Solution Brief

Network Management and Planning with the SoSmart Software Suite

Disaggregation of the optical network requires a similarly open approach to the management of the network elements. With the SoSmart Software Suite, Smartoptics provides a modular, SDN-based, management solution using open API:s and open-source software components.

smartoptics

Our Management Philosophy

Looking at the total life cycle cost of a communications network, the recurring operational and management expenses dominate. Smartoptics, being a strong supporter of open optical networking systems, is convinced that the disaggregation of legacy architectures taking place for the physical WDM network should also be applied to network management and control. Our management solutions are therefore based on the principles of open API:s and Software Defined Networking (SDN), with a focus on a high degree of automation and on the disaggregation of functionality by use of open-source software components, reducing the operational costs of the optical network.

An Open Network Management Architecture

Smartoptics, a pioneer in open optical networking, has from the start recognized the benefits of leveraging open architectures for optical networks. With an open architecture the functionality of once monolithic optical transport systems is disaggregated, using pluggable transceivers, open line systems and Software Defined Networking (SDN) control, resulting in optimal price/performance. This “IP over DWDM” approach, i.e. pluggable transceivers in routers and switches combined with open line systems carrying the DWDM channels over longer distances, is becoming the new standard when deploying optical networks.

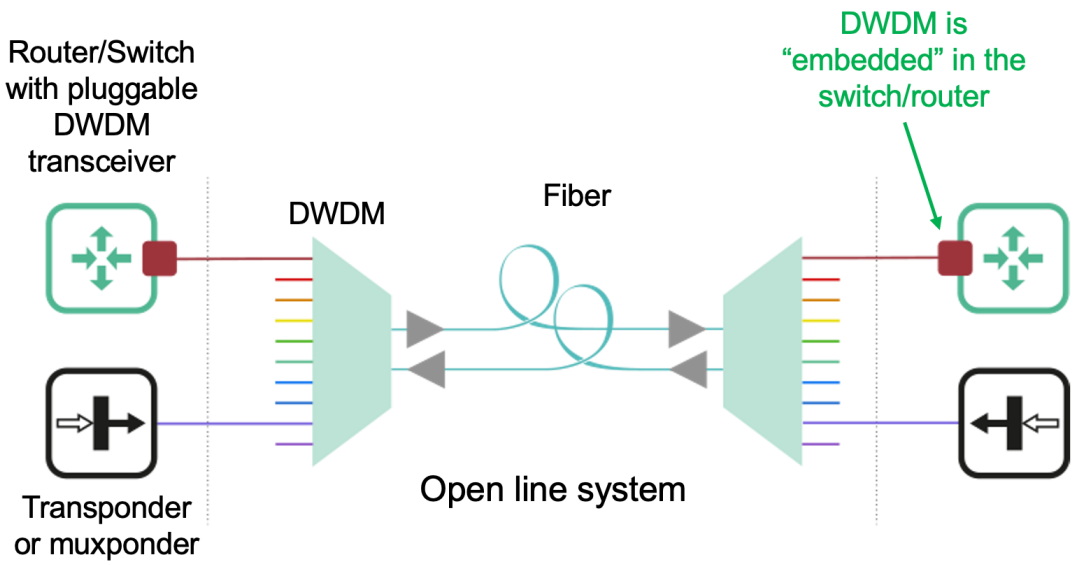

Figure 1. The Open Optical Networking Model

An open optical network requires a similarly open approach to network management. Where traditional optical transport system vendors have built proprietary software architectures for management of their own hardware, Smartoptics products provide open API:s that allow the customer to leverage open-source solutions available today, to develop their own applications on open SDN platforms, or to buy complete management solutions from other commercial players.

Our approach to network management is open and based on standardized API:s, which brings several advantages. Rather than being dependent on the functionality and evolution of any vendor specific management platform, you may now leverage the advances of an open-source effort such as the TransportPCE SDN controllers. It gives you a much higher degree of flexibility in designing the network management solution and adapting it to the optimal workflow for your organization. With open management API:s in the network elements, you can go for anything from a sophisticated SDN-based and centralized network management system to just staying with the simple command line interface in the network elements. Any development of customer specific solutions to manage your network is thus considerably less complicated in this modern and open environment than for a closed architecture, which is restricted by proprietary software functions tightly embedded in the network elements.

A Focus on Automation

Smartoptics traditional focus has been on the corporate data center interconnect (DCI) market where a high level of automation ("plug-and-play") is greatly appreciated by our customers. Automation aspects are therefore particularly important to us, and we are convinced that such operational benefits are of value for all our customers. We are hence designing for as many automation capabilities as possible within our products, both when used "stand alone" and in an SDN framework.

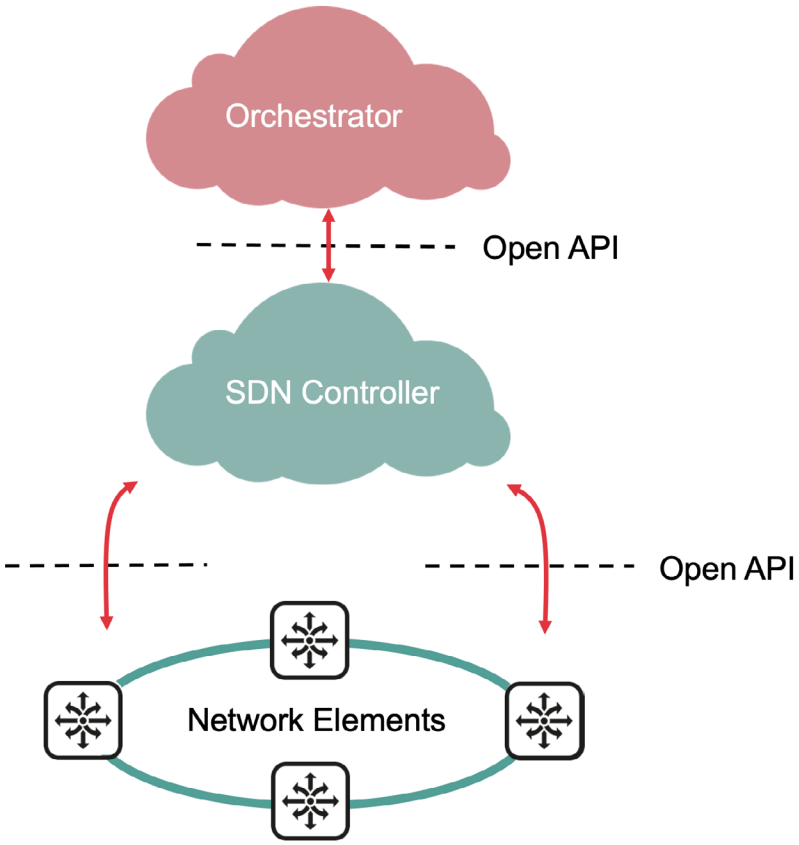

Figure 2. Smartoptics Open Network Management Architecture

The DCP Families and their Management

Smartoptics has paid significant attention to the management of the products based on the Dynamic Connectivity Platform (DCP) to make them the superior choice, both for customer having highly trained optical specialists, and for customers who want a “ready-to-go”, “plug-and-play” solution.

- The DCP-R and DCP-F families, often deployed in operator networks, are primarily designed to be remotely managed. The management can either be via a command line interface (CLI) or by using Software Defined Networking (SDN) principles based on the Open ROADM MSA initiative. The capabilities of this mode of management using the SoSmart Software Suite are further outlined in this solution brief.
- The DCP-M family, primarily used in point-to-point networks for Data Center Interconnect (DCI), is optimized for zero-touch, fully self-configuring/ regulating deployment. The DCP-M can also easily be managed from the SoSmart Software Suite using SDN principles. Support exists for SNMP traps and MIBs that can be integrated into any third-party management system for surveillance purposes.
- The DCP-Series of modular transponders and muxponders in the DCP-2 chassis, often deployed in operator networks, are similarly designed to support remote management by the SoSmart Software Suite.

The availability of zero-touch, CLI and SDN-based management for each individual DCP product is release dependent.

DCP-SC

DCP-R

DCP-F

Figure 3. The DCP families comprise shelf controllers and products for Flexible Open Line Systems, Transponders and Muxponders

The SoSmart Software Suite

SoSmart is a modular software suite for SDN-based management of Smartoptics products in an open, multi-layer and multi-vendor optical networking environment. The management suite has a new and modern software architecture with open API:s that enable a high level of management flexibility, modularity, multiple integration possibilities, and openness.

The Smartoptics SoSmart Software Suite for open network management includes the following building blocks:

- **The SoSmart Manager** – The application for optical network visualization, configuration and management, including fault, configuration, administration, performance, and security (FCAPS) functions, and controlled via an advanced graphical user interface (GUI).
- **The SoSmart Controller** – An open source SDN controller based on TransportPCE.
- **The SoSmart Planner** – An integrated optical planning and simulation tool with the same GUI as the SoSmart Manager and using the open-source module GNPy for path simulations.

The SoSmart Software Suite interworks seamlessly with the DCP-R (ROADM) network elements, each of them having data models based on Yang and supporting the Open ROADM API:s, which are made accessible via the NETConf protocol. This open approach has an advantage: The DCP-R network elements may, if so required, also be directly controlled by other SDN controllers supporting the Open ROADM API:s and NETConf.

The SoSmart Software Suite also provides configuration and monitoring capabilities for the Smartoptics' DCP-M and DCP-2 type of network elements by use of SNMP and the gNMI protocol.

Furthermore, and to simplify the integration with your higher-level network management orchestrator, the SoSmart Controller includes a northbound RESTConf API/ONF TAPI which can be used to control the entire network layer from an external system. This provides for a simple and easy integration of the complete, DCP-based, optical network with the management and provisioning systems you already have in use.

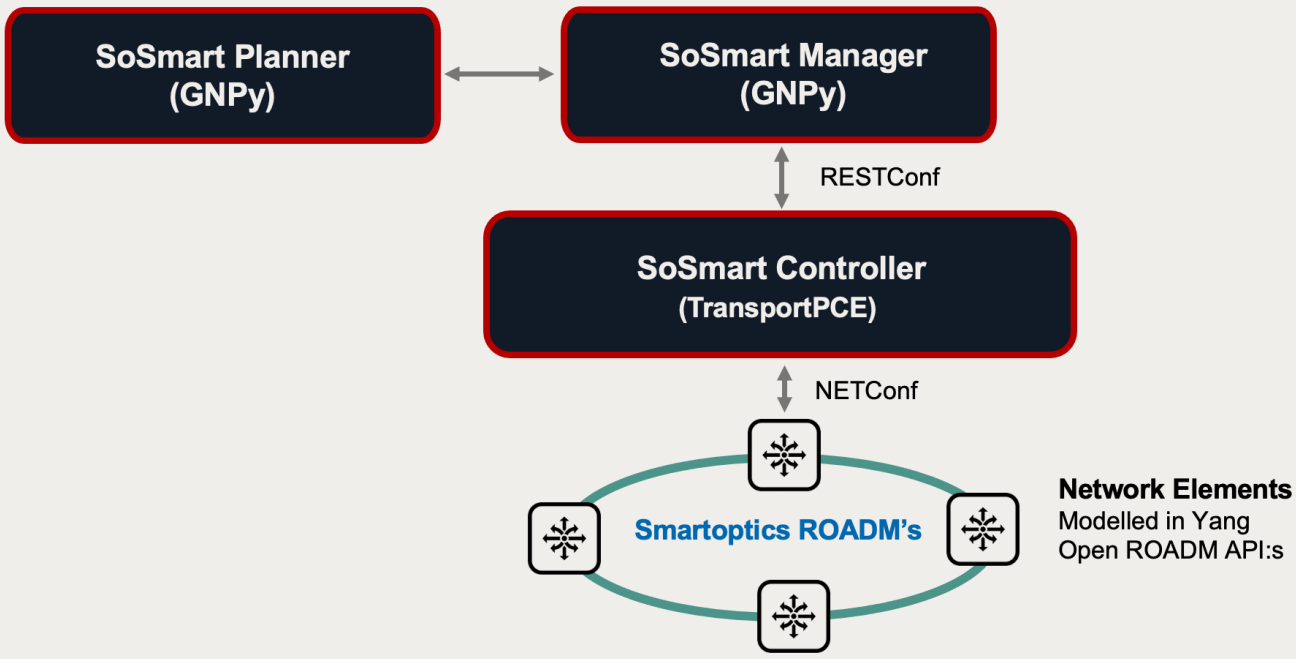

Figure 4. Smartoptics SoSmart Software Suite modules

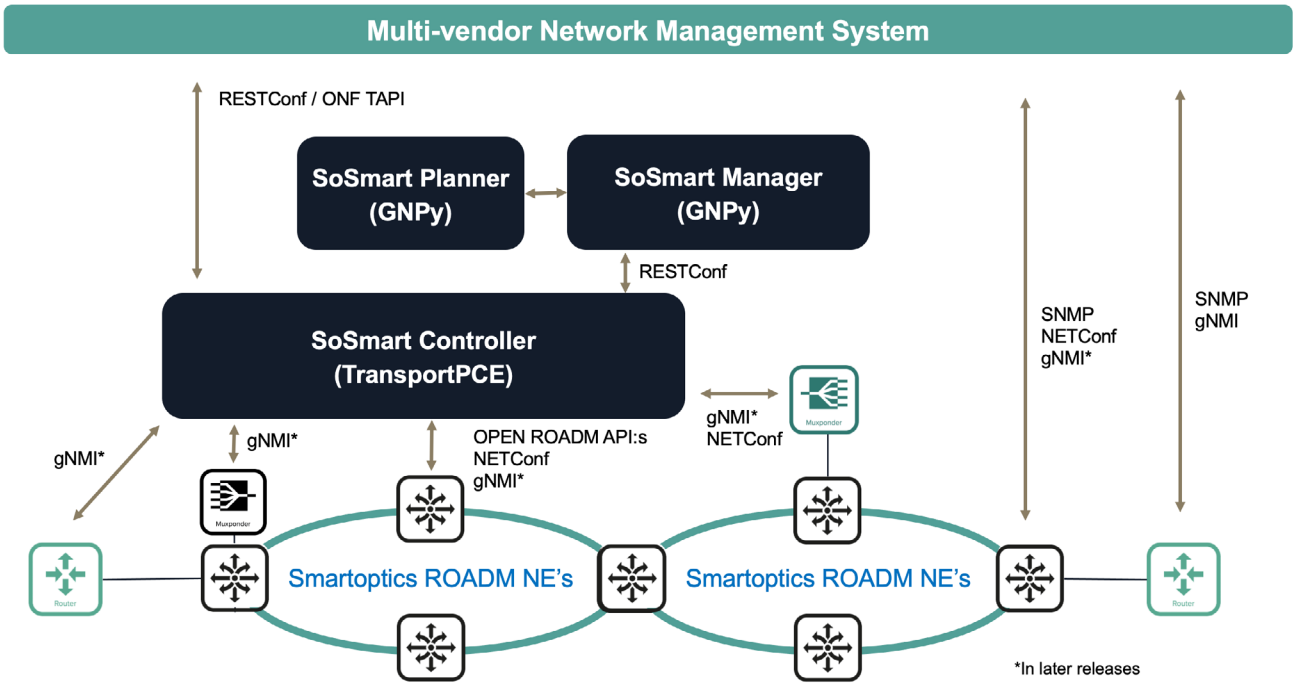

Figure 5. Examples of SoSmart interoperability alternatives in a ROADM network

As seen in the illustrations, the building blocks of the SoSmart Software Suite can be mixed and matched in a very flexible way to best adapt to the requirements of your management philosophy. (The Smartoptics products are shown in black, while green symbols indicate products and systems from other vendors.)

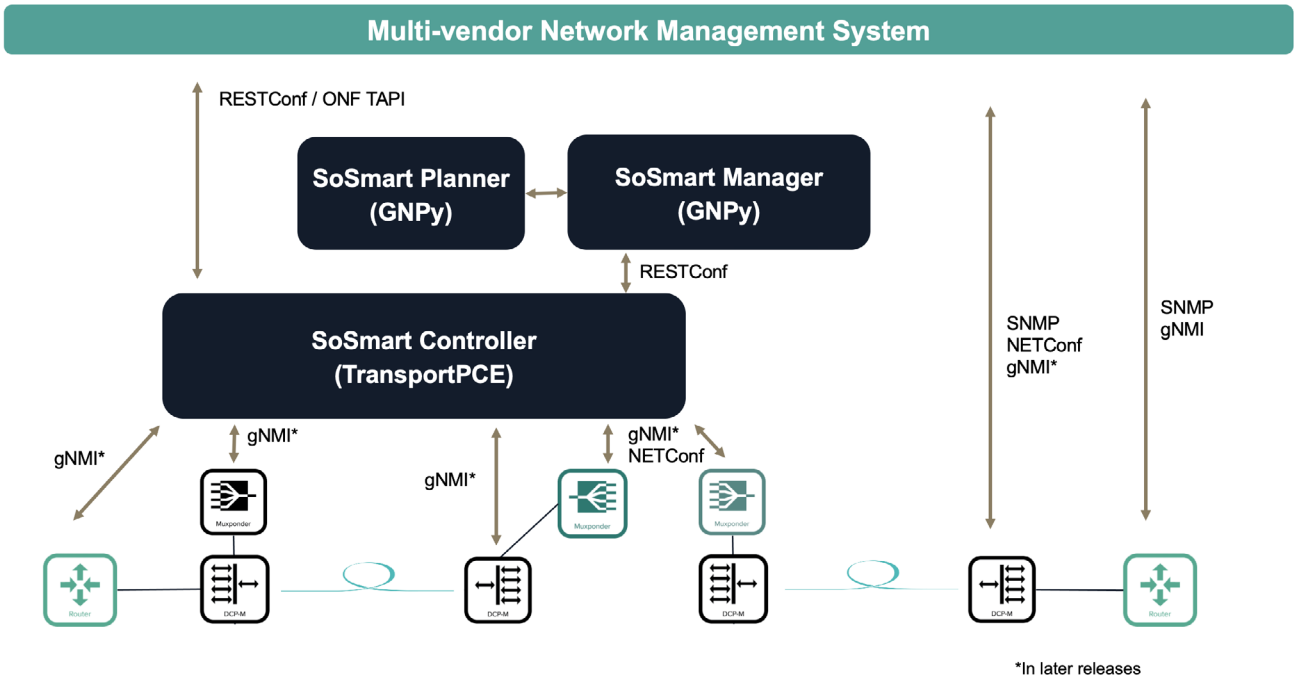

Figure 6. Examples of SoSmart interoperability alternatives in a DCP-M network

You may for example go for a complete management solution from Smartoptics, including the SoSmart Manager, the SoSmart Controller, and the SoSmart Planner. In this case you perform the complete provisioning and management of the optical network via the SoSmart Manager and its graphical user interface.

Alternatively, you may use the SoSmart Controller provided by Smartoptics as the interface to the Smartoptics network elements and integrate this controller with other applications and orchestrators already deployed in your organization. And you may then also include the SoSmart Planner in the software package provided by Smartoptics.

Or you may use your already existing SDN controller with its SDN applications/orchestrator and connect this SDN controller directly to the Smartoptics network elements. Thanks to our compliance with the Open ROADM API:s and the use of the standardized NETConf protocol, the DCP-based network elements can easily be integrated with most SDN controllers or orchestrators.

The DCP Embedded Software

The software embedded in the DCP network elements is Linux-based and uses Yocto as an open-source collaboration framework. The application layer provides unified, programmable northbound management capabilities including access control and redundancy/replication as well as software upgrades and rollback functions for the device. Information is stored according to Yang data models wherever relevant.

The diagram below gives an overview of the different blocks within the DCP embedded software and the management interfaces available.

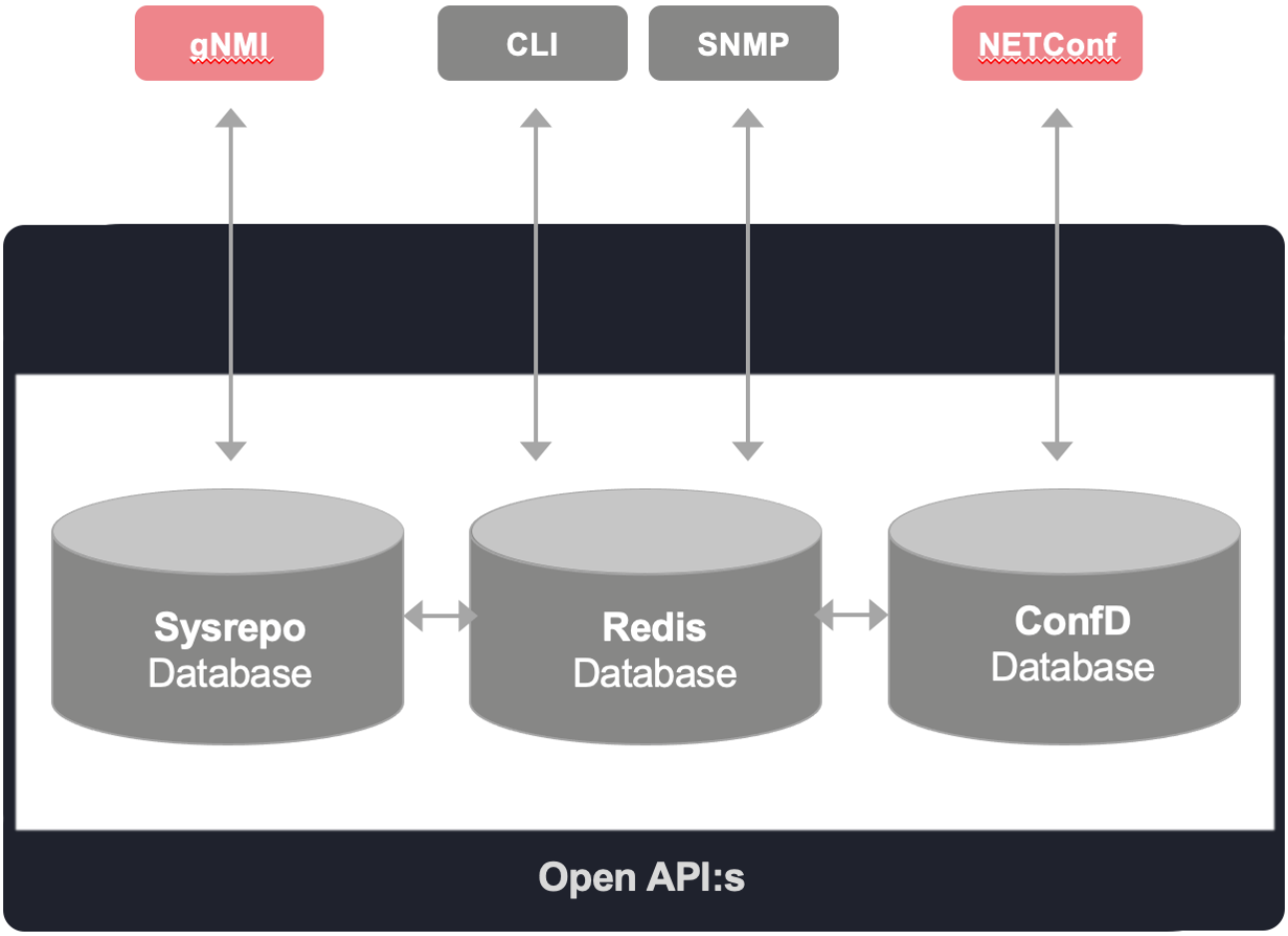

Figure 7. DCP embedded software architecture

The SoSmart Controller

The SoSmart Controller utilizes the open-source Transport Path Computation Element (TransportPCE). TransportPCE can be described as a controller application running on top of an OpenDaylight SDN platform. Its primary function is to control an optical transport infrastructure using a non-proprietary south bound interface (NETConf). TransportPCE may be interconnected with a GUI or controllers of different layers, a higher layer controller and/or an orchestrator through standardized API:s (RESTConf). The control functions include the capability to configure the optical equipment, and to provision services according to a request coming from a GUI, higher layer controller and/or an orchestrator.

The TransportPCE modular architecture is shown in the next figure. Each main function, such as Topology management, Path Calculation Engine (PCE), Service handler, Renderer responsible for the path configuration, and Optical Line Management (OLM) is associated with a generic block relying on open models, each of them communicating through published API:s.

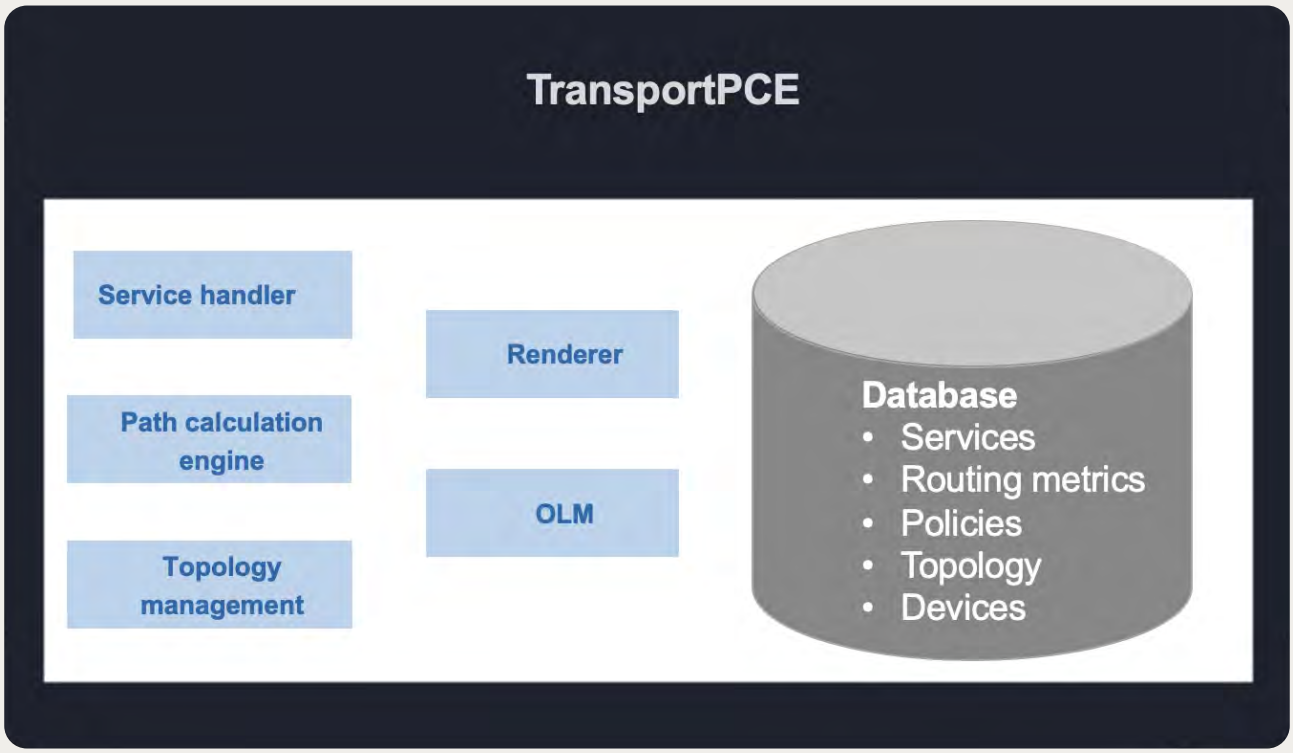

Figure 8. The Transport PCE modular architecture

SoSmart Controller Communication (DCN)

The SoSmart Controller communicates with the network elements through a standardized NETConf interface that complies to the OpenROADM API:s. Later releases will also include support of the gNMI protocol. Information about the network element is modelled according to Yang wherever relevant, the advantage being that data is validated and stored in a standardized way.

The communication links to the individual network elements are typically implemented over a secure and dedicated IP-network (DCN) reaching each optical network node. Since the node may consist of several individual devices, the communication solution is designed to allow for a local router – a shelf controller – providing one IP-address per node according to the OpenROADM standard.

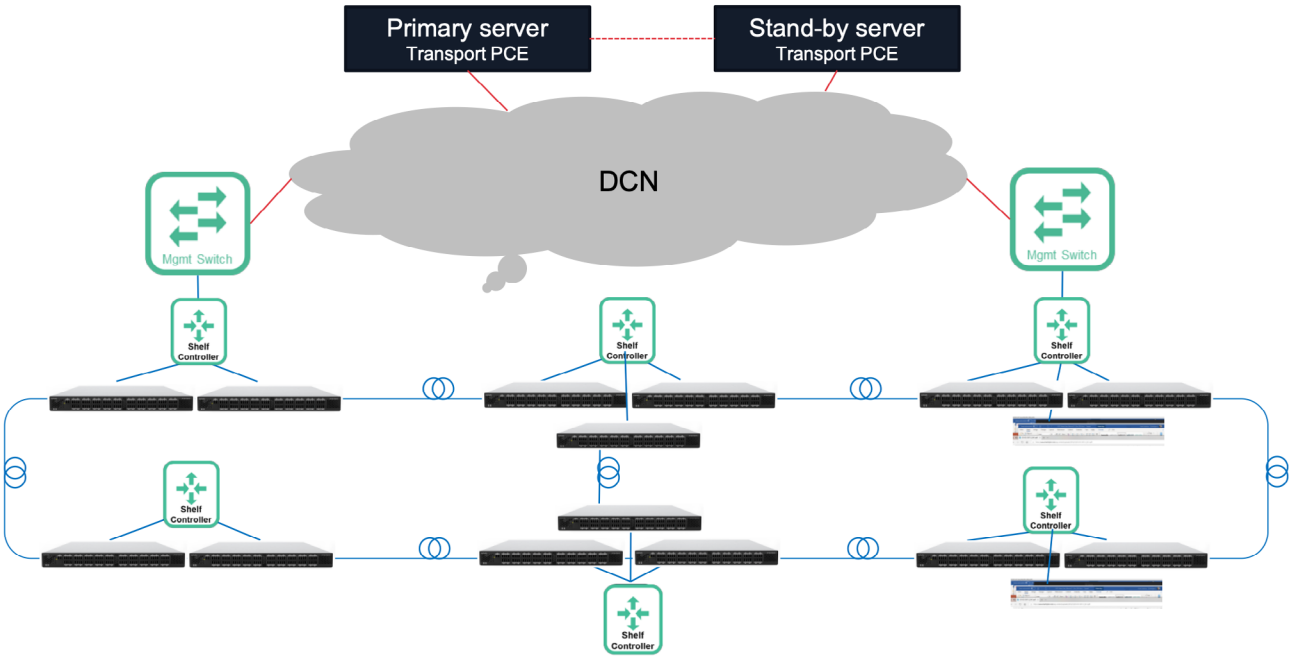

Figure 9. DCN solution for DCP management

The SoSmart Manager

The SoSmart Manager is the interface between the physical optical network and the staff operating the network, and hence the graphical user interface (GUI) plays a crucial role for the efficiency of network provisioning and management. The GUI must provide the network operator with sufficient status information, while at the same time simplifying the configuration and management of the optical network as much as possible.

When using the SoSmart Manager you get a graphical view of the optical network based on the geographical locations of the network elements and their GPS coordinates. The network elements and the interconnecting fiber links are shown on top of a background map provided by OpenStreet Map, making it simple to identify the physical location of every site. Provisioning of new nodes and fiber links is done by simple point-and-click actions and information about active services as well as other types of status information is presented in the GUI. All essential fault, configuration, administration, performance, and security (FCAPS) functions are also easily performed via the SoSmart Manager GUI.

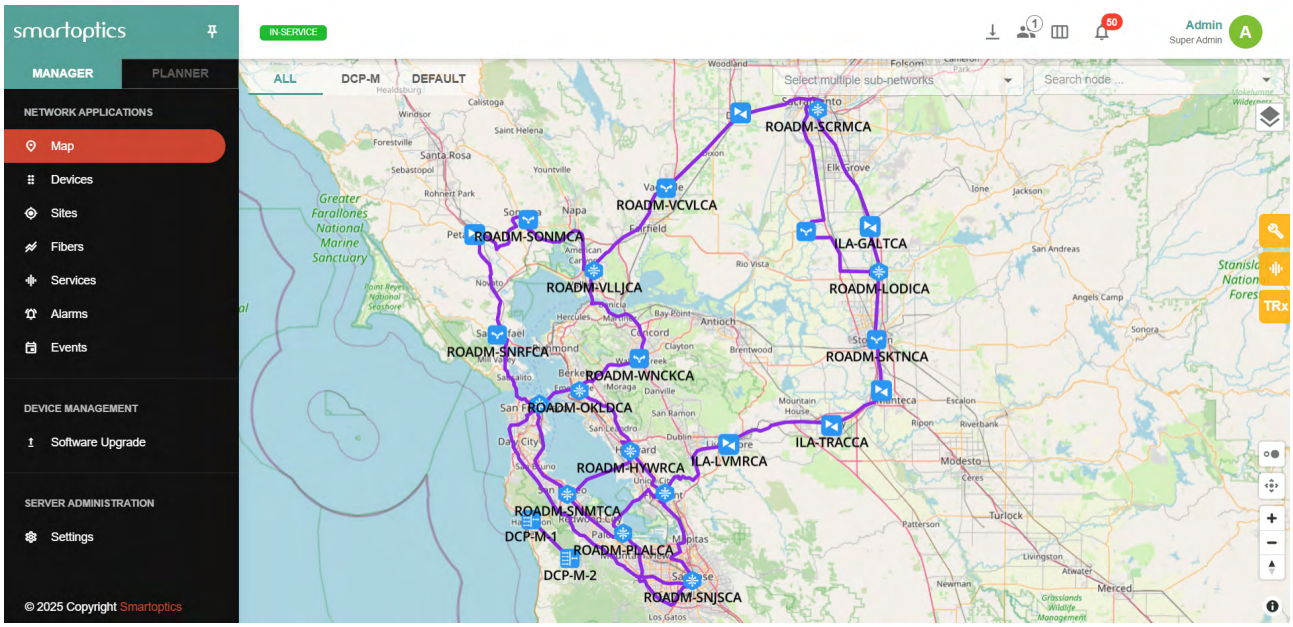

Figure 10. The SoSmart Manager Graphical User Interface

The Graphical User Interface

The graphical user interface in SoSmart Manager helps the network operator to visualize, configure and manage the optical network. It is designed to be straight forward and intuitive to use when opened in a web browser after a valid login. Navigation is easy with menus on the left and the main workspace on the right side of the display. Graphical representations and selectable menu alternatives are used wherever possible. Your optical network is graphically presented on a map with node locations accurately defined based on their GPS coordinates. The network map is dynamic so you can zoom in and out, tilt and rotate. The nodes can be expanded and their degrees and included network elements can be listed. Quick information about any node and fiber is easily obtained by a simple mouseover action.

The main menu on the left-hand side of the GUI contains links to application windows such as Map, Devices, Fibers, Services, Alarms, and Events. For the system administrator, there are also links to windows for account management, server logs, authentication, backup & restore, and various security settings.

On top of the workspace, you will find a bar with some general functions for quick access, e.g. the action queuing list, active users list, notifications list, and additional user settings. There is also a “Download file” button that allows you to export the entire network configuration as a JSON file.

Mounting the Network Configuration

The nodes to manage can be added (mounted) to SoSmart Manager in several ways, for example by right-clicking anywhere on the map or by using the Devices window.

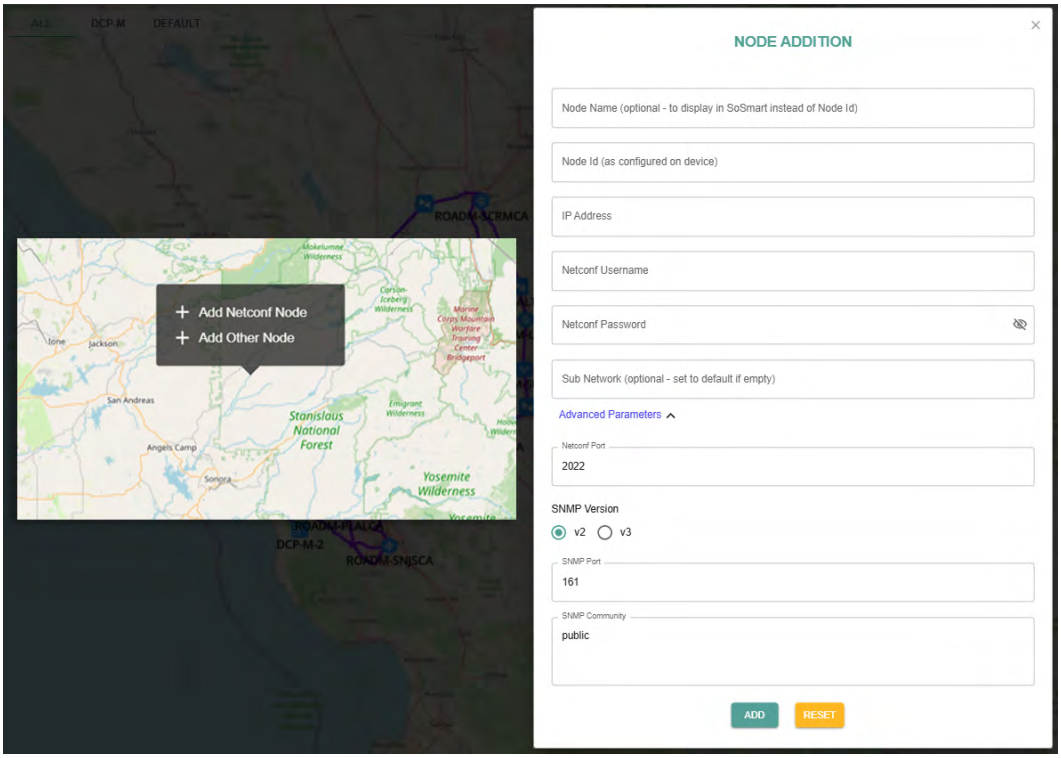

Figure 11. Adding new nodes

When a node is mounted and given that the corresponding network element(s) have been correctly configured when deployed, SoSmart Manager retrieves all relevant data for the node directly from the network element(s) at the physical site.

For DCP-M nodes, the connecting fiber links can be mounted both automatically and manually by the user. For DCP-R and the In Line Amplifier (ILA) nodes, the fiber topology is automatically discovered when the nodes are added to SoSmart Manager. Once the fiber link exists, the fiber link and its detailed attributes can be viewed in the Fibers window.

It is also possible to import and mount a complete network topology in SoSmart Manager from a JSON file that has been prepared off-line.

Point and Click Service Provisioning – Configuration Management

Layer 0 path calculations and wavelength service creation between nodes as well as Layer 1 transport service creation between Smartoptics transponders are easily done by simple point and click actions. Just select a port in the node where the optical channel shall start and a port in another node where it shall end, specify the traffic format, set the center frequency and slot width for the Flexgrid, and you are done. The SoSmart Manager will automatically calculate the path and estimate its performance using the open-source GNPy module.

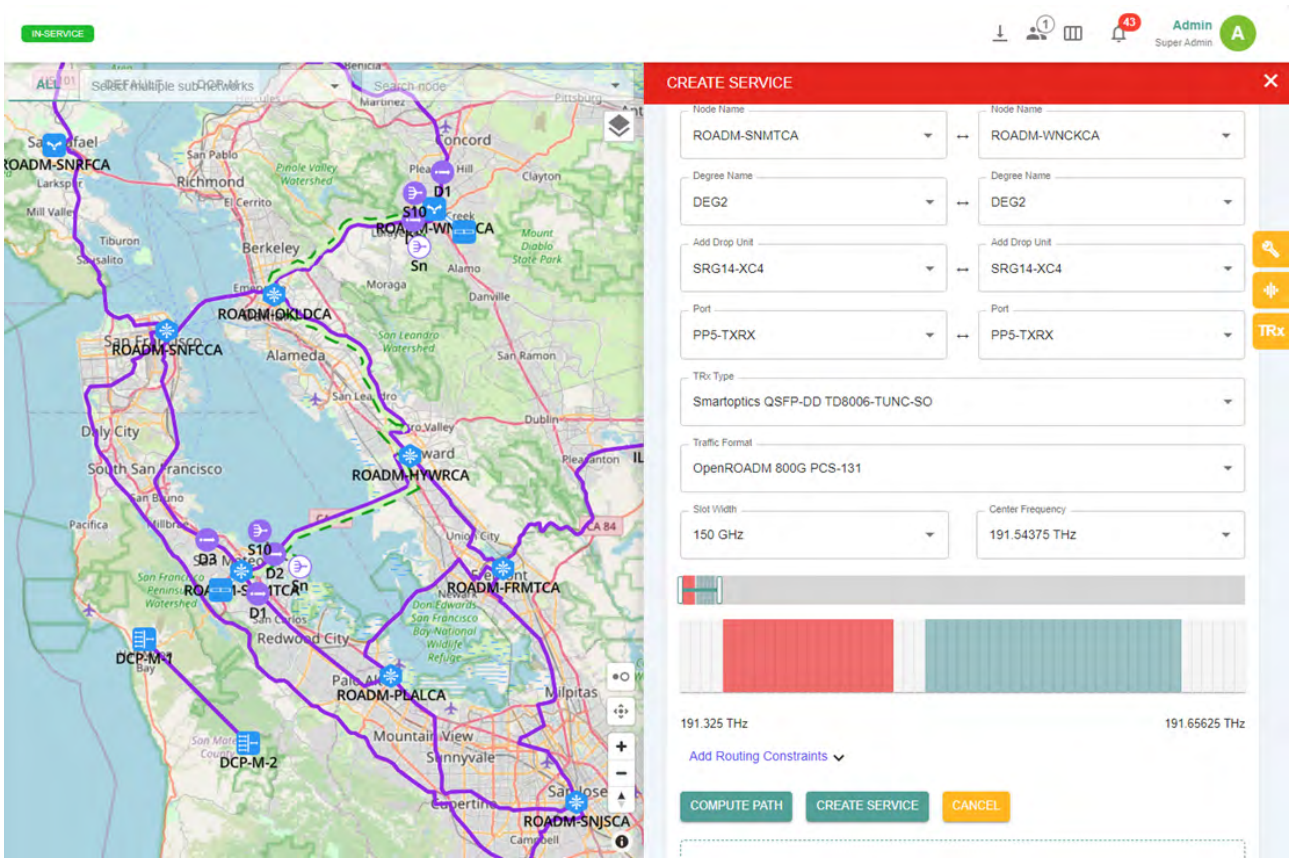

Figure 12. Selecting the start point and Flexgrid parameters during service provisioning

The service is then available and listed in the service list showing its operational status. Each service list item can be expanded for further details about the network elements involved. In this way it becomes possible to monitor the characteristics of the service end to end, from the transceiver in the router, via a transponder and the ROADMs, all the way to the receiving router. And when the overall network view is displayed, a simplified indication of the service route and its operational status are also shown graphically.

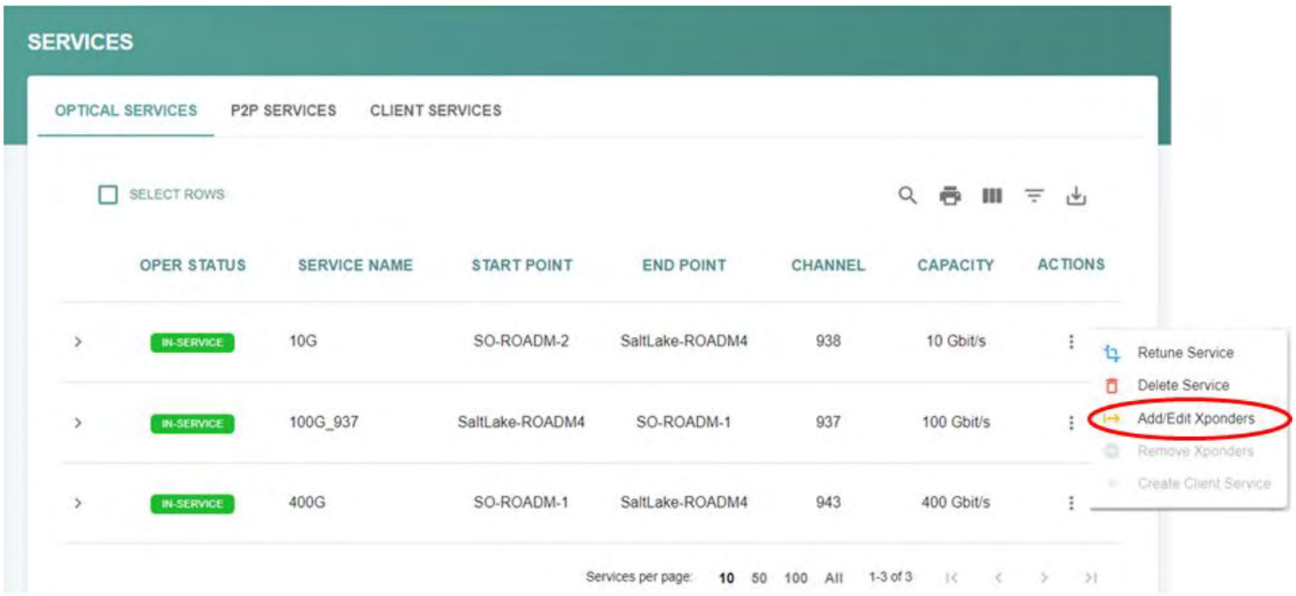

Figure 13. Example of a services list containing service information and the Action buttons

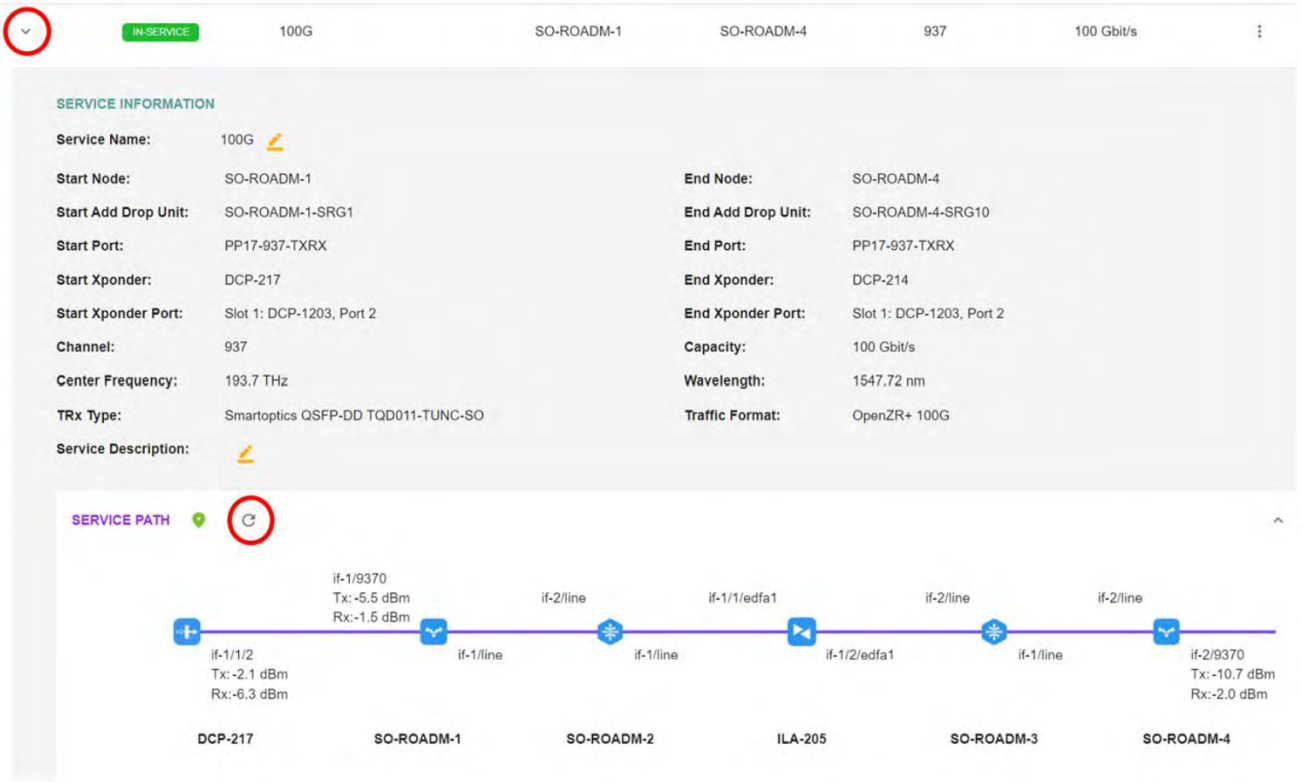

Figure 14. Detailed end-to-end service information and the traced service path

SoSmart Manager automatically saves the GNPy simulation results from the path computation measurements, and you can view them whenever needed from the Services tab.

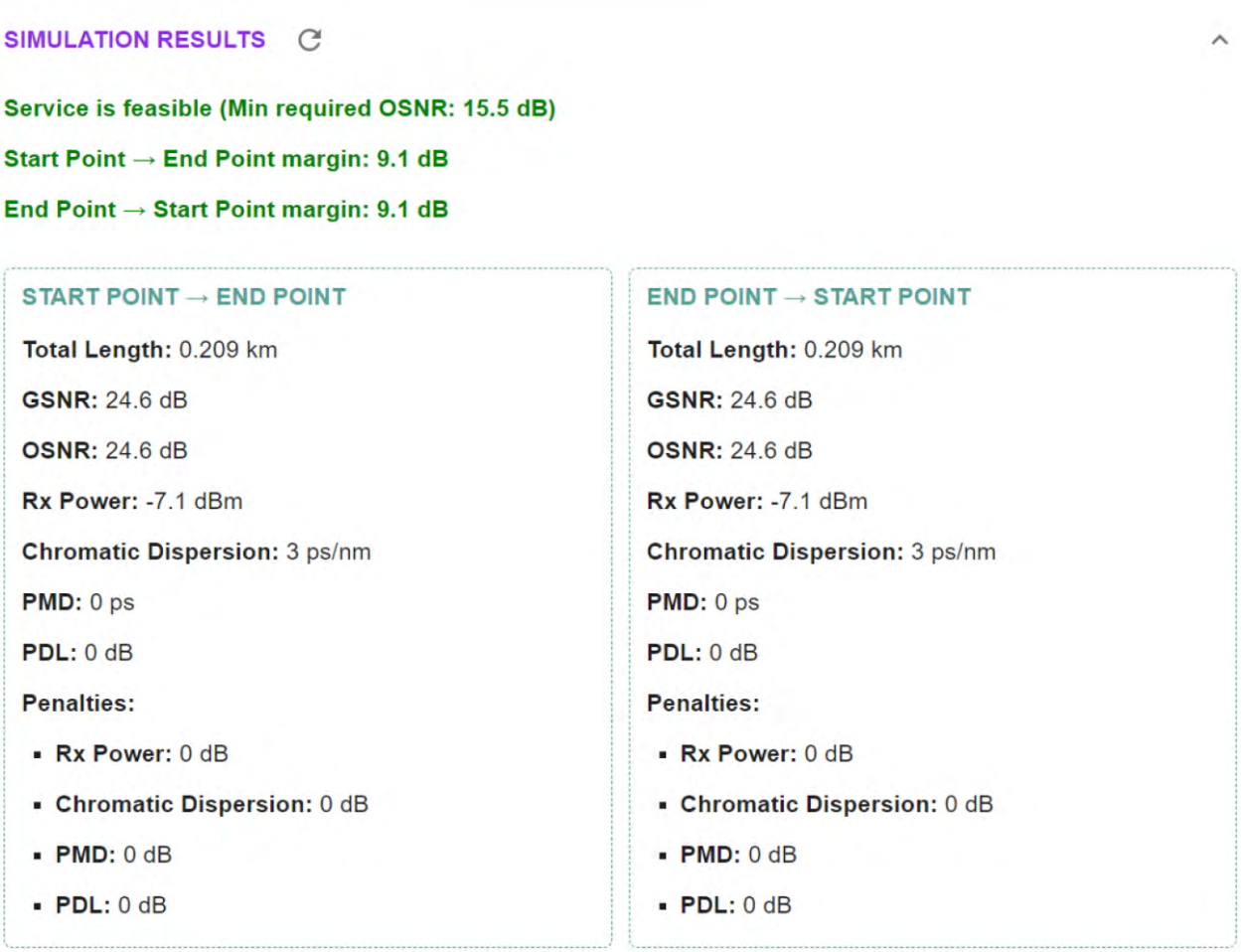

Figure 15. OSNR and GSNR GNPy simulation results for a service

All services are tuned to the correct optical power levels in the provisioning step, but if the span loss values on different spans or the transceiver output powers vary after a while, it is possible to use the function “Retune Service”. This means that the control loops will be regulated once more to adjust to the new conditions.

Fault Management

The SoSmart Manager provides easy to see visual alarm indications in the map view of the network. There are also alarm lists and alarm logs for nodes, fibers, and services to simplify fault-finding and trouble shooting. It is even possible to add and configure SMTP servers for the purpose of sending out email alerts to key personnel as soon as an alarm is detected.

On the top-bar in the map view, SoSmart Manager lists the total number of currently active alarms of a given severity in the network. In the absence of any alarms, the status shown will be “IN-SERVICE”. The individual nodes in the map view also indicate if there is one or several alarms by showing either a blinking circle or a static circle around the node icon. The color of the circle is set by the alarm with the highest severity. The fibers in the map view indicate a fiber problem by blinking in red.

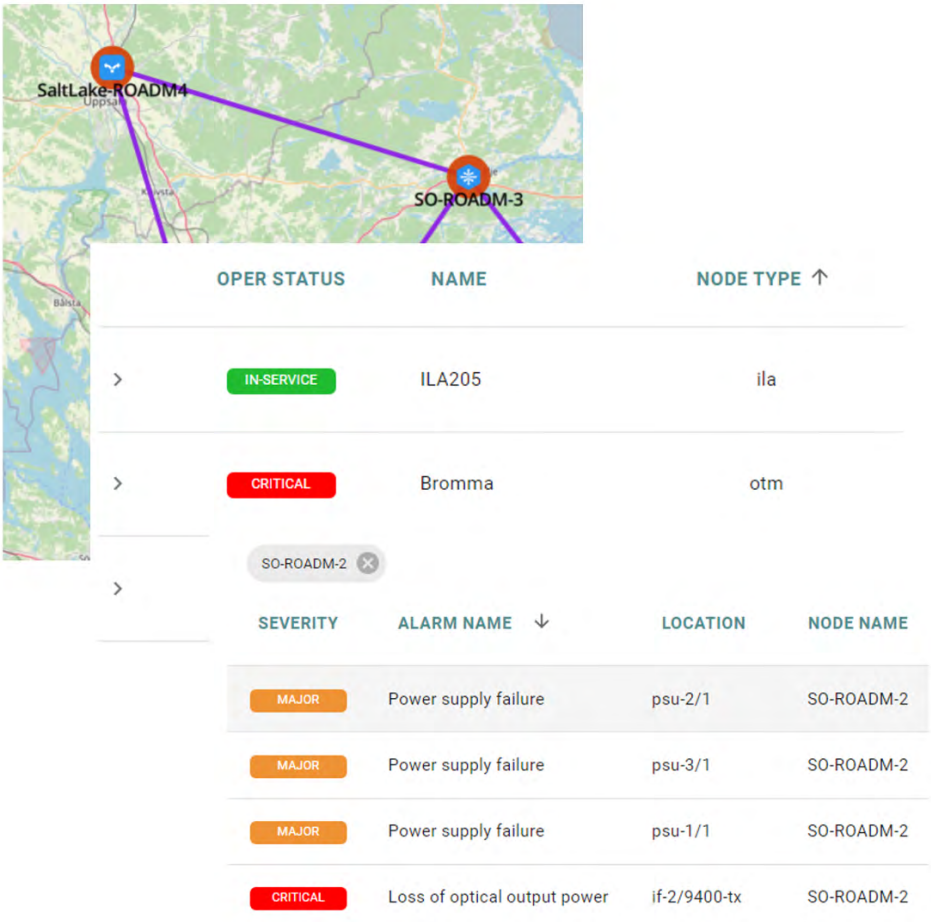

Figure 16. Alarm indication on node level in the map view and alarm lists

The Alarms window, opened from the main menu on the left, has three tabs: One with a pie-chart summary of the active alarms, one with a list of all the active alarms, and one with the log information that contains both the active and the cleared alarms. Regardless of the node type, the Alarms window contains information for all the nodes.

Administration Management

The SoSmart Manager includes all the necessary functions for an efficient administration of your optical network. The Manager ensures that you have an up-to-date inventory down to HW revision and serial numbers of the individual network elements. If so required, the complete inventory can be exported as an excel file. The Manager also keeps track of event logs as well as mandatory software upgrades and necessary node element back-up files.

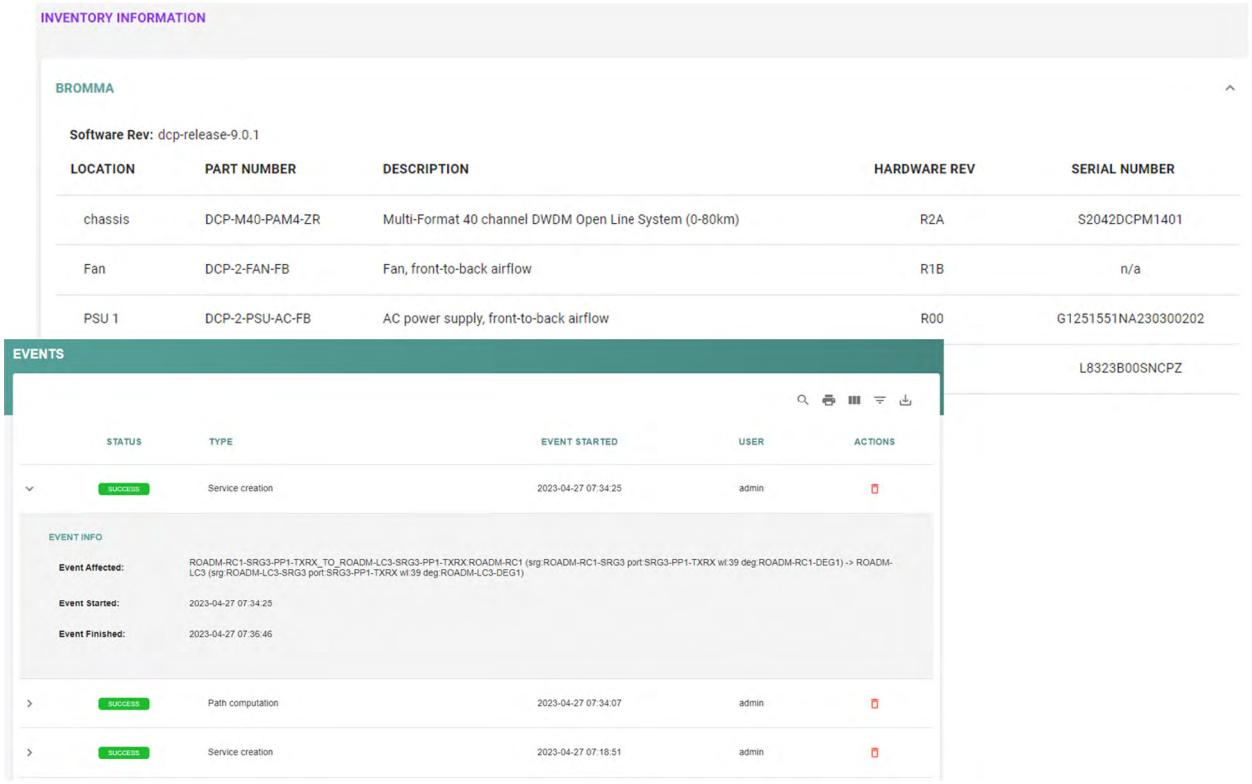

Figure 17. Inventory list and event log

To make SoSmart Manager more useful when it comes to performing repetitive and simple, yet important actions, such as node update, node edit, span loss, and fiber length measurements, a bulk action feature is included. The bulk action feature allows the network operator to perform the same action at once for many nodes, e.g. when updating inventories for all the nodes in the network.

Another cost and time saving feature of the SoSmart Manager is its capability to remotely upgrade the embedded software in DCP-R, DCP-2, and DCP-M devices.

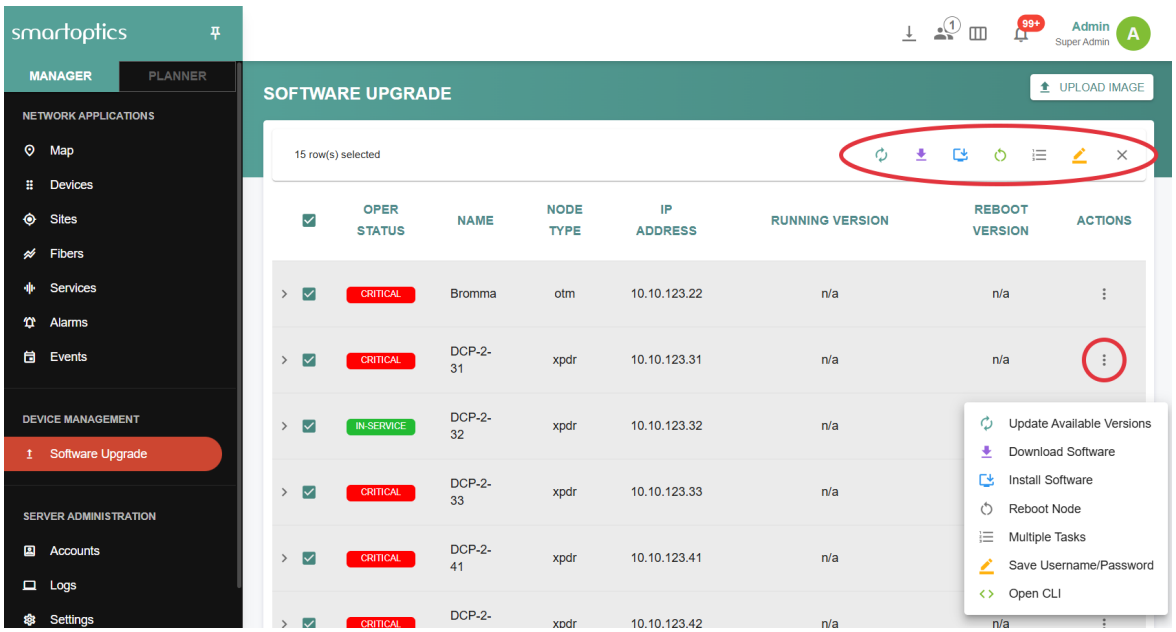

Figure 18. Software upgrade of multiple devices with SoSmart Manager

Software upgrade is a three-step process where the network operator first downloads, installs, and subsequently reboots the nodes to complete the upgrade process. When multiple nodes are selected, the action buttons for these functions are presented at the top right corner (circled in red), and for individual nodes these functions can be accessed using the three dots in the Actions column.

Performance Management

Performance monitoring by SoSmart Manager comprises span loss and fiber distance measurements, the OCM viewer, and live OSNR estimations.

The span loss data is used by ROADM nodes to control the settings for the line VOA. It is important to update the span loss data if the fiber data changes or if a new fiber span is added. The span loss and fiber distance measurements are performed by using an action button in the Fiber window. It is possible to update all spans at the same time or just select an individual span.

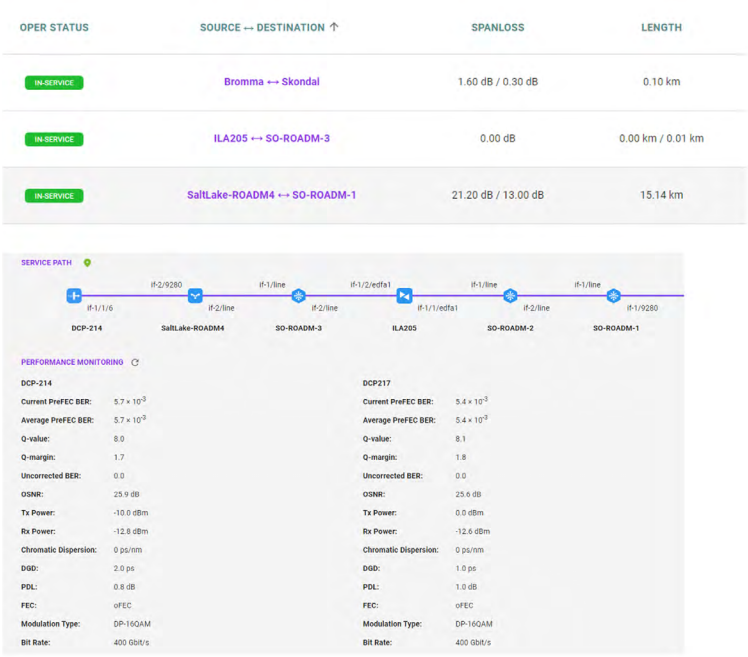

Figure 19. Span loss information and detailed service path data

The OCM viewer visualizes the power per channel in the pre-amplifier or in the booster amplifier on a specific ROADM degree that has been double clicked in the map view. The graph will show the power level per channel that is measured by the OCM. By hovering over the dots in the graph it is possible to see the power level, traffic format, width, and WSS Attenuation.

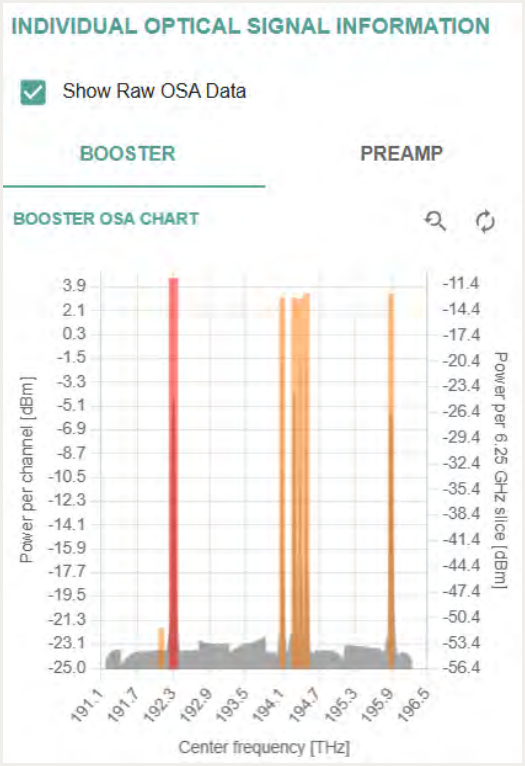

Figure 20. The OCM viewer

Security Management

After a successful first deployment or an upgrade, the SoSmart Manager can be accessed using a web browser over HTTPS at the IP address or domain name of the server. The Manager supports multiple, simultaneous active network operators, each having their own user account with a predefined level of permissions – standard or read-only access. In addition, at least one system administrator with extended permissions must be defined.

The administrator can view all existing and pending accounts in the account management window. He can also create new user accounts by clicking the ADD ACCOUNT button in the top right corner and approve or deny pending account requests from new users.

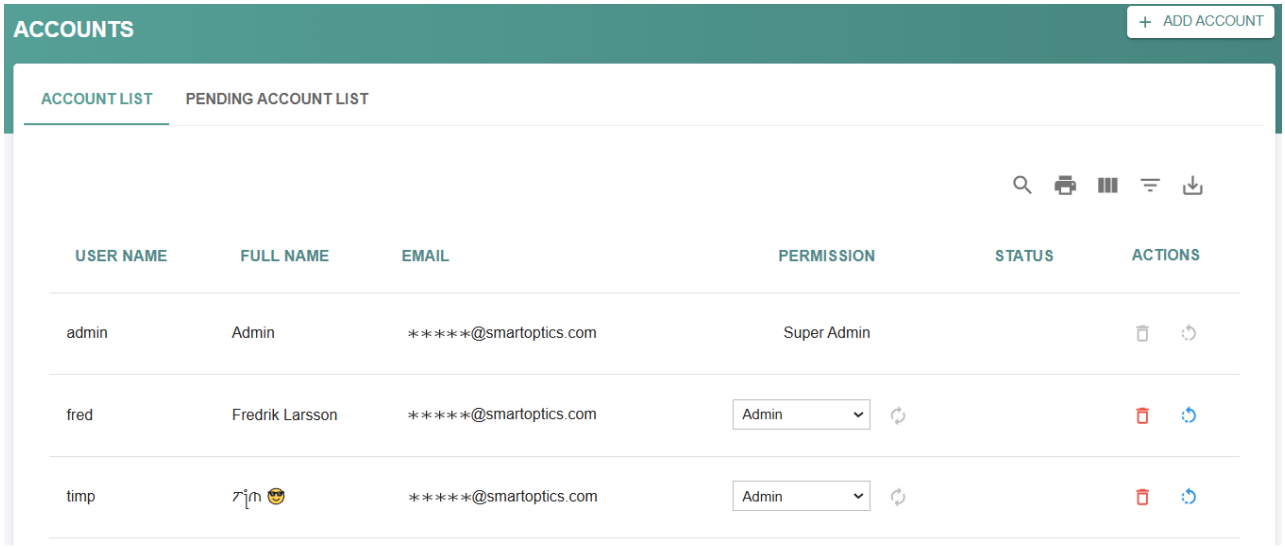

Figure 21. Account management window with existing and pending user accounts

User authentication is done either by user ID and password, if required complemented with two-factor authentication, or by use of the customer's external RADIUS or TACACS+ server. An automatic, time-based, logout can be activated.

The SoSmart Manager and the SoSmart Controller contain databases. Most of the network information such as topology, alarm status and interface settings are stored in the network elements, but information about services, e.g., names, descriptions, start and end points are stored in the SoSmart Controller databases. It is important that these databases are backed up regularly. Functions for scheduled and automated backup of the databases are therefore available. When restoring a database, it is possible to restore it to the latest saved backup or to select a specific backup for restore.

The SoSmart Planner

The SoSmart Planner presents you with the same user interface as the SoSmart Manager, making optical network planning and path simulation an uncomplicated matter. It is primarily designed for use with Smartoptics' products. However, the long-term objective for SoSmart Planner is to support planning of multivendor optical networks.

By default, the SoSmart Planner is installed together with SoSmart Manager, but it is also possible to install SoSmart Planner as a standalone application. Having the same user interface makes it very easy to switch between the live network in SoSmart Manager and a simulated network in the Planner. You can also import an existing live network configuration from the Manager to the Planner, for example when you are designing a network expansion.

In SoSmart Planner each network configuration and simulation you set up can be saved as a project, and you can easily use multiple projects to compare the performance of alternative configurations.

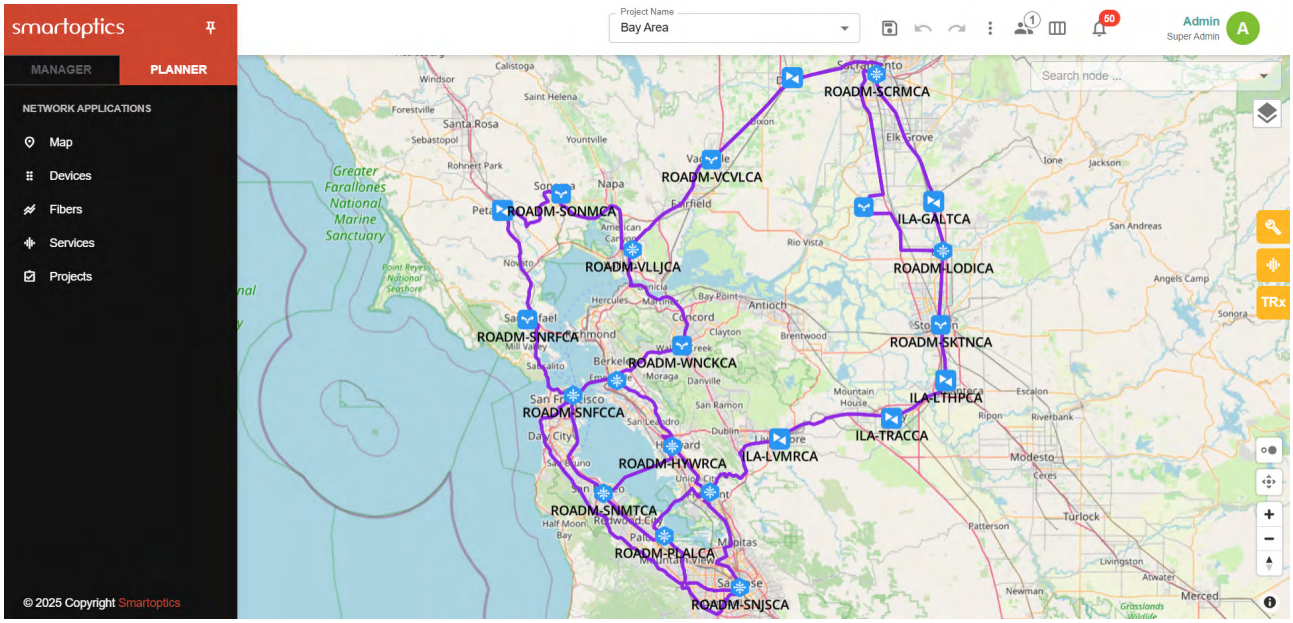

Figure 22. The SoSmart Planner user interface

The SoSmart Planner builds on the GNPy (Gaussian Noise model in Python) module, which is a open source optical planning software from the Telecom Infra Project (TIP) MUST OOPT subgroup PSE. It is a fully open-source library driven by a consortium of operators, vendors, and academic researchers intended for rapid development of production-grade route planning tools, easily extensible to include custom network elements performant to the scale of real-world mesh optical networks. GNPy can be used for both real time network simulations and for off-line simulations. The SoSmart Planner with GNPy is fully capable of doing both advanced OSNR simulations and advanced GSNR simulations where non-linear effects are taken into consideration.

The graphical user interface in SoSmart Planner gives the operator the possibility to visualize, configure, and make simulations for different routes in the network. The result of each simulation is presented in a comprehensive graphical and table format.

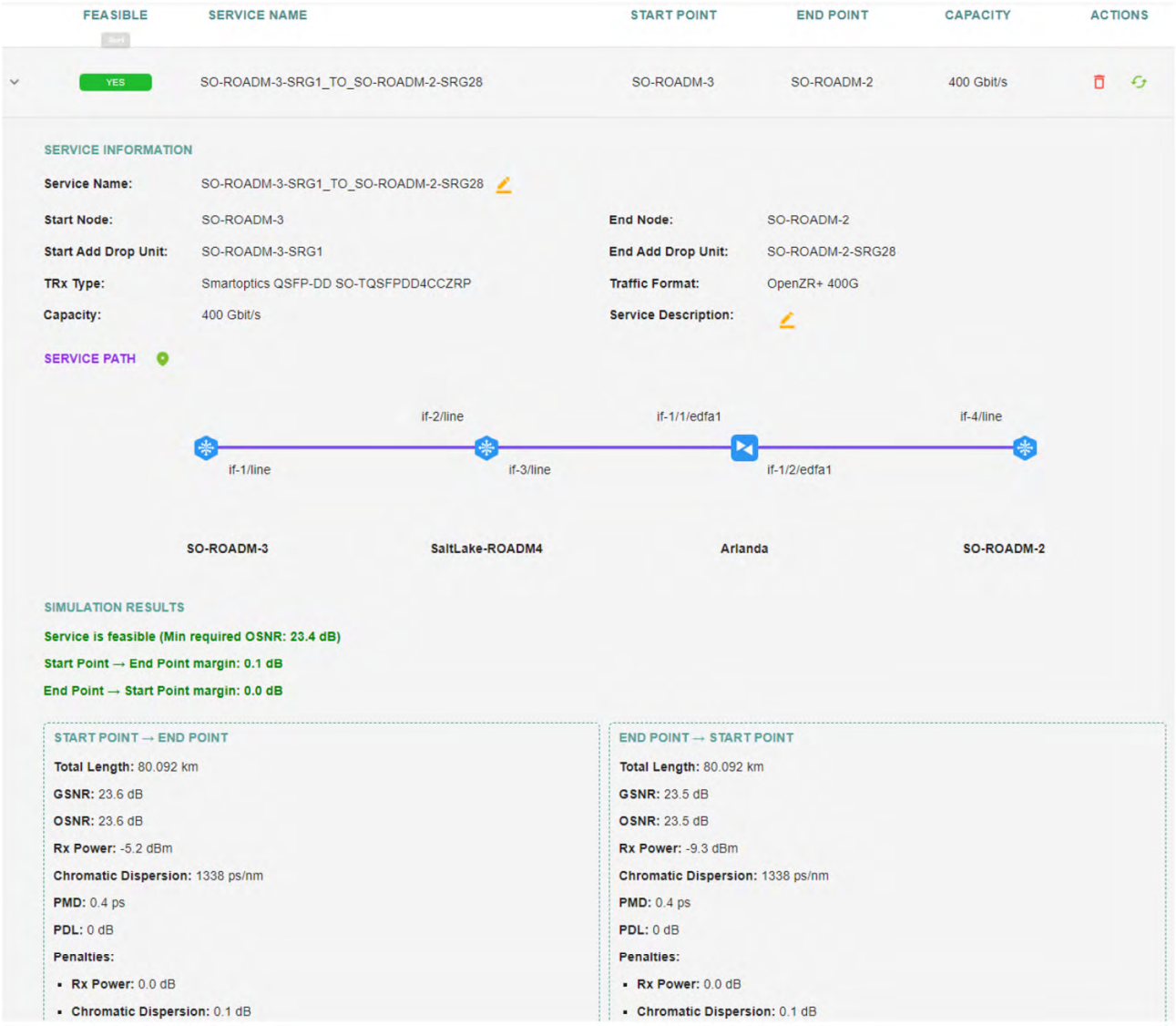

Figure 23. Example of a service simulated by GNPy in SoSmart Planner

Hosting requirements

Installing and hosting the SoSmart Software Suite is as easy as operating the network. The SoSmart Manager, Controller and Planner are all installed as docker containers on standard server hardware. A docker container can package an application and its dependencies in a virtual container, isolated from other processes in the system. This is a modern way of running applications which is extremely easy to install and at the same time consumes little processing resources compared to other alternatives. Because of their isolated nature, docker containers are also very well suited for running on cloud servers.

Both the SoSmart Controller and the SoSmart Manager can be hosted on Virtual Machines on VMware, and server redundancy can be achieved through modern data center technologies.

The minimum and recommended server requirements for installation of the SoSmart Software Suite are:

- An x86, 64-bit server with Linux as the operating system
- Linux distributions (Ubuntu 22.04 and RHEL)
- 4 Virtual CPUs (min.) or 8 Virtual CPUs (recommended) (Intel(R) Xeon(R) Gold 6138 CPU @ 2.00GHz or similar)
- 16 GB RAM (min.)
- 100 GB diskspace (min.)
- Google Chrome (recommended browser)

Summary

The disaggregation of the optical network requires a similarly open approach to the management of the network elements. With the SoSmart Software Suite, Smartoptics provides a modular, SDN-based, management solution using open API:s and open-source software components for the line systems and the transponders/muxponders in the DCP families. The SoSmart Software Suite includes a Manager with an advanced GUI for point-and-click provisioning of services, a separate planning tool and a Controller for interaction with the network elements. Thanks to its standardized north-bound interfaces and modular structure, the SoSmart Software Suite can easily be integrated with already deployed orchestrators and other management solutions for your transport network.

About Smartoptics

Smartoptics provides innovative optical networking solutions for a new era of open networking. We focus on solving network challenges and increasing the competitiveness of our customers. Our customer base includes cable and telecom operators, cloud providers, Internet exchanges, governments and thousands of enterprises.

At Smartoptics, we leverage modern software design principles and expand network horizons by taking an open approach in everything we do. This empowers our customers to break free from unwanted vendor lock-in, remain flexible and minimize costs.

Our solutions based on open networking standards and protocols are used in metro and regional network applications as well as in metro access networks. The products we deliver are based on in-house developed hardware and software and enhanced by associated services.

Smartoptics is a Scandinavian company founded in 2006. We partner with leading technology and network solution providers and hold numerous certifications and approvals from major switching and storage solution providers such as Brocade, Cisco and Dell. We have a global reach through our salesforce and more than 100 business partners including distributors, OEMs and VARs. As a challenger, we take pride in our open approach, smart design principles, and ambitious customer service.

For additional information about Smartoptics, please visit us at https://www.smartoptics.com/

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