport Networks Move Toward Automation

Transport networks in general and optical networks in particular have traditionally been operated in a rather manual and static way. But this is changing: relentless demand for additional bandwidth, advances in software tooling, and the advent of open networks have served as catalysts for the adoption of business process-driven automation of transport networks by communication service providers (CSPs). A recent Heavy Reading study on "Open, Automated, and Programmable Transport Networks" revealed that more than 80% of respondents were already investing in automation at the time of the survey or planned to do so by the end of 2023.

The same study also showed that, among the areas identified for automation, monitoring and analyzing network performance (73%) and managing network inventory (56%) are well ahead of any other function. That choice makes a lot of sense since having reliable data about the network and its status (here referred to as a "source of truth") is the basis of any forward-looking planning and operational activity, and later intent-driven automation.

Network analytics and automation applications typically exchange data between a variety of software systems – from operations support systems (OSS) to business support systems (BSS) to network management systems (NMS) – and can even include manually maintained data. As such, the establishment of such a source of truth cannot be underestimated. Such a common and verified database ensures that:

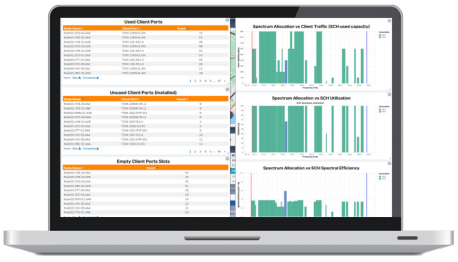
- All systems use consistent data with the same naming conventions
- All involved parties have access to verified data
- Analytics can be used, and decisions are taken based on correct inputs
- Automation can be implemented with high confidence and to its full potential, not running into garbage-in/garbage-out traps
- Once established, it is easier to keep information updated and maintained at high quality

Network Planning Levels

Network planning encompasses a wide range of processes and activities. The highest level of network planning is responsible for defining the general topology and rules for an optical network, which are, among other considerations, based on the available sites and fibers as well as the services that a CSP intends to offer. The lowest level of network planning goes down to site and rack layouts and link engineering.

Benefits of Nokia Transcend Open Wave Explorer Analytics and Automation

- Establishment of a "source of truth" offering reliable data for analytics and automation
- Accessibility and consolidation of statistics for planning and operations
- Higher efficiency in planning and operations processes
- Risk reduction through proactive network management
- Optimization of network resource usage



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In this document, we focus on the operational network planning level, a forward-looking activity that consistently makes sure that the resources in the network are optimally used and that network hardware and spectrum capacity for new demands are always available and at the lowest possible costs.

Demand For Proactive Network Management

In the operational network planning process defined above, both the CSP's planning and operations teams need to ensure that the existing optical network resources are operated and evolved with the highest possible efficiency and the least OpEx and CapEx investment. Apart from day-to-day operations, like alarm management or provisioning, the following scenarios of proactive network management need to be considered:

1. Lifecycle management
2. Spectrum and capacity management
3. Network optimization
4. Identifying and mitigating potential upcoming risks (an "early warning system")

These use cases are explained in more detail below.

1. **Lifecycle management** in this context refers to the introduction and removal of network hardware, with the goal of ensuring that network resources evolve in a timely manner and that end-of-life considerations are taken into account. Lifecycle management needs to identify both opportunities to reduce the ecological footprint of network resources through modernization as well as target opportunities for migrations to newer technologies to increase network capacity.
2. **Spectrum and capacity management** is the orchestration of available network resources to operate existing network services, and the network analysis and optimization required to ensure that the CSP is ready to implement new end customer demands in time. In times of high bandwidth demand, network planners need to use the available fiber spectrum in an optimal way, and they need to secure sufficient hardware capacity on both the client and line sides.
3. **Network optimization's** goal is to improve the efficiency of the resources used in the network. Typical examples of suboptimal resource usage are the following:
   a Blocked network resources resulting from services that are no longer in use but that have not been decommissioned.
   b Spectrum utilization that has been fragmented by services implemented in previous technology generations and no longer match the spectral footprint requirements of modern solutions.
   c Misuses due to discrepancies between various databases in OSS and NMS systems that need to be reconciled.
4. **An early warning system** monitors the trends of critical network parameters over time, tracking their changes and enabling proactive measures if any of these trends exceed a designated threshold value. Such an early warning system can account for both the need for investment due to capacity shortage, as well as replanning needs for performance parameters approaching a critical limit.

Quite obviously, these use cases are neither static nor independent. As an example, a shortage of capacity (identified in use case 2 or 4) might drive a migration activity to hardware supporting higher capacity (use case 1) or a network optimization activity to free up capacity (use case 3). Looking ahead is imperative for network planners to avoid worst-case scenarios such as being unable to create a new payable demand for an end customer due to lack of resources or being impacted by quality issues arising from network degradation that could have been avoided if, for example, fiber performance data trends were tracked by an early warning system.

Implementation of Proactive Network Management

Any network analytics or automation requires a source of truth, which is an underlying reference database that stores all necessary information, consistent and verified. Information about an optical network is distributed across a multitude of sources:

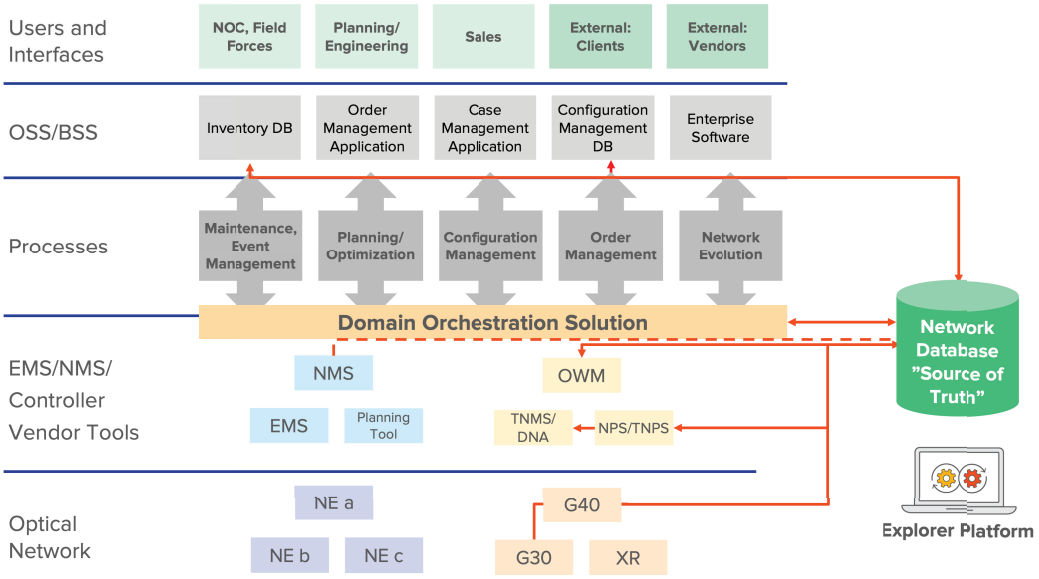

Figure 1: Source of truth concept

- NMS, EMS, and, if applicable, controllers and orchestrators provide a view of the real-time status of the network, covering inventory, topology, configurations, services, and health information. Their databases need to be bidirectionally connected to any automation platform and thus to the source of truth.
- For analytics purposes, data from OSS, BSS and inventory systems will contribute to the source of truth with various data depending on use case, e.g., location, customer service-level agreement (SLA) requirements, planned expansions, spectrum utilization constraints, site constraints in space and power, etc.
- Planning tools may identify fiber constraints or preferred routes.
- End of life information is provided by the equipment vendors.
- Before automation is fully in place, even ad hoc lists or data sets that are manually maintained might be needed to supplement the source of truth.

Before proceeding to automate their network, and depending on the use cases, the operator, with support from the automation solution vendor, needs to establish the initial set of data to be used as the source of truth, including defining the cadence for updating the data. That update frequency can range from real time, e.g., for alarm data, to once per quarter, for fiber data.

Nokia's Transcend Open Wave Explorer Analytics and Automation platform implements the source of truth via an OpenSearch database. This database is used as a basis for a first layer of analytics, supported through OpenSearch dashboards, and for a second layer with tailored analytics and automation applications. Physically, the database and the loader software that is required to correlate and stitch together the incoming data are deployed within the operator's IT environment, either on a physical server or on a virtual machine. In the data correlation and stitching process, any data can be put into context if a common identifier is given. As an example, all that is required when adding client SLA information to a service is the identification of the customer by name, and the association to a service name or service ID.

Demands on Analytics and Automation Platform

Multi-vendor capability

The source of truth is vendor agnostic by definition: the same data should be available for any optical network, regardless of equipment vendor, though it will likely be retrieved via different means and in different formats. Data extraction in multi-vendor environments is easiest when there are standardized northbound interfaces among the multiple sources of data or when an orchestration layer consolidates the network information and provides a standardized vendor-agnostic interface to it.

Ease of operation

To offer real value to its users, any analytics and automation platform must support logical workflows and allow easy adaptation to specific demands. While this sounds trivial, it can only be achieved if the automation solution provider is able to combine technical network knowledge with solid process consulting capabilities.

Ease of customization

The only constant in CSP networking demands is change. And the same applies to workflows and decision trees. Keeping analytics and automation software up to date with network, operational, and business changes is imperative for leveraging the benefits of an analytics and automation solution. Proactive attention to this prevents operators from having to reintroduce manual processes while waiting for automation software updates.

Open interfaces

Any analytics and automation software solution needs to be integrated into the existing CSP IT ecosystem, allowing it to retrieve and ingest data, and to orchestrate changes in the network through interfaces to the NMS/EMS. Standard open north- and southbound interfaces, as well as a pool of data loaders, scripts, and applications that execute everyday actions in the network, are mandatory for any such platform.

The use of the OpenSearch platform for Open Wave Explorer's general analytics functionality allows even low-skilled users to tailor the required evaluations and decision matrices. Nokia's software consulting team combines vast knowledge about network technology with the capability to analyze customer-specific workflows and translate them into guided software-supported processes.

Nokia Open Wave Explorer Analytics Use Cases

In the following section, this document describes how Open Wave Explorer creates a network source of truth and provides powerful data analytics to enable proactive network planning and management. For each of the use cases identified below, Open Wave Explorer offers a concise overview to easily spot topics that need further attention, as well as the means to drill deeper into network information and determine necessary actions in detail.

Inventory and lifecycle management

Open Wave Explorer includes a summary dashboard to provide users with an overview of resources in their network, overall or filtered by site, type, whether used or unused, and how that inventory evolved over time. The dashboard view includes overall statistics for upcoming or already active end of life (EoL) situations for network elements.

For more detailed analysis on what needs to be done to mitigate these EoL issues, Open Wave Explorer guides the user to break down the network information per scenario to:

a Identify in the replacement scenario where and what number of hardware units need to be replaced and how many services will be affected by the replacement.

b Evaluate in the consolidation scenario how many services can be moved to newer equipment and which ports are free and can be used in this move.

Any such results can be complemented with instructions for next actions, and then exported for follow-up by responsible departments.

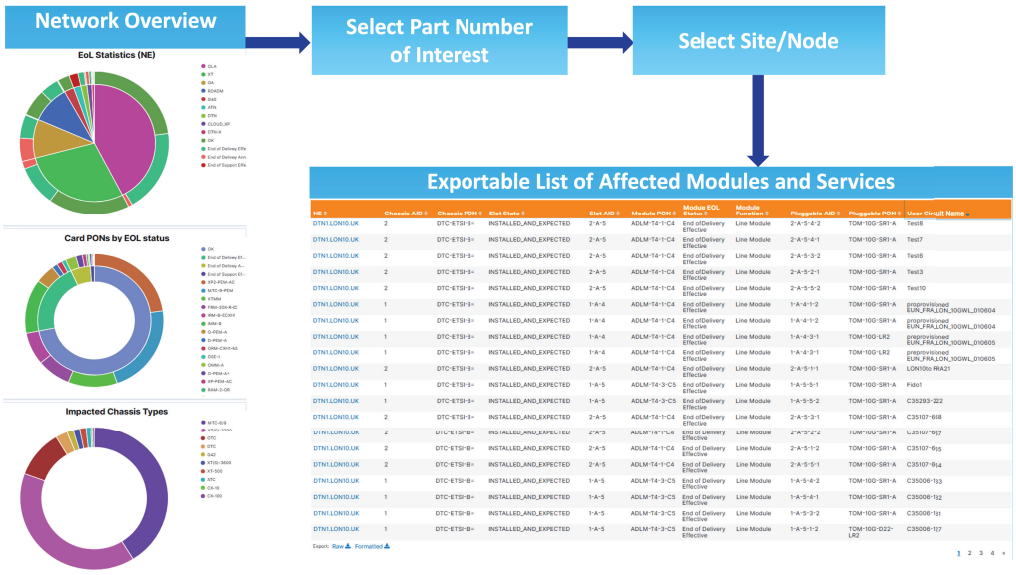

Figure 2: Workflow for preparing network migration

Figure 2 shows a simple workflow embedded in Nokia Open Wave Explorer that leads from an overview showing the overall inventory and the modules affected by EoL considerations to the detailed information of the services affected by the removal of these modules at one site.

The benefits of this capability go beyond the achievable 90%+ effort savings in conducting the analysis – making it so easy enables operators to move from reactive change planning to proactive lifecycle management that is embedded in an overall network planning process.

Spectrum and capacity planning

Spectrum and capacity planning, i.e., making sure that the given network assets are optimally used for offering services to clients, is, without a doubt, at the essence of optical network planning. Given this, it is astonishing that most operators are still using a common spreadsheet (e.g., Excel) for allocating existing and new demands in the predefined optical spectrum of their fiber assets. Working with tables that have 400+ columns (assuming a 12.5 GHz grid) might be feasible for operators with small networks and few optical routes, but it certainly gets extremely cumbersome for meshed, dynamic networks that are used to their limits.

Nokia Open Wave Explorer provides an instantaneous overview of how much of the existing equipment inventory is in use on the client and the line side, as well as what spectrum is occupied and what is available for new demands. The results are shown both graphically and in tabular form. As an example, for optical multiplex sections (OMS) or end-to-end optical routes, Nokia Open Wave Explorer shows the configured super-channels and their capacity; the available spectrum, including free contiguous blocks of predefined sizes, e.g., 50 GHz and 112.5 GHz blocks; and the maximum contiguous block of frequencies.

For new demands, based on the selection of a few basic parameters, Nokia Open Wave Explorer shows how to best implement change, if existing super-channels can be used or new ones may be created.

In addition, Nokia Open Wave Explorer shows trends for each of the parameters relevant to capacity planning, thus allowing potential shortages to be addressed proactively.

As for the previous use case, the benefits of using Nokia Open Wave Explorer go beyond the mere reduction of planning times by up to 70%. Adding more transparency and better insight into used resources improve quality of planning and enables much faster turnaround to client requests.

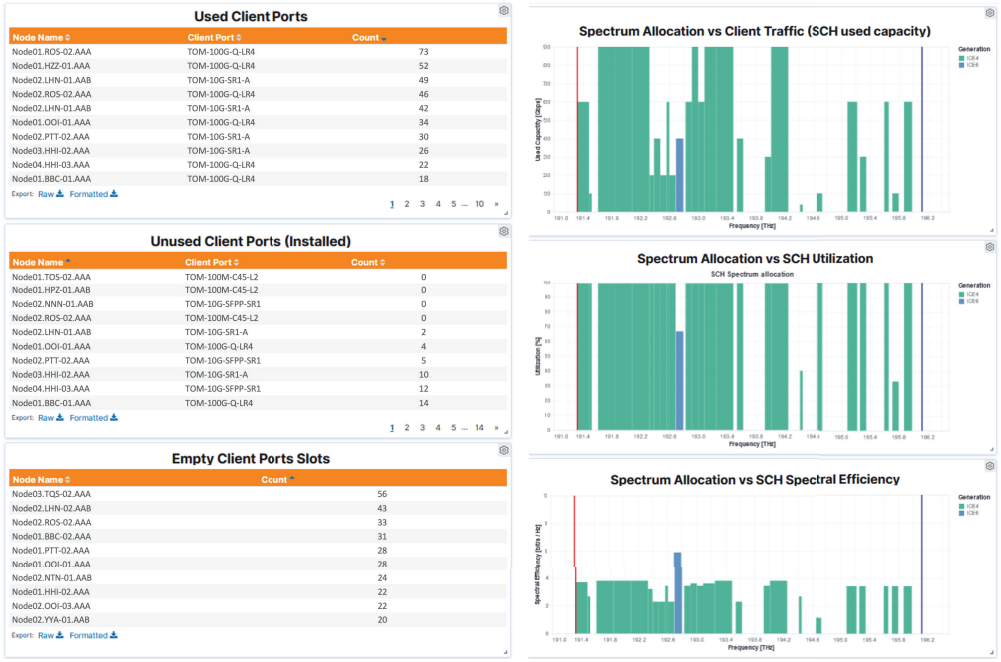

Figure 3: Spectrum and capacity information

Network optimization

Network optimization corrects the less than optimal use of network assets by identifying faults and removing them. While there are multiple aspects that can be optimized in a network, the current version of Nokia Open Wave Explorer focuses on three of them:

1. **Elimination of unused services**:

   Over the years, networks accumulate services that block capacity and spectrum while not actually being used or even paid for. The root cause of such services is manifold, ranging from test services to client services that were never removed once they stopped being used. Nokia Open Wave Explorer uses three methods to identify such potentially unused services:

   a Name patterns, i.e., service names containing “test” or any other descriptions that hint to a temporary nature.

   b Long-term service-affecting alarms, e.g., a service that has a loss of signal or similar for weeks without any action being taken on it.

   c Evaluation of performance data, where this data shows that there is no actual traffic flow over a reserved capacity.

   While all these indicators still need verification in an operator’s BSS before services are deleted, having an automation system tagging them greatly helps in capacity recovery.

2. **Spectrum defragmentation**:

   Every new transponder generation in optical networks has come with higher capacity, higher efficiency – and, for the most recent generations, new rules for spectrum allocation. Consequently, planners’ rules for effective spectrum utilization that have worked for some time become void or even counterproductive with the introduction of the next product generation. The result is optical spectra that might have free slices, but those slices may not be usable by the transponders that are to be deployed. The solution to this problem is defragmentation, meaning moving existing demands in a way that frees up bigger blocks of contiguous spectrum, ideally blocks that are multiples of the spectrum demands of the most modern equipment, e.g., 112.5 GHz blocks for sixth-generation transponders.

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Nokia Open Wave Explorer supports such defragmentation by providing insight into spectrum blocks that can be moved and through an in-built workflow for network defragmentation.

3. **Removal of database inconsistencies:**

   Once a CSP has a single source of truth, it can be used to align the datasets within the OSS and NMS systems. The databases used by those systems tend to have different names for the same identifiers (e.g., a service ID). The origin of these discrepancies range from different historical naming conventions to accumulated erosion caused by, for example, copy/paste errors. Removing these inconsistencies, while not freeing up resources or improving network quality per se, certainly improves process quality and makes business process automation easier.

   For Nokia Open Wave Explorer, the identification of such inconsistencies is a built-in mechanism for establishing a source of truth and thus can be easily reused for setting up intersystem database synchronization.

Again, the benefits of network optimization using Nokia Open Wave Explorer are manifold. Depending on the mechanisms the CSP used before adopting Nokia Open Wave Explorer, the efforts for executing the three activities listed above decrease by up to 90%. But even larger benefits can be achieved if these activities become part of a regular routine, consistently freeing up capacity (saving CapEx) and providing higher flexibility for processing new demands (higher revenue).

Operators typically start by applying these activities to a limited part of their network to evaluate the size of a problem and then decide, based on the results (e.g., >5% unused services), the implementation forward and the cadence of repetition of these optimizations.

Early warning system

Orchestrator solutions, NMS, and EMS provide an accurate reflection of the current state of the optical network. They provide continuous and real-time updates on events like fiber breaks that require immediate attention. But other critical parameters need to be observed over time to determine a need for actions. These parameters cover several aspects of an optical network:

1. **Quality trends** over time range from tracking fiber parameters like signal degradation to the number of fiber breaks for a given OMS or the number of critical events for defined areas (or optical paths) in a network.
2. **Client trends** include client-specific evaluation of alarms, events, and service utilization to enable better client management.
3. **Spectrum and capacity trends** target proactive management of hardware and available spectrum to be prepared for any new client demands.

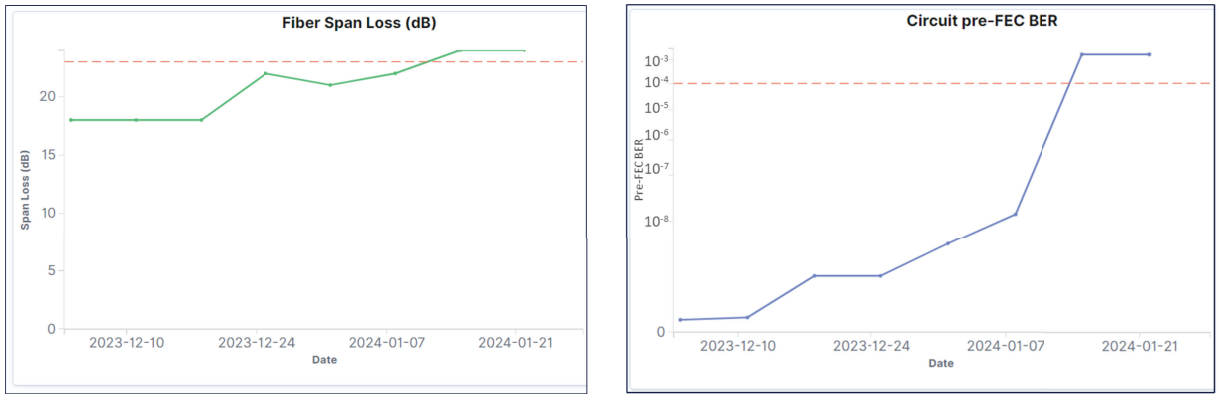

Figure 4: Trend analysis examples with threshold line

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Nokia Open Wave Explorer's early warning system supports the definition of thresholds for each individual parameter and sends automated emails to defined distribution lists should a threshold be passed.

The benefits of such an early warning system are largely risk avoidance and OpEx savings, by making network changes in a proactive and planned manner as opposed to costly emergency actions.

Conclusions

The ever-increasing need for bandwidth combined with higher network complexity requires network planners to proactively manage network assets, including equipment and fiber, to avoid congestion and potentially costly recovery activities. In parallel, significant progress in workflow automation software and artificial intelligence allows for the evolution of business processes to software-supported workflows.

Nokia Open Wave Explorer addresses both these topics:

- By consolidating all relevant and reliable data into a single source of truth, Open Wave Explorer enables targeted, use-case-driven network analytics and thus proactive operational network planning processes. Open Wave Explorer is then used to automate network-related workflows, e.g., to do intent-driven provisioning of new services or migrations.
- That same source of truth and related analytics are then the basis for the network-driven decision trees that are incorporated into end-to-end business process automation.

Due to its flexible implementation options and its ease of customization, network operators can smoothly introduce Nokia Open Wave Explorer as first layer of proactiveness and automation.

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

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