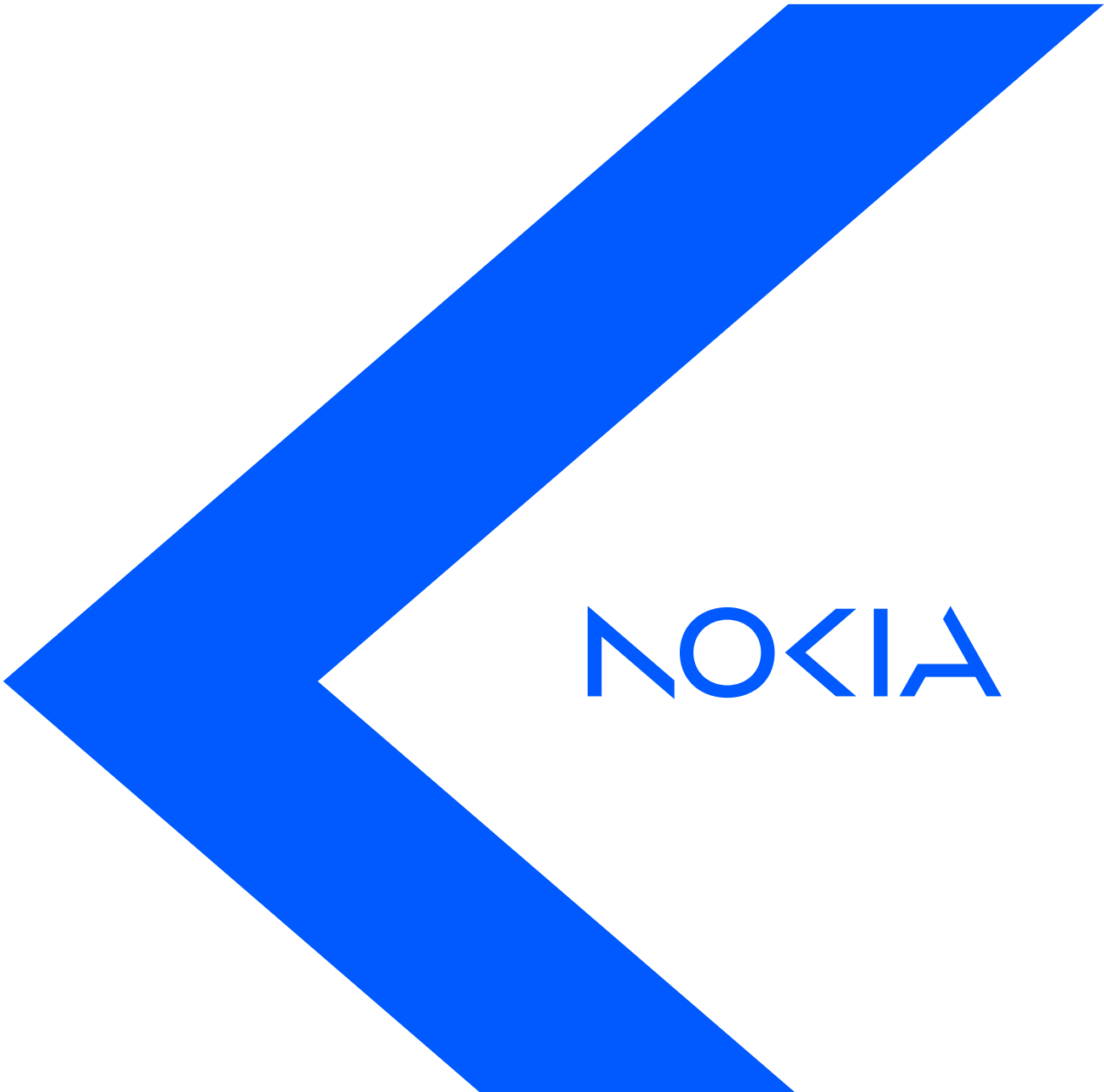
Nokia multilayer optical networking

Building networks ready for the future

Application note



Abstract

Network operators face significant challenges as they work to modernize their optical networks. These networks must support traditional services that have been available for decades, introduce new higher-speed services to support enterprises' evolution to the cloud, and provide the infrastructure for fixed and mobile broadband internet services. They must also be ready for open software-defined networking (SDN) architectures to improve service delivery time and reduce network cost.

To address this complex mix of demands, service providers must intelligently converge several photonic, optical transport network (OTN) and Ethernet networking capabilities to enable cost-efficient transport, scale, increased availability and lower network latency.

This paper describes how the Nokia 1830 Photonic Service Switch (PSS) multilayer solution helps you address these challenges. It includes a short case study that shows how a Tier 1 provider used the solution to modernize its network, increase capacity, reduce service delivery time and dramatically simplify network operations.

Contents

Introduction

To keep pace with the changing market, service providers must transform their networks to massively scalable, higher-performance, openly programmable network fabrics using equipment that enables faster service deployment, optimized performance and increased revenue. The need to enter new markets while ensuring that existing services adhere to service-level agreements (SLAs) during any network evolution adds to the challenge.

To provide a foundation for future success, networks need to be:

- Highly flexible and efficient for any service type, maximizing photonic, OTN and Ethernet layer resource utilization and streamlining interlayer operations
- Massively scalable across access, metro, regional aggregation and core networks, and offer the ability to interconnect edge cloud data centers that are moving closer to customers
- Capable of delivering lower latency, maximizing service transport in the photonic layer with flexible ROADMs that can adapt to changing network topology requirements
- Reliable for both traditional and new services
- Programmable, to prepare for the evolution to new SDN architectures

Nokia multilayer solution

The Nokia multilayer solution leverages optical transport and switching technologies to address any service provider deployment. This solution reduces cost by providing equipment that is sized for specific network locations such as at the edge or in the core. It also simplifies operations and management by making clusters of equipment appear as one logical network element.

Nokia's multilayer solution achieves this level of efficiency by complementing a strong set of hardware platforms with foundational software designed for converged network element operation. This enables network operators to:

- Create and deliver services that meet unique SLA needs for any end user, making it easy to offer wholesale network provider services
- Take advantage of OTN and packet networking features that support Carrier Ethernet-based service offers, efficiently fill wavelengths towards aggregation sites and reduce port density requirements on routers
- Create logical nodes from a cluster of application-specific equipment that delivers the right levels of photonic, OTN and Ethernet networking capabilities to a specific deployment point
- Seamlessly scale a logical network element with additional application-specific photonic, OTN or Ethernet equipment
- Unlock new efficiencies with an optical control plane and management system that can abstract the complexities of networking multiple optical network layers across an end-to-end optical network
- Support different administration domains for different converged network element functions

The multilayer optical solution is based on several technologies including next-generation dense wavelength division multiplexing (DWDM), packet OTN (P-OTN) transport and switching and a flexible set of physical chassis matched to various network needs. These capabilities are delivered through the Nokia 1830 PSS and 1830 PSS-x platforms.

These platforms enable service providers to deploy services rapidly, reduce network total cost of ownership (TCO) and extend network lifecycles. They transform traditional DWDM into a flexible transport layer with capabilities such as OTN switching fabrics positioned either at the edge through a distributed fabric or towards the core in centralized, blade-based OTN fabrics. This OTN capability complements transport over 100Gbps- or higher wavelengths, agile GMPLS wavelength routing, and scalable multilayer switching and services. The platforms provide efficient transport at any scale, from compact access devices to devices for a converged WDM, OTN and Ethernet core.

Nokia 1830 PSS portfolio overview

The 1830 PSS portfolio consists of platforms optimized for a variety of optical network applications, from interconnecting data centers to efficiently scaling large metro, regional and long-haul core multilayer, multiservice optical networks. The portfolio includes a series of platforms for general optical transponding, multiplex and transport, labeled PSS-4II, PSS-8, 16II and PSS-32, and also a series of platforms purpose-build for OTN switching, labeled 1830 PSS-8x, PSS-12x and PSS-24x.

1830 PSS-x series platforms

The 1830 PSS-8x and 1830 PSS-12x are OTN switching solutions, optimized for both metro aggregation and metro core applications. The 1830 PSS-24x offers even more capacity for core applications. They provide the flexibility and efficiency that operators need to support an evolution to higher-capacity services delivered to unique end-users while maintaining existing revenue streams.

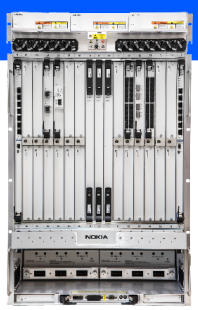
The 1830 PSS-8x supports high-capacity metro aggregation in a small form factor, while the 1830 PSS-12x offers higher switching scale and 500G capacity for metro core applications. The platforms share common cards and are designed to support a wide range of client interface types from 100 Mb/s to 400GE. They enable a smooth transition from legacy networks to a modern service delivery platform, ready to deliver B100G services. Designed to support 4Tb/s (1830 PSS-8x) and 12 Tb/s (1830 PSS-12x) of non-blocking switching capacity in a single rack, the two platforms also offer a network evolution path that enables operators to keep up with bandwidth demands while minimizing space and power requirements.

The 1830 PSS-24x platform is optimized for large scale packet/optical transport network switching applications, placing flexible electrical switching scale at international, national, regional and metro core network locations. It also offers a 24Tb/s non-blocking OTN and packet switch in a single shelf, 100G - 500G coherent uplinks and upgradability to 48Tb/s capacity through interconnection of shelf pairs. This non-blocking OTN switching capacity in a single rack along with terabit-capable card slots, makes the1830 PSS-24x an industry-leading solution for optimal delivery of wholesale services in addition to operators existing service offerings.

Nokia 1830 PSS-x series platforms

- Scalable in all dimensions: non-blocking OTN fabric, B100G, 400GE clients
- Efficiently grooms services into high-performance transport wavelengths
- Deterministic performance

Metro aggregation



Metro core

Large metro core, backbone core

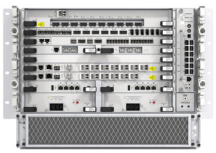
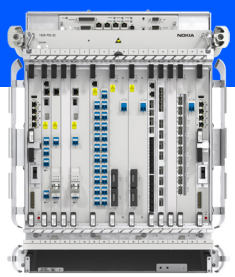
1830 PSS-8x	**1830 PSS-12x**	**1830 PSS-24x**
4 shelves per 300mm rack, 8 slots	2 shelves per 300mm rack, 24 slots	2 shelves per 600mm rack, 24 slots
1.6T to 4T	**4.8T to 12T**	**9.6T to 48T**

1830 PSS series platforms

The 1830 PSS-8, 16II and PSS-32 packet optical platforms support multiple transport network applications, including multiservice metro transport and aggregation, optical core/long-haul deployments and photonic switching configurations for colorless, directionless, contentionless with Flexgrid (CDC-F) wavelength routing. The platforms support next-generation DWDM multiservice transport from access to core and help operators build agile and scalable networks that can accelerate the delivery of mobile, video, business, wavelength, Ethernet, data center interconnect (DCI) and cloud services.

Nokia 1830 PSS series platforms

- Optimized for transponders with blade-based OTN packet switching
- Dynamic photonics – ROADMs to the edge, CDC-F core
- Deterministic performance

			
1830 PSS-4II	**1830 PSS-8**	**1830 PSS-16II**	**1830 PSS-32**
Access, edge, data center	Access, edge, data center	Metro or data center	Core or large data center
AC or DC power	AC or DC power	AC or DC power	DC power
2RU	**3RU**	**8RU**	**14RU**

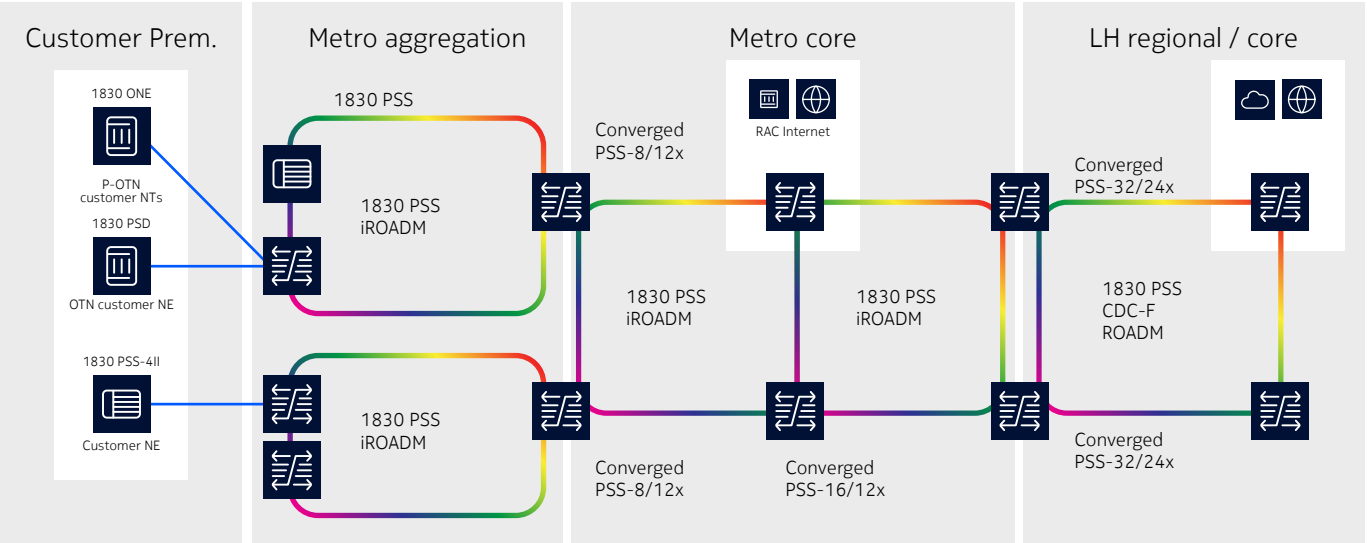
The 1830 PSS platforms support an efficient evolution to scalable 100G services deployment with capabilities such as:

- 100G–800G and higher transport wavelengths, optimized for capacity and distance
- Industry-leading service port densities, including sub-10G through 400G client services
- Multilayer switching agility and intelligence that enable dynamic reconfiguration of network resources
- Compact, low-power platforms for maximum network operational efficiency

These capabilities enable CSPs to sustain their revenue streams as customers demand more bandwidth and enterprises move towards 100G connectivity between their routers and data centers.

In large scale switching applications, the 1830 PSS portfolio typically handles photonic switching (i.e. ROADMs) and the deployment of 100G+ services. Also available is a blade-based 100G OTN switch integrated onto a 100G universal transponding service card. This device allows for efficient edge grooming of sub 100G traffic prior to transport across the metro network.

Nokia converged optical network solution



Together, the Nokia 1830 PSS and 1830 PSS-x series platforms form a converged multi-layer, multiservice optical networking solution. The solution aggregates any service type and efficiently grooms them into optimally filled transport wavelengths. Additionally, the solution can support higher rate clients such as 400GE, making it truly B100G ready. From an open networking or management perspective, these platforms are an integrated device. They enable simplified operations while application-specific equipment maximizes network efficiency to reduce cost per bit.

Nokia optical multilayer networking efficiency

Nokia's GMPLS photonic, P-OTN and photonic/P-OTN multilayer software maximizes the benefits of the multilayer OTN solution described above. It supports new service offers while lowering network CAPEX and OPEX.

New service offers

The Nokia GMPLS implementation supports flexible tiered SLA availability levels. Operators can use these capabilities to create new revenue-generating services.

Lower network CAPEX

The Nokia GMPLS implementation lowers network CAPEX through:

- Photonic wavelength routing that optimizes the placement of primary and restoration paths for transport wavelengths, which can reduce network CAPEX by up to 30 percent
- Support for tiered SLA availability levels, which allow new service creation while reducing network investment requirements by 25–40 percent
- The ability to combine independent IP and private line networks into a single multilayer network, which can reduce network expansion investment by 23–75 percent, with more savings possible as IP routers move to 100GE client and 400GE core interfaces

Lower network OPEX

Nokia GMPLS multilayer networking simplifies operations compared to running photonic and P-OTN in separate control environments. Its cost-saving capabilities include:

- Connecting services using path constraints (e.g. shared risk groups, cost metrics, network partitioning, maximum hop count) that span photonic and OTN network layers
- Coordinated photonic and OTN restoration removes manual operations during network reversion and maintenance functions. For example, when a fiber is broken or taken out of service for maintenance, the GMPLS software automatically handles the subsequent impact on wavelengths and switched services. When the fiber is put back in service, it automatically reverts to the original network path.
- Fast, network-wide GMPLS or GMPLS/SDN restoration from fiber failures over any number of fiber routes, including the restoration of fully filled optical fibers with DWDM wavelengths
- Optimal use of resources throughout the network by maximizing wavelength capacity, bypassing electrical switching resources and sharing restoration resources between services

A service provider optical network transformation

A Tier 1 communication service provider (CSP) with metro and regional optical networks was struggling to keep up with exploding data demands, especially those associated with on-demand video with time-shifting features. The CSP needed a network scaling approach that could support new service availability levels, reduce service latency and enable its transport network to handle capacity growth and operations with much greater efficiency.

Network modernization challenges

Past expansion cycles had left the CSP with eight levels of network aggregation within its optical network, with cumbersome peering points between some metro and regional network sections. With future demands in mind, the CSP determined that it needed to:

- Reduce the number of network aggregation levels to four to support new traffic patterns
- Simplify peering points between metro and regional networks and keep services in the photonic layer as much as possible to lower CAPEX and reduce service latency
- Maintain existing service availability levels and use restoration approaches that efficiently support new service availability levels
- Scale network capacity to address increasing demand for 100GE services and increasing levels of sub100G services as well as future services beyond 100G (B100G)
- Maintain traditional Synchronous Digital Hierarchy (SDH) services, which was becoming more challenging because the supporting equipment was becoming obsolete

Solution

The CSP redesigned its network topology to address future capacity demands in a much more elegant and operationally efficient manner. It created new 1830 PSS 4/8-degree ROADM sites at over 700 locations using Nokia's advanced ROADM technology, including CDC-F ROADMs. This new technology enabled the CSP to:

- Easily add new fiber routes to support efficient capacity growth and improve service restoration performance
- Support new levels of service availability by using the GMPLS control plane to automatically restore the network after protection events
- Reduce service latency by networking services using photonic DWDM wavelengths and ROADMs as much as possible
- Simplify operations, including a new ability to change DWDM light paths with the touch of a button
- Scale its network to prepare for 100GE services and beyond

The CSP also enhanced strategically selected ROADM sites with 1830 PSS-x OTN and packet switching capabilities. These capabilities enabled the CSP to:

- Efficiently groom traditional and sub-100G services on to high-performance 100G/200G transport wavelengths.
- Support any service client type

The resulting converged network elements, based on optimized 1830 PSS and 1830 PSS-x configurations, cost-effectively placed the right mix of photonic, OTN and Ethernet networking capabilities at various metro and regional sites to prepare for future network scaling needs.

Benefits

The reconfigured 1830 PSS optical network has enabled the CSP to:

- Support 40X more capacity
- Ease growth with 4X faster time to market for new services.
- Simplify operations with an easier-to-maintain network that supports reduced site visits and faster failure resolution times
- Address any client service, from 100GE and beyond services to sub-100G services and traditional SDH services.

Table 1: Tier 1 CSP uses Nokia converged optical P-OTN solution to modernize its network

Challenge	Solution	Benefits
Create a simplified network that supports ultra-efficient resource utilization and operations for: • ~75 national core sites • ~55 regions, each of which has multiple large cities • Data center-based services that need to move closer to end customers	Nokia's converged optical P-OTN network element solution: • 700+ modern ROADMs including 4/8-degree ROADMs and CDC-F for the core • Support for all service types • OTN aggregation & switching for efficient on to transport wavelengths • GMPLS wavelength routing	Ultra-efficient OTN aggregation for sub-100G services Ready for B100G services 50% lower network complexity – 4 levels of aggregation instead of 8
Support massive scalability across the entire network – access, metro, regional and core	Nokia's converged optical P-OTN solution, which can be deployed throughout the network using common tools and operations	40X more capacity instantly with room to grow further Ready for 100GE services and future 400GE services Consistent operations throughout the network
Ensure reliability for traditional and new services	Nokia's converged optical P-OTN network element solution with OTN support for sub-100G services	One flexible, scalable network for all services
Reduce network latency	Maximize transport in the photonic domain using Nokia's converged optical P-OTN network element solution with advanced ROADM capabilities, including CDC-F solutions, controlled by Nokia GMPLS wavelength routing software	Better spectrum utilization and reduced need to grow fiber base Fewer site visits because of ROADM wavelength reconfigurability, OTDR fault isolation and GMPLS wavelength restoration Reduced CAPEX and latency through increased use of the photonic networking domain

Transforming networks for success

Operators face tough challenges as they modernize their optical networks. Providing wholesale services in support of many varied end-users, each with their own service requirements presents a large opportunity. Most operators must now support longstanding traditional services, while meeting a range of SLA demands of the enterprise cloud, data center interconnect, broadband, wireless and internet services. They must also be ready to support new open SDN architectures that will reduce service delivery time and network cost.

Nokia's converged multilayer optical transport solution helps network operators address these challenges and build a foundation for greater business success. They let you use application-specific equipment designs to deliver the right amount of photonic, OTN and Ethernet networking capabilities in an easy-to-manage optical network that enables cost-efficient transport and capacity growth, increased availability and lower network latency.

Visit nokia.com to learn more about how the 1830 PSS solution can help you transform your network to achieve new levels of business success.

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.

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.

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