The Infinera Submarine Solution

The Infinera DTN as SLTE Brings the Benefits of Digital Optical Networks to the Submarine Market

The Infinera DTN DWDM system has been adapted to meet the needs of the submarine market, enabling submarine network operators to enjoy the benefits of Digital Optical Networks powered by large-scale photonic integration. The Infinera DTN used as SLTE (submarine line terminating equipment) includes new elements and new technology implemented in the existing Infinera DTN chassis. Submarine network operators can deploy the solution today and enjoy significant benefits including more capacity on their subsea network and Infinera's rapid deployment times, while at the same time preserving their investments in their undersea infrastructure.

Investment Protection

Bandwidth demand for submarine networks is growing significantly, including on festoon, regional, and trans-oceanic submarine networks. The Infinera DTN as SLTE is deployed at cable head-end sites, enabling undersea service providers to upgrade existing submarine networks, with a typical doubling of bandwidth capacity. Implementing this capacity increase without changing the undersea infrastructure enables operators to avoid a potential hundreds of millions of dollars of capital expenditure that is often involved in building a new subsea network. The Infinera DTN also provides dispersion compensation that is significantly simpler and cheaper than the existing per-channel dispersion management of other SLTE systems. Combined with the benefits of the Infinera DTN's digital operations and software automation, Infinera's SLTE solutions using the DTN significantly reduce engineering complexity for submarine cable upgrades and channel adds, allowing submarine network operators to deploy additional capacity on existing cable systems faster and at lower cost.

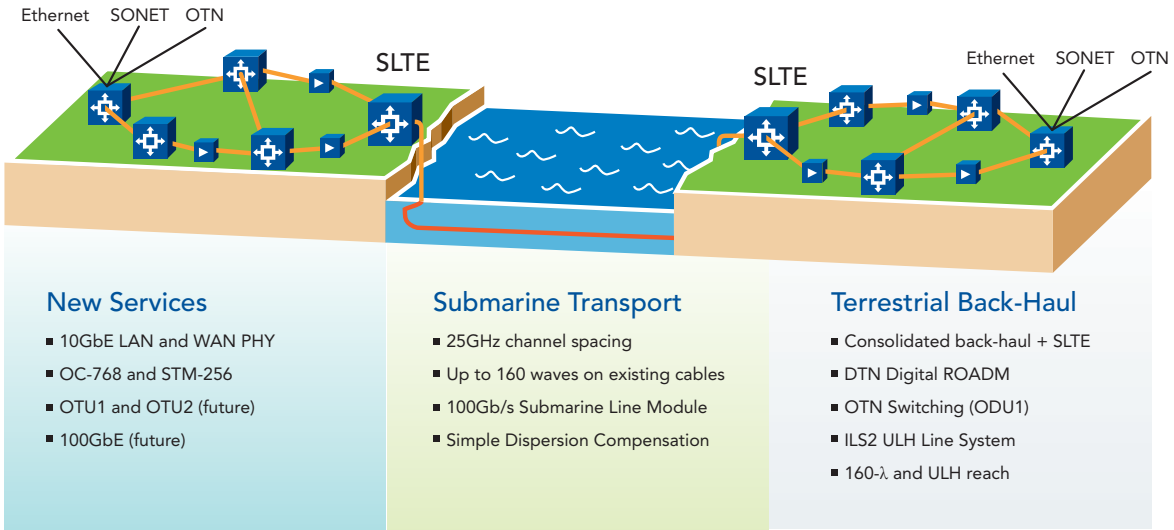

Figure 1. More capacity, new services, faster, and at lower cost with the Infinera DTN as SLTE.

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Cut Deployment Times by up to 83%

The Infinera DTN has earned a reputation for a fast and simple deployment process in terrestrial networks. With the Infinera DTN as SLTE, Infinera brings those same advantages to submarine networks. Infinera's large-scale photonic integrated circuits dramatically simplify a DWDN network, providing 100Gb/s of DWDM line-side capacity on a single circuit pack and eliminating up to 98% of the fiber connections in a DWDM network. This digital architecture enables Infinera submarine systems to be deployed in 4-6 weeks, compared to a typical 6-9 months for traditional submarine networking systems.

Infinera backs up the ease and speed of deployment with an innovative Just-in-TAM™ program, which guarantees delivery of Infinera Tributary Adapter Modules client interfaces within ten days of receipt of order. This enables many operators to add a new service or wavelength to a deployed Infinera system in ten days or less, providing important competitive advantages in today's highly competitive market.

Improve Space Utilization by up to 95%

The use of photonic integrated circuit (PIC)-based DWDM line modules with 100Gb/s capacity in the Infinera DTN means that an Infinera SLTE system will require significantly less space than conventional SLTEs, which often require entire rooms to deploy 40 wavelengths of capacity. An Infinera DTN used in SLTE mode can support up to 80 wavelengths in a single bay, due to Infinera's unique PICs, which integrate more than 60 optical components, and ten wavelengths of DWDM capacity, onto a single pair of chips. Infinera's photonic integration technology eliminates hundreds of FRUs and fiber connections required by traditional DWDM systems. In submarine applications, they deliver the same space-saving benefits.

In addition, the Infinera DTN for SLTE uses an innovative compact full-band dispersion compensation solution, the Infinera DCM3, instead of per-wavelength residual dispersion compensation as is typical in conventional SLTE systems (see Figure 3). Traditional dispersion compensation solutions for SLTE use spools of dispersion compensating fiber on a per-channel basis, often requiring a total of more than 100 DCM modules for a fully lit system. Multiple spools per channel typically require additional optical amplifiers, leading to a system that is large, complex to manage, and costly. The Infinera DCM3 module delivers variable dispersion compensation per channel for every channel in the system, all in a single module. The result is a solution that is highly space-efficient, more economical, easy to manage, and quicker to deploy. Combined, the Infinera DTN used as an SLTE provides dramatic density improvements, requiring up to 95% less space than conventional SLTE systems.

Consolidate SLTE and Backhaul

The Infinera DTN is the first DWDM platform that combines high-capacity DWDM transport with integrated digital bandwidth management. In SLTE configurations, the Infinera DTN can be used to consolidate submarine traffic and terrestrial backhaul traffic on a single platform. This eliminates the cost and complexity of back-to-back transponders, fiber patch-cords and additional inventories, using valuable space and working capital.

The Infinera DTN has become the number one platform in North American long-haul optical networks (Source: Ovum) because of the unique advantages of Infinera's Digital Optical Networks architecture based on its proprietary PICs. Those advantages, including speed, simplicity, and flexibility are available now for the first time to the submarine network world with the Infinera DTN as SLTE.

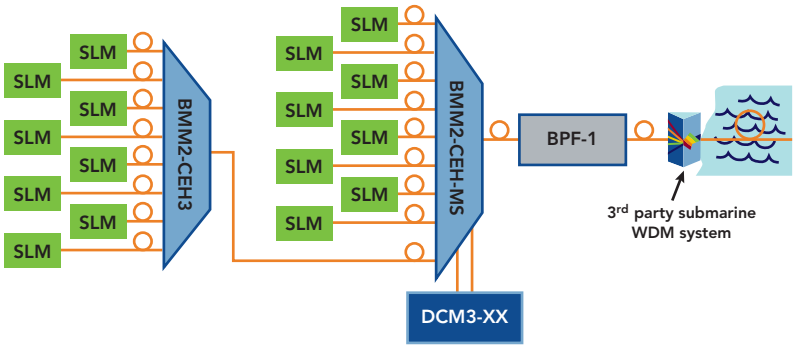

Figure 2. Architecture of Infinera DTN as SLTE, showing the multiplexing of 160 wavelengths onto a single subsea fiber. Subject to undersea fiber and bandpass, the Infinera solution can support up to 160 wavelengths on a fiber.

Traditional SLTE DCM

Infinera SLTE DCM3

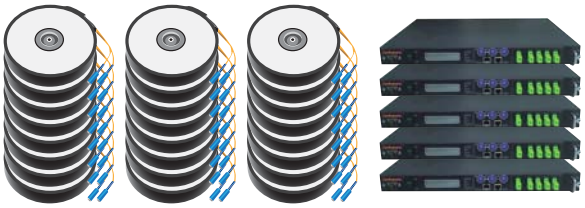

Figure 3: Traditional SLTE dispersion compensation can require up to 20 times the space of the Infinera DCM3 solution.

Key Elements of the Infinera Submarine Solution

Submarine Line Module (SLM):

- Up to 100Gb/s of PIC-based multi-wavelength capacity in a single circuit pack
- Each SLM provides a single fiber output with up to 10 wavelengths, compliant with 25GHz channel spacing on the ITU-T G.694.1 wavelength grid
- Total capacity: up to 160-wavelengths on a fiber
- Each wavelength operates at 11.1Gbps using an enhanced G.709 OTU2V digital wrapper
- High-gain FEC ensuring end-to-end system operation at guaranteed BER of less than 10^{-15} across the network
- Three SLM versions available to optimize for transmission distance

Tributary Adapter Module (TAM):

- Pluggable interfaces terminate client signals
- Mix and match: any TAM in any slot
- Wide range of service interfaces supported; SONET/SDH services at 2.5G, 10G or 40G; Ethernet services at 1Gb/s (GigE) and 10Gb/s (10GbE) in LAN or WAN PHY configurations

Band Multiplexing Module (BMM2):

- Optically multiplexes/de-multiplexes signals from multiple SLMs onto a single fiber
- Integrates optical amplifiers to amplify the DWDM signal before transmission into the undersea fiber
- Provides insertion point for Dispersion Compensation Modules (DCM), and optical monitor ports for testing and maintenance

Dispersion Compensation Module (DCM3):

- Provides full-band compensation of residual chromatic dispersion for all DWDM channels in a single module
- Provides variable dispersion compensation for each DWDM channel
- DCM3 modules can provide both pre- and post-compensation of residual dispersion, minimizing non-linear penalties and maximizing optical reach
- Significant space and cost savings versus typical, per-channel, SLTE DCM solutions using DCF spools

Band-Pass Filter (BPF):

- Adapts Infinera SLTE output to the existing submarine cable system operating spectrum, filtering out wavelengths outside the operating range of the undersea EDFA repeaters
- Supports an express add/drop function to allow pass-through of SLTE monitoring channels from existing 3rd-party submarine system

Key Benefits of the Infinera Submarine Solution

Double the capacity: The Infinera DTN enables service providers to upgrade existing submarine cables to 25GHz channel spacing, enabling up to a doubling of total cable capacity up to 160 wavelengths.

Integrated dispersion compensation: The Infinera solution uses an integrated dispersion compensation technique that is significantly simpler and cheaper than the per-channel dispersion management of traditional submarine systems.

Dramatically shorter lead times: Infinera equipment is delivered in weeks, or even days, rather than the many months lead time that is typical for submarine systems.

Reduced operational complexity: Digital operations and software automation reduce engineering complexity for deployment and channel adds, allowing submarine network operators to deploy additional capacity on existing cable systems faster, and at lower cost, than is possible using conventional SLTE systems.

New service opportunity: The Infinera system supports newer service types, such as 10GbE LAN PHY, and 40G services. These may not be available on traditional SLTE systems.

Investment Protection: The Infinera DTN as SLTE can add years of life to an existing submarine plant by enabling an operator to provide up to double the capacity on its subsea infrastructure without the cost of laying an entirely new network. In addition, the Infinera solution reduces operating costs by providing a solution that is easier to manage, quicker to deploy, and requires far less parts.

About Infinera

Infinera revolutionized the optical networking industry in 2004 with the launch of the Infinera DTN, the first optical system based on large-scale photonic integration. The Infinera DTN is the first optical system to offer high-capacity DWDM transport, integrated bandwidth management, and GMPLS-powered service intelligence in a single platform. Infinera's Bandwidth Virtualization™ architecture turns the optical network into a pool of flexible resources which can be reconfigured and used to provide services at any speed and between any two points on the network with unrivalled speed of service delivery and ease of use.

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