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Legacy connectivity migration in defense networks

Application note series: Network modernization with the Nokia 1830 Photonic Service Switch (PSS)

Application note

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Abstract

Governments need to protect their citizens from an increasing variety of threats while supporting connected forces. Often the need for increased connectivity among defense forces is at odds with threats posed by cyber enemies. The need for better connectivity cannot compromise force security or sensitive information.

Communications networks must support the continuing evolution of defense and intelligence, including net-centric operations, remote weapons platforms and the highly connected warfighter. At the same time, embedded systems need to be supported for their useful lifespan by the optical transport network. These factors and the need to control costs are driving investments in network modernization that allow for staged, careful packet service upgrade while supporting legacy applications.

This application note is the second in a series of papers outlining requirements, technology options and Nokia photonic solutions needed to construct a modern packet optical defense network. The series includes:

- “Photonic networks for defense”: Outlines photonic layer requirements and highlights the Nokia 1830 Photonic Service Switch (PSS) as the foundation for defense operations
- “Legacy connectivity migration in defense networks”: Discusses solutions for migration of legacy TDM services and applications toward a modern packet optical network

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Contents

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Evolution through the net-centric age

For decades, networks have relied on Synchronous Digital Hierarchy/Synchronous Optical Network (SDH/SONET), Asynchronous Transfer Mode (ATM) and wavelength division multiplexing (WDM) technologies to build resilient and secure photonic communications networks. SDH/SONET offers reliable, circuit-based connectivity for TDM-based user equipment for a wide variety of mission-critical applications. Application-specific networks are still common, with applications such as video, voice and telemetry data multiplexed and transported through TDM systems.

While effective, this approach is fast reaching obsolescence as packet-based technologies have become the preferred way to connect and transport virtually any traffic type. With the availability of TDM solutions declining and the aging of embedded equipment, defense networks need to migrate toward a packet optical architecture. Supporting net-centric defense platforms requires an ability to simultaneously support TDM and packet-based traffic.

An optical backbone based on the Optical Transport Network (OTN) standard and coarse or dense WDM (CWDM or DWDM) can provide the flexibility, scalability, reliability and security needed to ensure continuous, efficient net-centric operations. This network has the inherent capability of connecting any traffic type: circuit TDM, IP packet, Ethernet, High Definition - Serial Data Interface (HD-SDI) video and others.

Legacy connectivity migration

Communications networks must support legacy traffic while newer technologies are phased in. Total system rip and replace is rare because most operators upgrade their infrastructure on a carefully planned basis, favoring long-lived assets. Connectivity to older voice and ATM systems may be required for years while newer systems are adopted. The ability to support legacy TDM applications and packet-based applications across the same network is key to aiding modernization of the communications network. This implies a high degree of flexibility to add or remove services as end applications are upgraded or decommissioned. At the same time, all connectivity must be highly reliable, deterministic and secure.

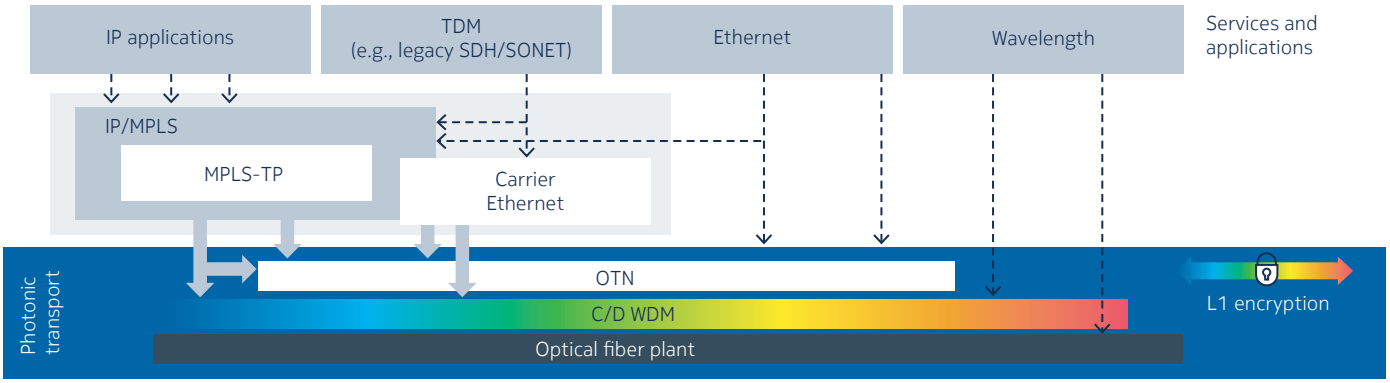
A communications network built for net-centric operations must meet several requirements:

- **Flexibility and scalability**: Application-specific networks are no longer viable in an environment where needs rapidly change and resources are limited. For example, multi-sensor surveillance platforms may need to simultaneously support video and assorted remote telemetry, plus secure voice traffic. As these systems continue to become more sophisticated, networks must scale in capacity while being flexible enough to support any data protocol, including Ethernet, IP, TDM, video, Fibre Channel and others.
- **Reliability**: To ensure continuity of operations, the network must be highly resilient. Networks must be built using equipment designed for high availability, utilizing redundant systems and automatic protection mechanisms. The network also should utilize diverse connectivity paths and a rich set of diagnostics to predict and prevent outages before they occur.
- **Security**: All data must be safe from theft and intrusion to protect forces from enemy intercept.
- **Traffic segregation**: Networks are sometimes shared among agencies or armed forces. This implies a need for logical network segregation.
- **Deterministic performance**: The network should assign priority to critical applications to ensure availability during peak traffic periods. For example, tactical operations data should be assigned a higher priority than routine data center backup traffic, such that if total demand exceeds available bandwidth, only the lower priority data center backup traffic is temporarily impacted.

- **Ease of use**: The network must be easy to provision, operate and maintain. Software control should extend across network elements, reducing the need for physical hardware changes and allowing remote provisioning.
- **Long asset life**: Budgeting cycles typically require that capital assets be depreciated over long time periods. A modernized network must support technologies from at least 15 years ago and for 10 years into the future. This implies use of a modular and extensible architecture, allowing older technologies to be easily maintained or phased out while new technologies are gradually introduced.
- **Economically attractive**: All the previous requirements must be met with a high degree of economy, balancing initial capital expense with ongoing operational expense. Use of common platforms for multiple applications and a high degree of software control are desirable, as are modular equipment architectures and common software control.

These requirements are met through use of a photonic network capable of supporting the services and applications shown in Figure 1. This ecosystem is described in the Nokia application note, “Photonic Networks for Defense”.

Figure 1. Packet optical network



Nokia solution

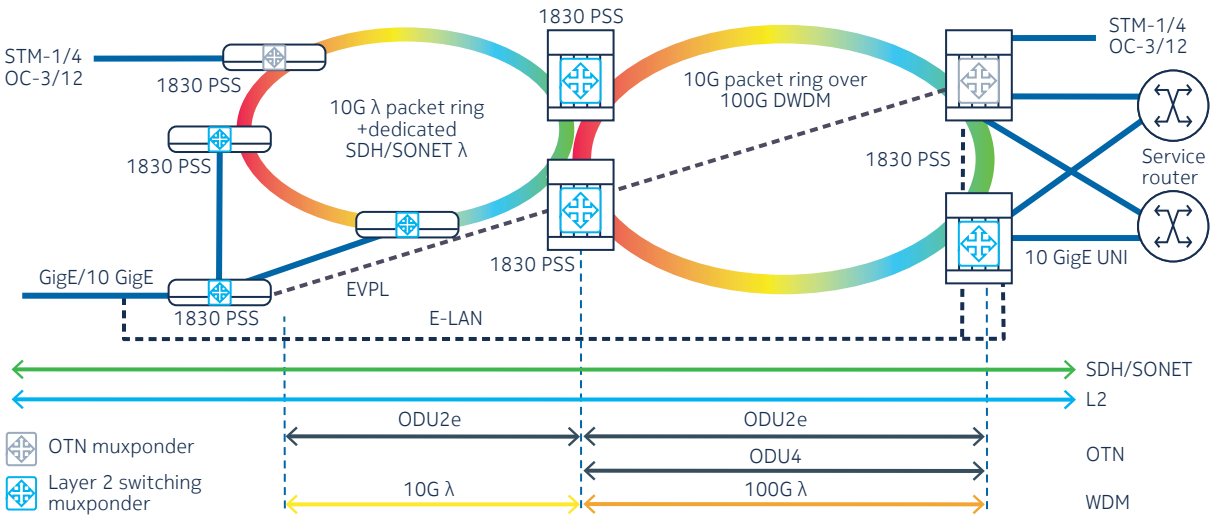
TDM migration with Nokia 1830 PSS

The Nokia 1830 PSS can provide the flexibility needed to simultaneously connect TDM and packet-based traffic, with the ability to scale up packet capacity while reducing TDM capacity as needed. The JITC-certified, modular system architecture and available interface cards open virtually endless possibilities of SDH/SONET, Ethernet, Fibre Channel and other traffic protocol combinations.

As a network operator migrates toward a packet-based infrastructure, they will still need to support some TDM traffic. Using the 1830 PSS, the network operator can migrate toward packet connectivity through a combination of solutions that can be selected to match their specific needs. The 1830 PSS offers several options for supporting TDM services over a packet core.

- **OTN Layer 1 muxponders**: The 1830 PSS product family includes “multiplexing transponders” that multiplex and map SDH and SONET signals into an OTN signal. Existing SDH/SONET traffic, for example, can be taken from an existing add-drop multiplexer, encapsulated as an OTN wavelength and then multiplexed with other OTN and packet traffic. This hybrid scenario is shown in Figure 2.

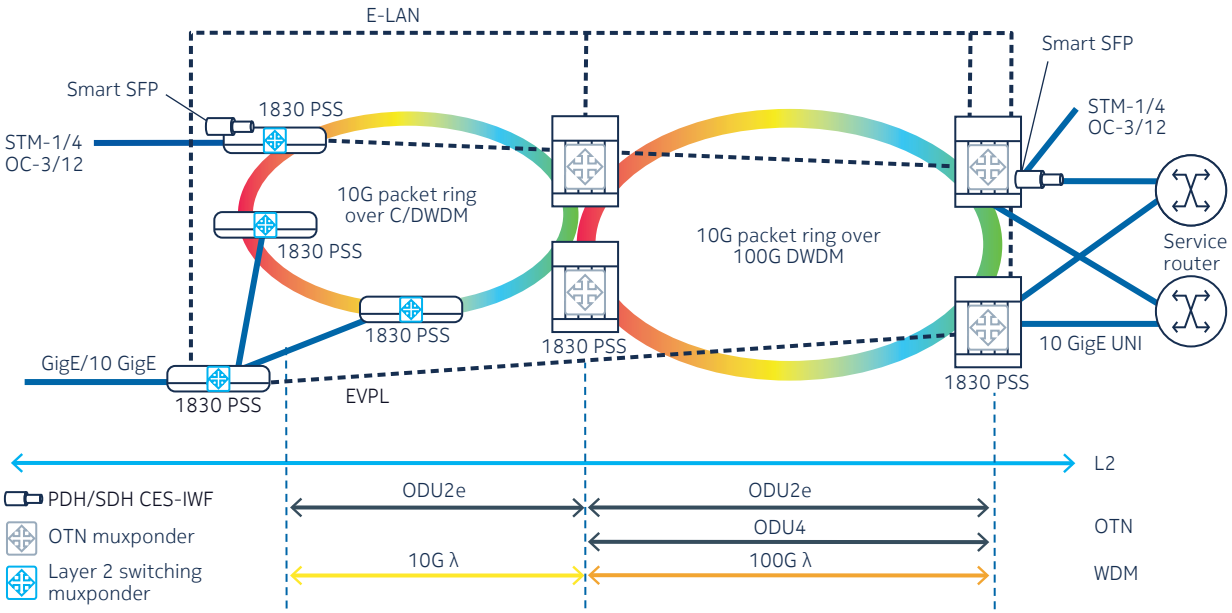
Figure 2. TDM-to-packet transport migration: Hybrid scenario



- **Layer 2 switching cards**: The 1830 PSS product family includes a set of interface cards that provide Ethernet aggregation and switching capabilities for a set of 10M/100M/1G/10G client ports switched to high-speed line ports configured as OTUk, 10GBASE-R or 100GBASE-R Ethernet ports. These cards support pluggable optics, enabling a wide set of configuration possibilities.

  For TDM-to-packet migration applications, these cards can work with Transparent SONET over Packet (TSoP), Channelized SDH/SONET over Packet (CSoP) or Transparent PDH over Packet (TPoP) smart SFP modules. These modules allow an operator to deploy an 1830 PSS Layer 2 switching card (such as 11QPE24, 11QCE12X or 11OPE8) on a node that may simultaneously be supporting other packet or TDM services. As operations allow, the operator can migrate their TDM core to a converged packet scenario, as shown in Figure 3.

Figure 3. TDM-to-packet transport migration: Converged packet scenario



The TSoP provides a TDM interface with legacy access equipment operating at either OC-3/STM-1 or OC-12/STM-4 rates and presents an Ethernet interface to the 1830 PSS Layer 2 cards. Similarly, the TPoP SFP provides an E1/DS1 interface to the legacy TDM access point and presents an Ethernet interface to the 1830 PSS. Together with the CSoP, these smart SFP modules comply with industry standards and support all the functionality of their respective TDM clients. The operator can add a desired number of modules and supporting Ethernet ports based on the number of legacy TDM interfaces present at a particular node.

As needs change and these legacy services are upgraded to Ethernet devices, the smart SFP module is simply removed and the Ethernet port is then utilized for the upgraded service. This method provides an economical, reliable and easily manageable upgrade solution.

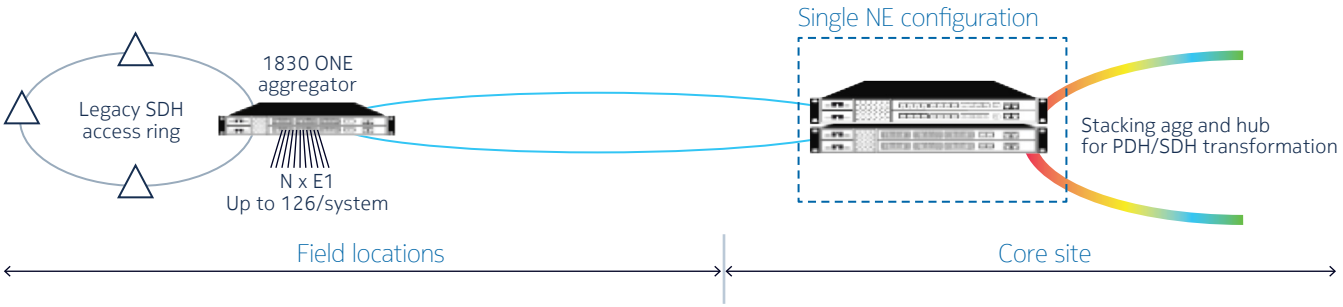
- **Nokia 1830 ONE**: Many legacy TDM applications require aggregation of a relatively large number of low data rate interfaces. For example, some networks use SCADA equipment to collect telemetry data from tactical units or field facility units. These networks may use 64 kb/s channels, multiplexed into higher rate signals, such as E1 (2.048 Mb/s) or E3 (32.368 Mb/s) before hand-off to the optical network.

  Often, the systems require high densities of E1 interfaces at one location and need service protection, resiliency and OAM features. While these signal protocols are outdated, their use is still common in many networks. Supporting these systems while upgrading core networks is important as replacement is not always economically feasible.

  A phased migration toward transport across packet-OTN networks is a common approach. This is easily accomplished through use of the Nokia 1830 ONE in conjunction with the Nokia 1830 PSS. The Nokia 1830 ONE provides high density, high port count service aggregation onto OTN backbones and full interoperability with the 1830 PSS. Depending on application needs, the 1830 ONE can be utilized to map legacy services directly onto an OTN payload or configured for multiservice transport.

  The 1830 ONE is comprised of three, 1RU compact shelves: 1830 ONEa aggregator, 1830 ONEh hub and 1830 ONE micro ROADM. Figure 4 shows an example of a deployment where the 1830 ONE aggregator collects up to 126 E1 services in field locations, connecting to an 1830 ONEh hub node at a core site. Traffic from this core site is then handed off to a core OTN network supported through the Nokia 1830 PSS.

Figure 4. High-density, low rate TDM aggregation with Nokia 1830 ONE



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Conclusion

Net-centric operations require communications networks that are highly agile, scalable and secure. This implies use of networking technologies that allow for the addition of packet-based applications while simultaneously providing connectivity for older, embedded systems. A high degree of flexibility allows the network operator to add new capabilities and phase out older systems as needed. Nokia offers a full suite of networking solutions to accomplish the migration of legacy systems to a modern packet optical communications network.

Using the features of the JITC-certified Nokia 1830 PSS and Nokia 1830 ONE the network can easily scale newer packet-based applications while continuing to provide TDM application connectivity. This is accomplished through Layer 2 switching cards and smart SFP modules, providing flexibility to design solutions that match needs for a mix of connectivity, including DS1, DS3 and SDH/SONET interfaces alongside Ethernet and storage networking interfaces such as Fibre Channel.

In the long term, as the need for PDH and SDH/SONET interfaces is reduced, network capacity and equipment ports can simply be reconfigured for packet traffic.

The Nokia product portfolio offers a complete set of options to meet modern communications requirements. The Nokia 1830 PSS offers the most powerful photonic network solution to meet these needs. To learn more, visit our optical networking web site on nokia.com.

Acronyms

ATM	Asynchronous Transfer Mode
CES-IWF	Circuit Emulation Service - Interworking Function
CSoP	Channelized SONET over Packet
CWDM	coarse wavelength division multiplexing
DWDM	dense wavelength division multiplexing
E-LAN	Ethernet virtual private LAN
EVPL	Ethernet virtual private line
GE	Gigabit Ethernet
HD-SDI	High Definition - Serial Data Interface
IP	Internet Protocol
ITU-T	International Telecommunication Union – Telecommunication Standardization sector
JITC	Joint Interoperability Test Command
L1	Layer 1 - OSI reference model
L2	Layer 2 - OSI reference model
LAN	local area network
MPLS	multiprotocol label switching
MPLS-TP	MPLS - Transport Profile

NE	network equipment
OC-n	optical channel n
ODU	optical data unit
ODUk	optical data unit k
OSI	Open Systems Interconnection
OTN	Optical Transport Network
PDH	Plesiochronous Digital Hierarchy
PSS	Photonic Service Switch
SCADA	supervisory control and data acquisition
SDH	Synchronous Digital Hierarchy
SFP	small form-factor pluggable
SONET	Synchronous Optical Network
STM-n	Synchronous Transport Module n
TDM	time division multiplexing
TPoP	Transparent PDH over Packet
TSoP	Transparent SDH/SONET over Packet
UNI	user-to-network interface
WDM	wavelength division multiplexing

References on Nokia.com

1830 PSS product information

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