Nokia's software-based optical restoration

Optical network resiliency for an open networking future

Cloud, AI and video applications, as well as data center interconnect and the introduction of network technologies such as 5G mobile continue to place increasing bandwidth demands on metro and long-haul networks. In addition to finding cost-effective solutions for managing this traffic growth and offering real-time responses to new service demands, network operators need to reduce operational costs and ensure the highest level of network availability. The importance of network resilience is growing, as network infrastructure has become critical to an increasing number of activities in our modern world. Demanding service-level agreements (SLAs) and the need to continuously improve user experience mean services need to be recovered quickly following a fiber cut or an equipment failure.

These requirements have been key to the definition of Nokia's software-based optical restoration application, enabled by Nokia's Transcend network automation software.

Combining the benefits of path computation and service provisioning with network supervision

Nokia's software-based optical restoration makes use of Transcend control plane functionality. Transcend implements an SDN controller-based control plane with off-the-shelf support for 1830 Global Express (GX) Compact Modular Platform (G30 and G40 Series) and 7300 Series Multi-Haul Transport Platform, and an architecture that allows the extension of its functionality to open multi-vendor networks. This control plane offers path computation element (PCE) functionality at the DWDM and OTN layers, including optical performance validation, and performs real-time provisioning of services.

Leveraging PCE and real-time service provisioning, and combining them with global network supervision (i.e., monitoring performance and alarms across equipment and services), the software-based restoration application can restore traffic efficiently in an optical network following transmission or equipment failures.

Nokia's software-based optical restoration reacts to a network failure event, typically in response to service-affecting transmission or equipment alarms, through programmable triggers. Once the fault cause has been isolated, the application orchestrates the restoration of all impacted services at the lowest possible network layer, deciding on new paths and reconfiguring the required resources to recover traffic according to user-specified policies. If restoration happens at Layer 0, the new path will be validated against optical impairments and will use a different wavelength in case of wavelength contention.

The software-based restoration application not only enables high service availability, it also offers optimal restoration routes, considering real-time availability of resources as well as service properties, such as class of service, latency constraints and diversity with respect to other services.

Benefits of Nokia's software-based optical restoration

- Provides the highest level of availability and multi-failure service resilience for optical transport networks, including coordination of protection and restoration at Layer 0 and Layer 1
- Offers optimal optical restoration routes, with very efficient resource usage and optical feasibility validation
- Enables operator-defined programmable service restoration
- Ensures service resilience in open optical networks and across different vendors' network elements
- Promotes easy and smooth integration into multi-vendor software automation environments

Nokia's software-based optical restoration offers off-the-shelf support for 1830 Global Express (GX) Compact Modular Platforms (G30 and G40 Series) and 7300 Series Multi-Haul Transport Platform. Support for open optical networks is achieved via standard southbound interfaces or customized adapters.

Treating the whole network as a single restoration domain regardless of its size, the application combines Layer 0 restoration with Layer 1 restoration if and where needed and assures there are no rerouting conflicts when several services need to be restored due to the same event, which could lead to crank-back/roll-back and time wasted in false restoration attempts.

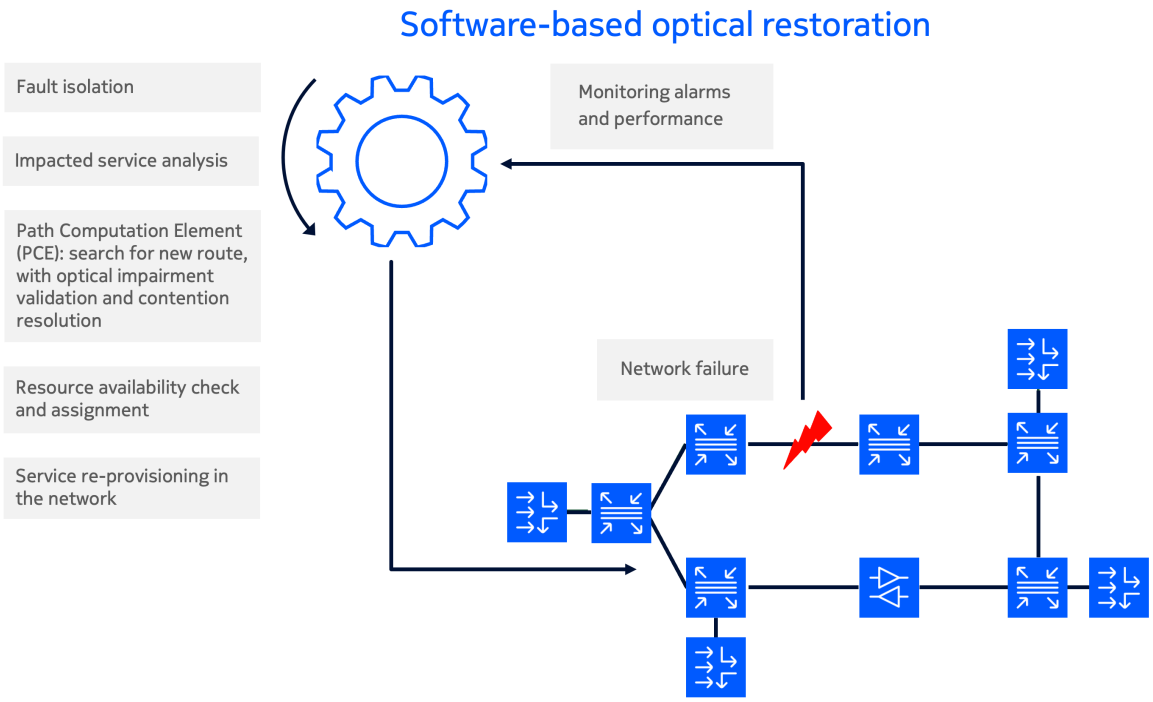

Figure 1: Basic concept of Nokia software-based optical restoration

Featuring programmable, versatile restoration options

Software-based optical restoration offers a range of configurable parameters to ensure optimal resiliency and meet operator-specific behaviors. Here are some examples of supported customization:

- **Restoration route type**: A Layer 0 or Layer 1 service can be configured to be dynamically restorable (akin to source-based restoration (SRB)) with restoration routes computed and assigned on the fly upon failure, leveraging real-time network status. This option makes the most efficient use of network resources but does not guarantee resource availability. Alternatively, preplanned restoration is supported, with backup routes selected ahead of any event. In this case, restoration resources can be strictly reserved for one (and only one) backup route to guarantee availability and restorability (also known as guaranteed restoration (GR), similar to 1+1 protection), or they can be shared among several backup routes. With dynamic and preplanned restoration options, a network operator can decide on the right balance between network resilience and solution cost by choosing if and where to deploy redundant resources, and if and where to reserve them for specific restoration routes.

- **Reversion control**: Restoration can be configured to be revertive or non-revertive on a per-service basis once a path affected by a failure has been recovered. Revertive restoration can be manual or automated.

- **Service awareness**: The software-based restoration application is aware of service properties such as SLAs. The per-service use of the adequate combination of protection and restoration, referred as protection and restoration combined (PRC), together with a restoration priority defined according to the class of a service, ensures higher-value services are recovered first in response to failures with resource contention.

- **Restoration triggers**: The application supports configurable restoration triggers, including triggers generated by different network objects (e.g., cards, ports, and termination points) and in different network layers, and can support complex triggers that combine information from multiple sources.
- **Restoration constraints**: The restoration application supports multiple types of constraints when defining new routes, including the inclusion/exclusion of nodes and links, diversity with respect to other services, latency, user-defined cost, and local repair.

The software-based restoration application can easily be extended for new transmission technologies and new functionalities can be added through simple software upgrades. Development and deployment of the optical restoration application is largely decoupled from hardware-based features. The possibility to include new software-based restoration functionality and bug fixes through upgrades of the management system translates into faster innovation cycles and increased ability to evolve and customize restoration functionality.

Nokia's software-based restoration computing resources can easily scale (e.g., with network size) for fast path computation without having to partition the network into restoration domains.

Ensuring multi-failure resilience

Nokia's software-based restoration application can provide very high resiliency in optical networks at risk of multiple simultaneous or concurrent failures with fast service recovery. It does so by combining dynamic restoration with traditional hardware-based fast traffic protection switching in the network elements, such as line-side, client-side, sub-network connection (SNC), optical multiplex section (OMS), or optical transmission section (OTS) protection. These rapid protection mechanisms are used to recover from a first network failure, triggering a switch from a working path to a protection path, while the optical restoration engine ensures a backup route to the working path ahead of the next failure.

Alternatively, in IP-optical networks, combining IP/MPLS fast protection with software-based optical restoration configured for route diversity can efficiently protect end-to-end Layer 3 router services against multiple failures.

Both Transcend PCE behavior and the software-based optical restoration response can be simulated in multi-failure scenarios. The algorithms are deterministic and pre-verifiable, and Nokia can perform realistic network modeling and analysis to quantify the level of resiliency that can be achieved with the software-based restoration application in a specific network.

Providing powerful user interface options

Nokia's software-based optical restoration application offers a user-friendly interface for management and control of restorable services, including via the Transcend Network Management System (TNMS) and Transcend Controller. This allows for fully integrated workflows of service provisioning, alarm and performance monitoring, and service restoration management via GUI and automation northbound interfaces. Transcend REST northbound interface (e.g., TAPI) enables management of the software-based restoration by other automation applications, OSS/BSS systems, or multi-layer orchestrators, leading to simplified, fast, and cost-efficient integration into any operational environment.

Network resiliency for an open networking future

The architecture of Transcend control plane and its use of common data models and standardized APIs at its southbound interface (e.g., OpenConfig), toward the network, enables restoration in open optical networks, with different Nokia or third-party line systems and optical transceivers.

Summary

Nokia's software-based optical restoration aligns with the industry direction of SDN-enabled automation. By supporting operators in achieving the highest levels of network resilience, this optical restoration application supports a combination of Layer 0 restoration with Layer 1 restoration where needed, avoiding rerouting conflicts when several services compete for restoration resources, prioritizing restoration of the most valuable services in case of resource contention and enabling resilience with restoration across multi-vendor networks. Software-based restoration offers a wide set of control features that allow operators to define the restoration behavior of their networks effectively and cost-efficiently.

About Nokia

At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering networks that sense, think and act by leveraging our work across mobile, fixed and cloud networks. In addition, we create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

With truly open architectures that seamlessly integrate into any ecosystem, our high-performance networks create new opportunities for monetization and scale. Service providers, enterprises and partners worldwide trust Nokia to deliver secure, reliable and sustainable networks today – and work with us to create the digital services and applications of the future.

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

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