

mTera SONET/SDH Migration

Evolving TDM Networks to OTN/Packet with the Infinera mTera Universal Transport Platform

Although spending on SONET/SDH infrastructure has declined significantly in commercial markets, the technology persists in many government and local networks as it continues to reliably perform trusted and valuable network functions. However, network operators with SONET/SDH infrastructure must contend with high operational costs related to maintenance, power consumption, and footprint, in addition to the increasing challenges of obtaining replacement parts. The Infinera mTera Universal Transport Platform (UTP), together with the other members of the Infinera optical transport portfolio, provides a range of options for lowering cost and complexity without losing the proven high resiliency, consistent management, and traffic variety of legacy SONET/SDH systems.

ANALYZING THE DRIVERS FOR SONET/SDH MIGRATION

Following standardization in the late 1980s, SONET/SDH achieved widespread adoption in the 1990s and became the dominant transport technology for network operators around the globe. Aided by the evolution to more packet-friendly next-generation SONET/SDH, network operators continued to invest billions in their SONET/SDH infrastructure well into the 2000s. Despite continued attempts to displace SONET/SDH, the technology remains in the networks of many network operators as it reliably performs functions such as mobile network synchronization and delivers highly resilient services to risk-averse end customers.

However, network operators with traditional SONET/SDH networks face several challenges, as shown in Figure 1. In addition to costly maintenance contracts, obtaining replacement parts can be a challenge as equipment manufacturers discontinue platforms and/or specific modules due to component obsolescence. Legacy SONET/SDH equipment also typically requires a larger footprint and higher power consumption relative to next-generation packet optical platforms. Together, these challenges result in high operational costs. Furthermore, the majority of SONET/SDH equipment supports a maximum interface speed of 10 Gb/s (OC-192/STM-64), which limits the ability to scale bandwidth cost effectively.

BENEFITS OF INFINERA MTERA FOR NETWORK TRANSFORMATION

- **Scale** STS-1/VC-4 switching to 1.68 Tb/s and 100G+ interfaces
- **Protect** trusted legacy SONET/SDH services with Infinera mTera STS-1/VC-4 and OTN switching
- **Migrate** end-to-end services with SONET/SDH to OTN and packet interworking
- **Avoid** high maintenance costs by refreshing legacy equipment with future-proof next-generation platforms
- **Reduce** power consumption with less than 3 W per Gb/s for STS-1/VC-4 switching, less than 0.7 W per Gb/s for OTN switching, and less than 0.9 W for packet switching
- **Minimize** the number of 100G+ line interfaces required with efficient STS-1/VC-4 grooming for SONET/SDH

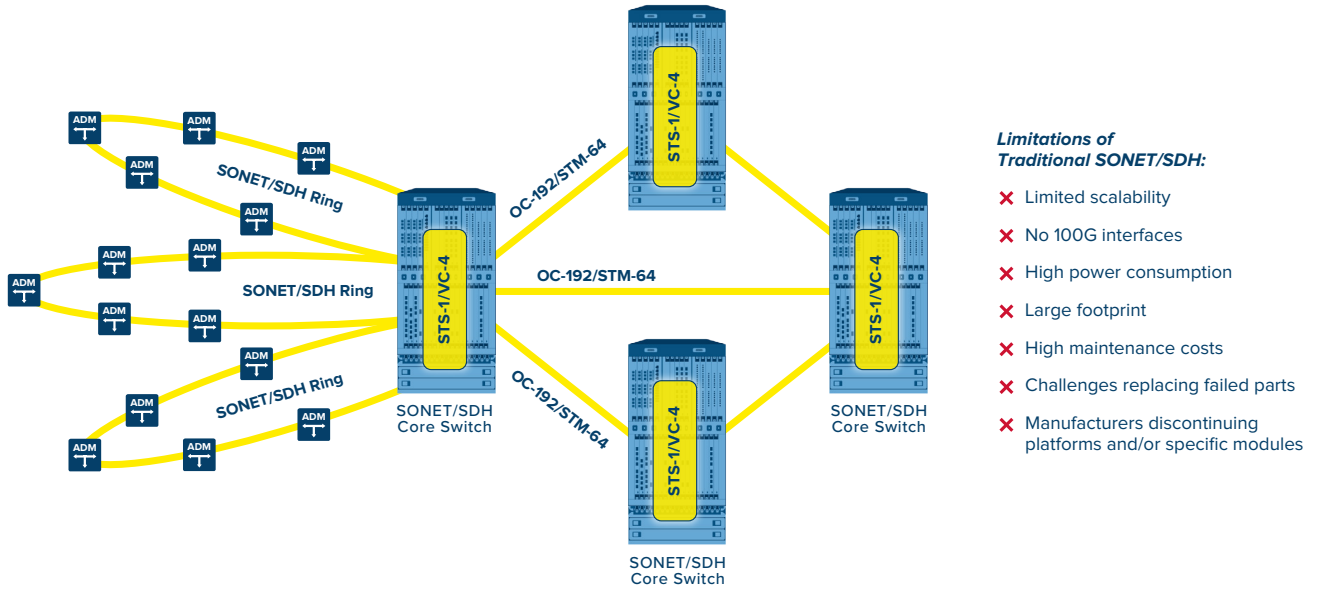


Figure 1: Traditional SONET network

CONVERGING OTN, PACKET, AND SONET ON A SINGLE PLATFORM

The mTera UTP provides several options for migrating SONET/SDH networks and services to next-generation platforms and technologies. It provides a future-proof architecture that offers universal switching of packet, OTN, and/or SONET/SDH. The mTera UTP can be deployed as a standalone OTN switch, a standalone packet switch, or a standalone SONET/SDH switch. Hybrid operation enables OTN switching, different flavors of packet switching, and/or SONET/SDH switching to function simultaneously in the same shelf and even on the same cards and ports, thus saving on equipment, power, and footprint. Hybrid operation also enables different switching types to share the same high-speed line interfaces, thereby reducing interface complexity and decreasing the number of wavelengths on the optical network.

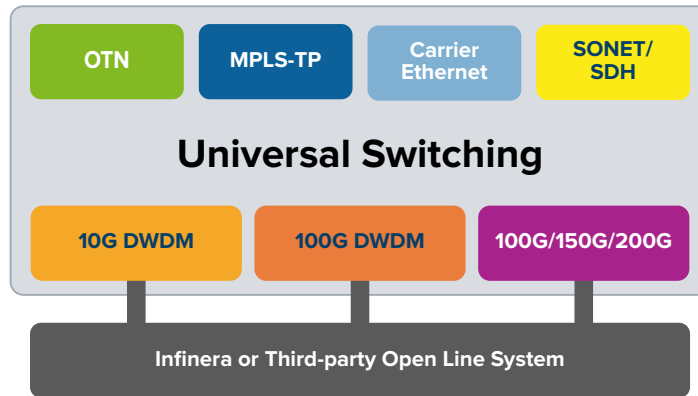


Figure 2: Infinera mTera UTP high-level overview

REPLACING LEGACY SONET/SDH CORE SWITCHES WITH THE 1.68 TB/S MTERA UTP

One common migration option, as shown in Figure 3, is to keep the SONET/SDH ADM rings and replace the core switches with the mTera UTP as a high-capacity STS-1/VC-4 switch. With the SSM-2S modules, the mTera 14-slot shelf can provide up to 1.68 Tb/s of STS-1/VC-4 switching in 19RU, and the mTera eight-slot shelf can provide up to 960 Gb/s in 10RU (23-inch rack) or 12RU (ETSI or 19-inch rack).

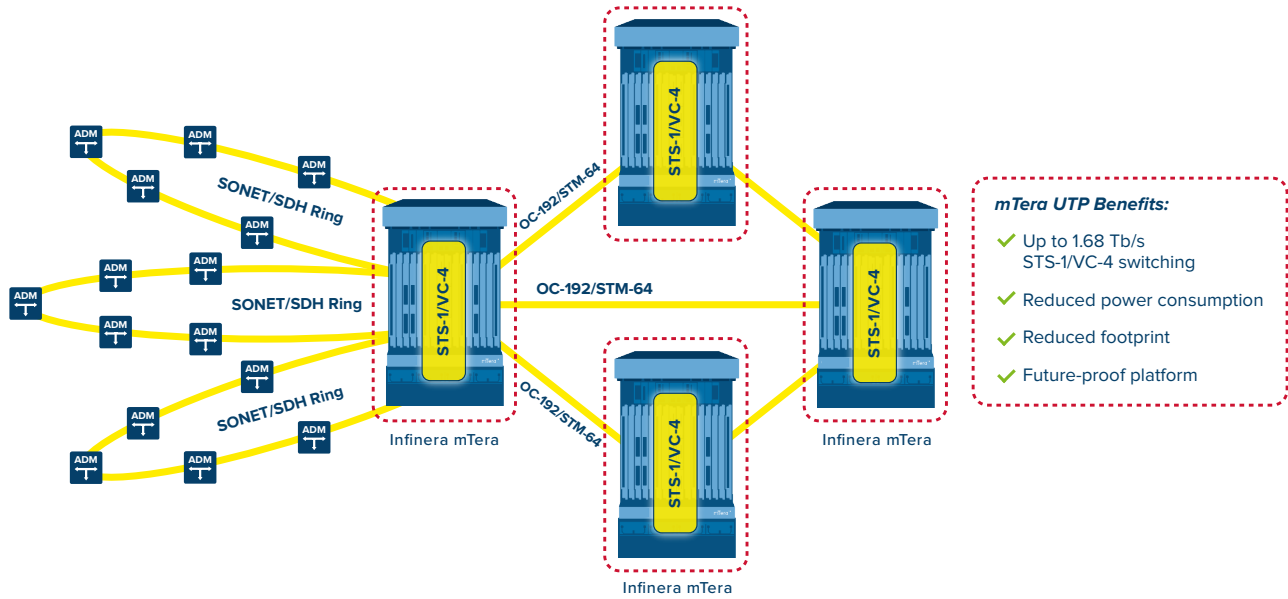


Figure 3: Replace core SONET/SDH switches with the mTera

Additional benefits include reduced power consumption and footprint, with STS-1/VC-4 switching at less than 3 W per Gb/s and up to 96 Gb/s per rack unit, as shown in Table 1.

	Infinera mTera UTP		
	Legacy SONET/SDH	STS-1/VC-4 Switching	Packet/OTN Switching
Maximum Switch Capacity	~320 Gb/s-640 Gb/s	1.68 Tb/s	7 Tb/s
Maximum Line Interface	10 Gb/s	200 Gb/s	200 Gb/s
Footprint (Gb/s per RU)	15 to 20	Up to 96	Up to 400
Power (W per Gb/s)	5 to 10	<3	<0.7 (OTN), <0.9 (Packet)

Table 1: Legacy SONET/SDH vs. mTera UTP

LEVERAGING SONET/SDH TO OTN INTERWORKING FOR 100G+ LINE INTERFACES

As shown in Figure 4, leveraging mTera UTP SONET/SDH-to-OTN interworking, the STS-1/VC-4 traffic can be mapped to OTN and transported over high-speed 100G and flexible-rate (100G/150G/200G) line interfaces. Optionally, these interfaces can be shared with other OTN-switched and packet-switched traffic to maximize their utilization.

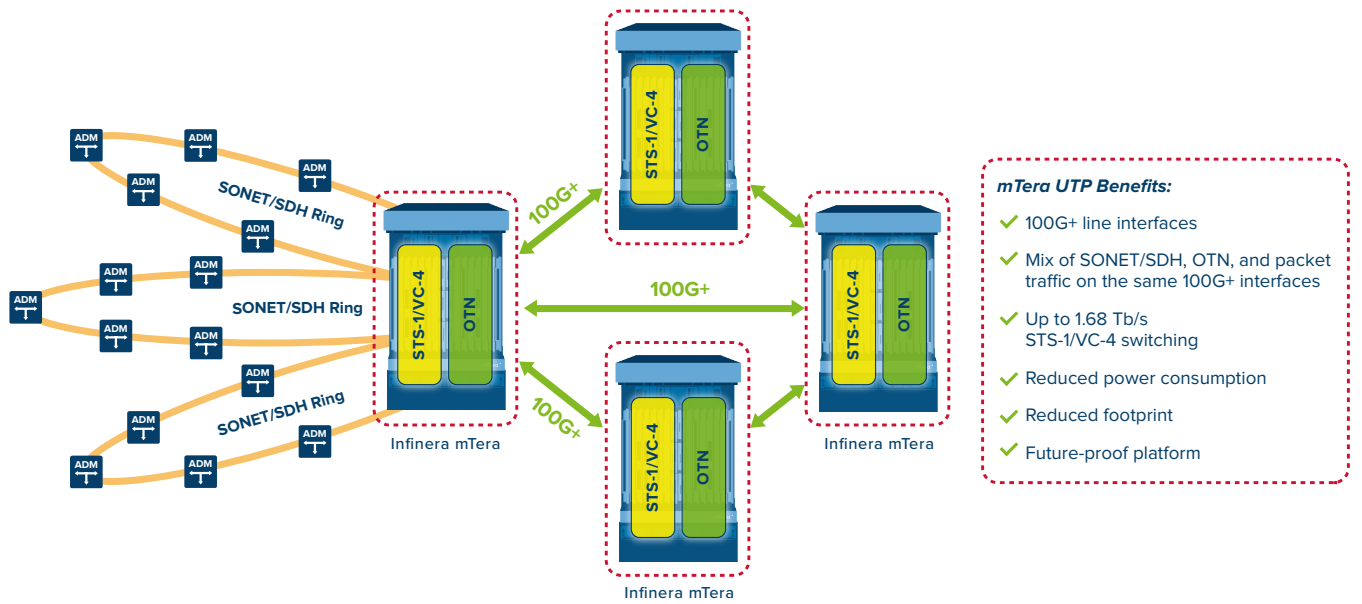


Figure 4: Transport SONET/SDH over 100G+ line interfaces

SCALING ETHERNET OVER SONET/SDH WITH A PACKET-SWITCHED CORE

Another option is to leverage mTera UTP SONET/SDH-to-packet interworking, taking Ethernet over SONET/SDH traffic from the ADM rings, terminating the SONET/SDH, and then mapping the Ethernet traffic into a packet switching instance on the mTera UTP. In this way, the full packet feature set of the mTera can be extended to Ethernet interfaces on the ADMs, and end-to-end Ethernet services can be delivered over multiple transport switching domains. This application can be supported in parallel with the previously described applications, with packet, SONET/SDH, and OTN switching able to share the same physical mTera hardware and interfaces.

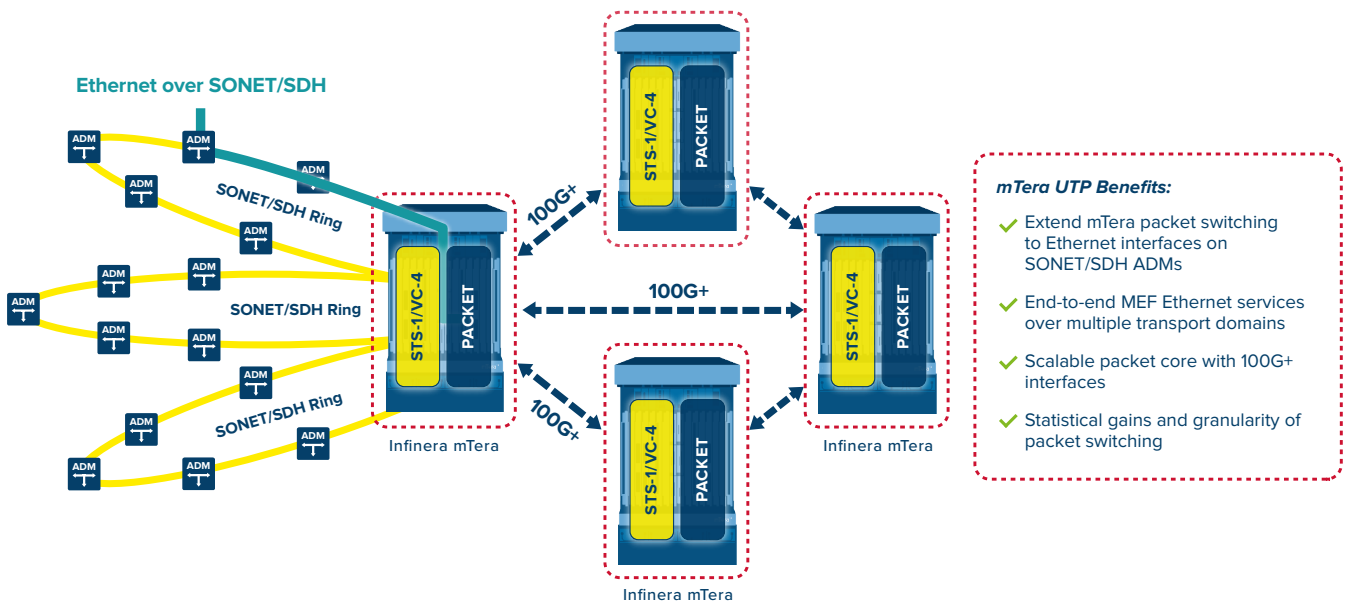


Figure 5: Ethernet over SONET-to-packet interworking

MIGRATING SONET/SDH RINGS TO UNIVERSAL TRANSPORT WITH THE MTERA UTP

In addition to deploying the high-capacity 14-slot mTera as a replacement for core SONET/SDH switches, network operators have the option to extend the benefits of universal transport to the SONET/SDH ADM rings by replacing entire rings or individual nodes with either the higher-capacity 14-slot mTera or the more compact eight-slot mTera. The eight-slot mTera provides 960 Gb/s of STS-1/VC-4 switching and up to 4 Tb/s of OTN/packet switching and can be mounted horizontally, consuming 10RU in a 23-inch rack, or vertically, consuming 12RU in a 19-inch or ETSI rack. In addition, the variety of mTera SONET/SDH protection and restoration schemes can be combined with OTN protection and restoration to provide end-to-end resiliency from the SONET/SDH rings over the OTN core.

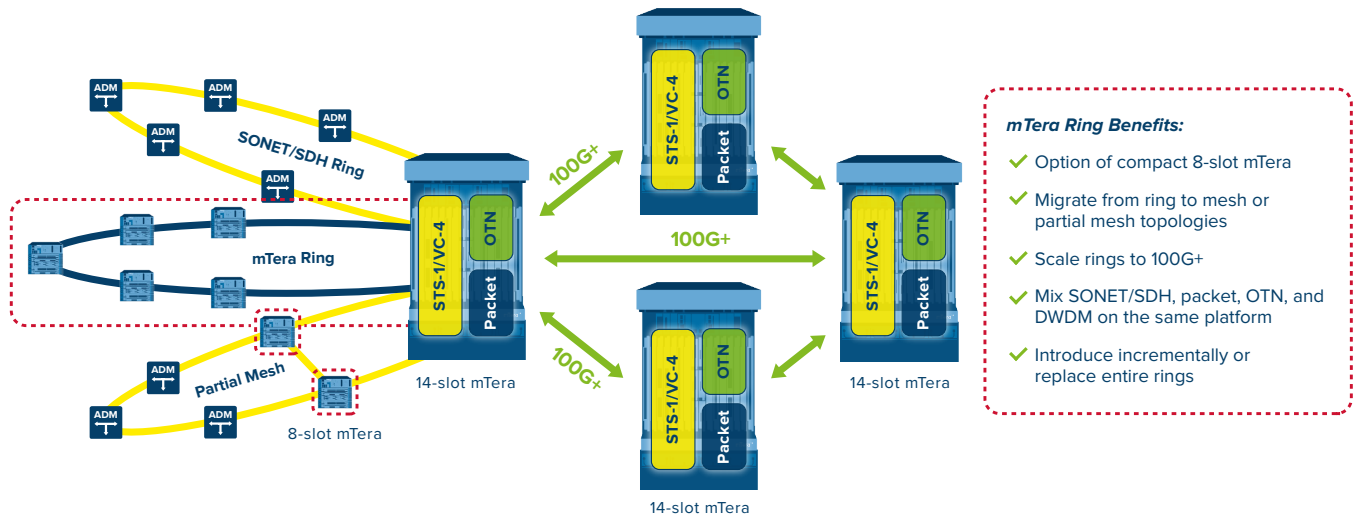


Figure 6: Migrate SONET/SDH rings with the mTera UTP

COMPLEMENTING THE MTERA WITH THE INFINERA 7090 CEM FOR T1/E1 CES

The mTera UTP supports OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, and OC-192/STM-64 SONET/SDH interfaces. Where there is a need to support lower-speed TDM interfaces such as T1/E1, the Infinera 7090 Packet Transport Solutions CEM platforms can complement mTera UTP rings with the ability to provide TDM circuit emulation services (CES) over MPLS-TP with support for T1/E1, DS3, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, and STM-64 interfaces, as shown in Figure 7.

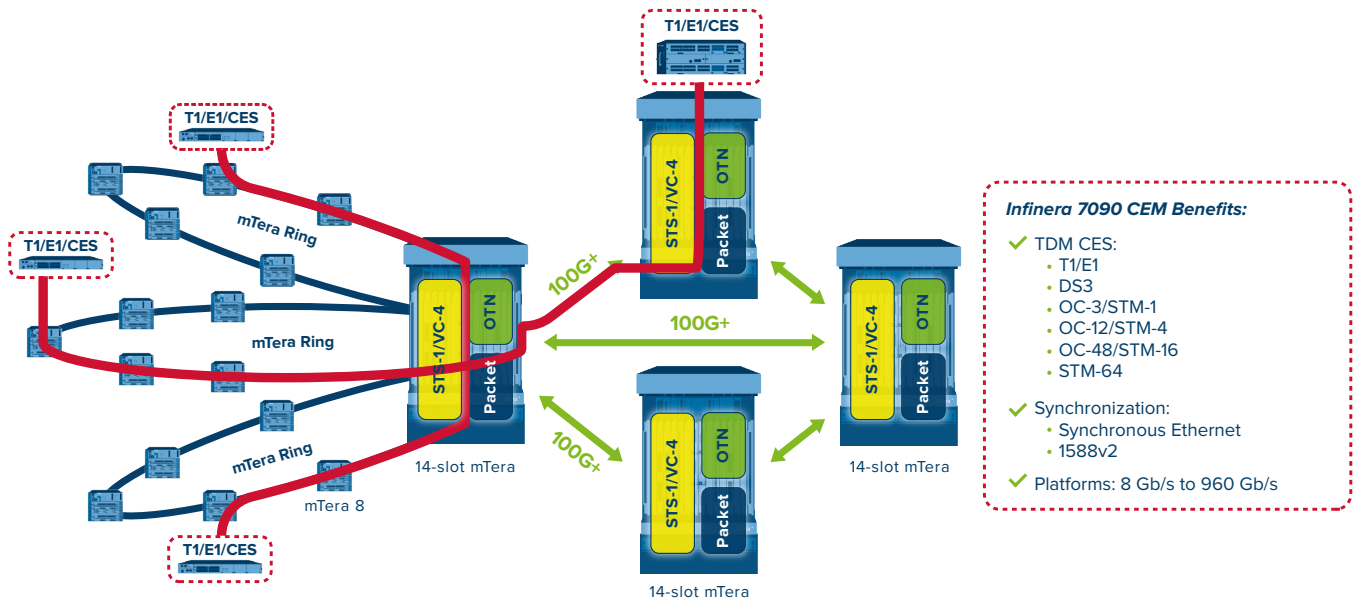


Figure 7: T1/E1 CES with the Infinera 7090 CEM

REPLACING SONET/SDH RINGS WITH OTN ADMS AND STS-1/VC-4 SWITCHING IN THE CORE

OTN ADMs provide another option for migrating SONET/SDH rings. The 2RU Infinera 7100 Pico Packet Optical Transport Platform can provide a compact 100G ADM with a pair of 100G muxponder/ADM modules. Alternatively, a 10G ADM option is available with the 7100's OMM-X module, which provides two 10G/OTU2 line interfaces and eight-low speed SFP client ports. SONET/SDH traffic can be mapped to ODU0s, ODU1s, or ODU2s and then transported over the 10G or 100G OTN ring to the mTera UTP.

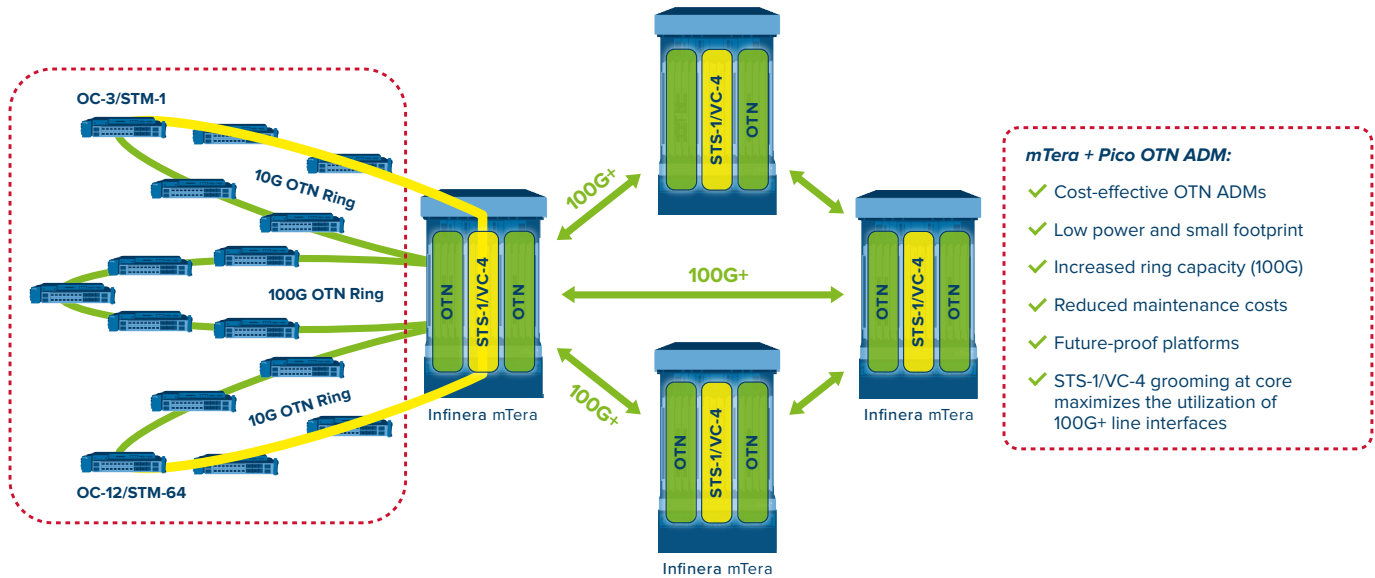


Figure 8: OTN to the edge with STS-1/VC-4 grooming in the core

At the mTera UTP, this traffic can either be switched natively as with OTN or it can be sent to an SSM-2S module for STS-1/VC-4 grooming before being mapped back to OTN. This STS-1/VC-4 grooming can result in much more efficient utilization of high-speed line interfaces, for example, enabling an OTU4 to carry 640 OC-3s/STM-1s, rather than 80 OC-3s/STM-1s where OC-3s/STM-1s are carried in ODU0s, as shown in Figure 9.

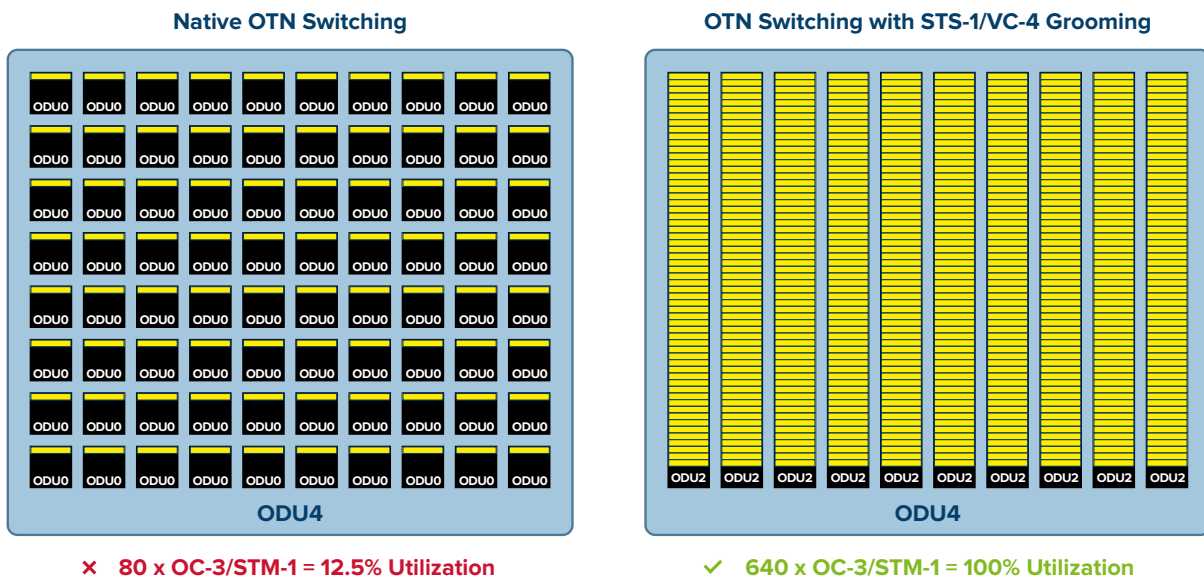


Figure 9: Native OTN switching vs. OTN switching with STS-1/VC-4 grooming

REPLACING SONET/SDH RINGS WITH PACKET/TDM CES RINGS

An additional option for the SONET/SDH rings is to migrate them to packet switching based on MPLS-TP, including VPLS/H-VPLS, with TDM CES for the TDM interfaces, leveraging the 7090 CEM Series. Benefiting from the granularity and statistical gains of packet, these rings can be used to deliver both Ethernet and TDM services through the mTera UTP as it provides a scalable core packet switch with the additional ability to perform SONET/SDH and OTN switching.

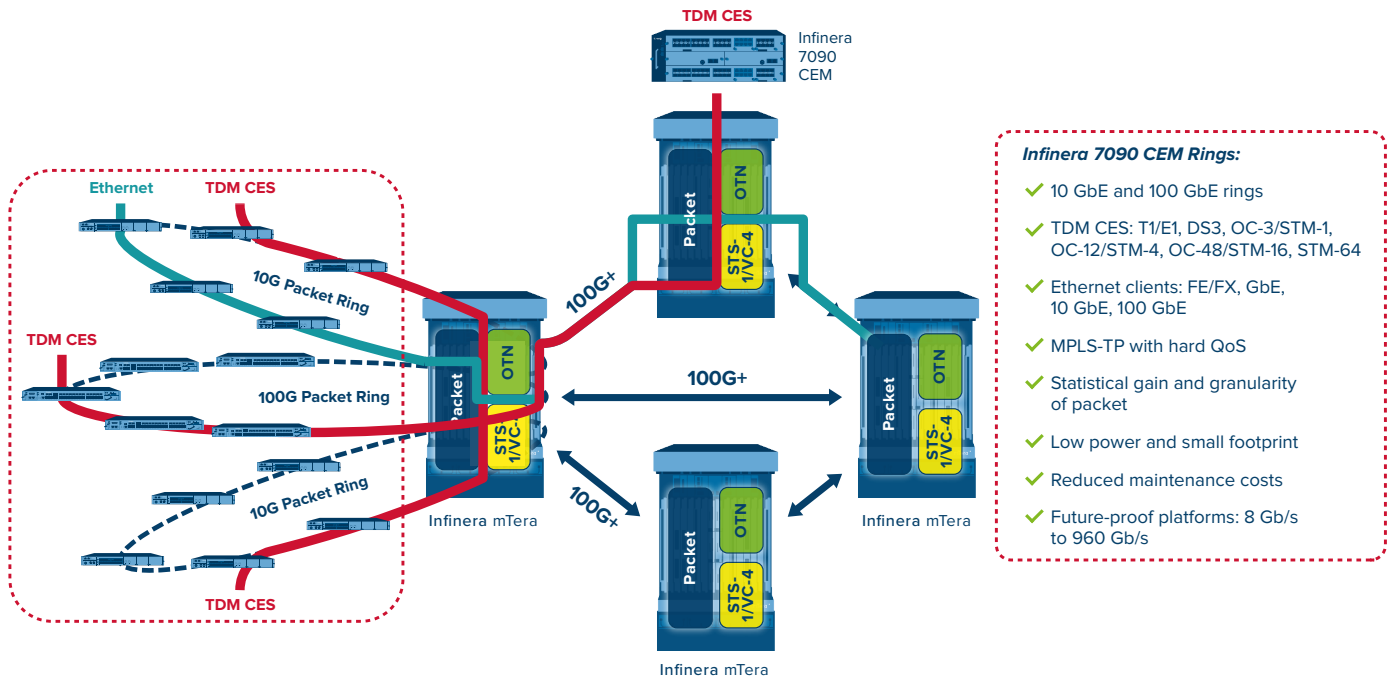


Figure 10: Packet/CES rings with the Infinera 7090 CEM

DELIVERING END-TO-END SERVICES WITH SONET/SDH-PACKET AND SONET/SDH-OTN INTERWORKING

Leveraging its universal switching and interworking capabilities, the mTera UTP can provide a gateway between the SONET/SDH domain and other transport domains based on OTN, MPLS-TP, and Carrier Ethernet technologies. The mTera UTP can enable end-to-end TDM and Ethernet services that span the SONET/SDH domain and the OTN domain. Universal switching can also enable end-to-end Ethernet services that span the SONET/SDH domain and packet domains, including MPLS-TP/H-VPLS, Carrier Ethernet VLAN cross-connect, and Carrier Ethernet bridging.

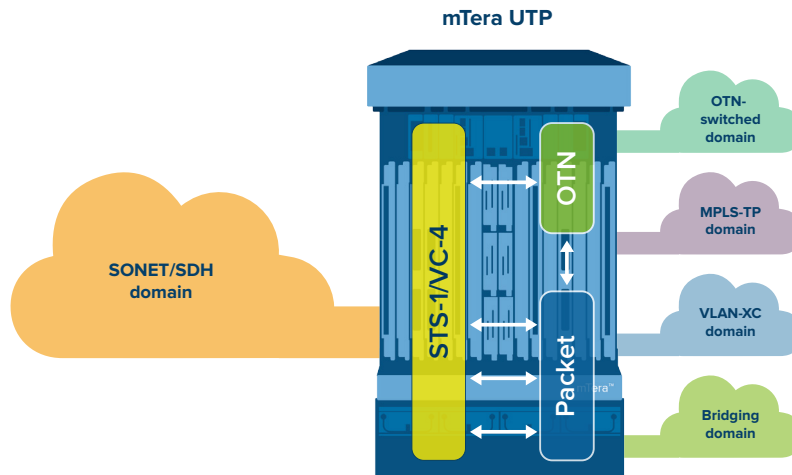


Figure 11: End-to-end services gateway

FEATURING THE MTERA SSM-2S SONET/SDH SWITCHING MODULE

The mTera SSM-2S module provides six 10G SFP+ ports for OC-192/STM-64 and 24 SFP ports for OC-3/OC-12/OC-48/STM-1/STM-4/STM-16. 120 Gb/s of native STS-1/VC-4 traffic per SSM-2S module can be switched between ports on the same SSM-2S module and between ports on different SSM-2S modules via the backplane and mTera universal fabrics. Therefore, the SSM-2S is designed to enable up to 1.68 Tb/s of STS-1/VC-4 switching in the 14-slot mTera and 960 Gb/s in the eight-slot mTera.

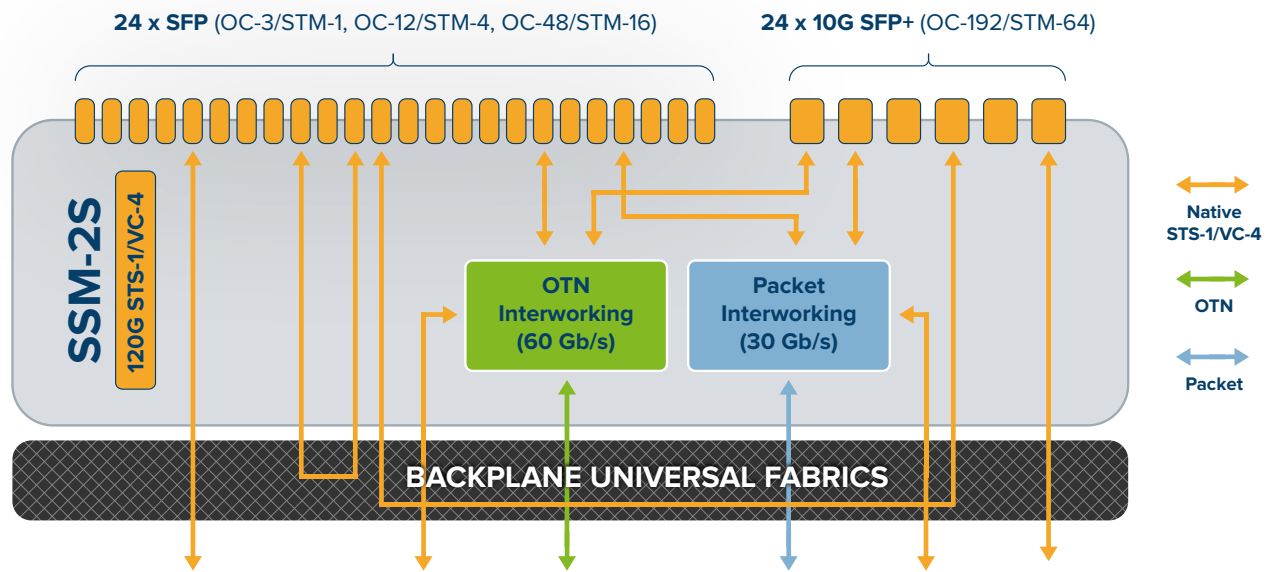


Figure 12: mTera SSM-2S SONET/SDH switching module

The SSM-2S module is also designed to support:

- **SONET/SDH-to-OTN interworking:** 60 Gb/s of STS-1/VC-4 traffic from the same module or other SSM-2S modules mapped to OTN and switched to the mTera OSM OTN/packet modules
- **SONET/SDH-to-packet interworking:** Terminate up to 30 Gb/s of Ethernet over SONET/SDH traffic from the SONET/SDH ports and switch the Ethernet traffic into the packet switching on the mTera OSM OTN/packet modules
- **Synchronization** via Stratum 3 clocks in the mTera timing and processor modules with timing references coming from either the interfaces on the switching modules or external timing interfaces (T1/E1/2MHz) in the shelf common equipment
- **SONET/SDH protection:** UPSR, SNC, 1+1 APS, and 1+1 MSP
- **ASON/GMPLS protection and restoration:** STS-1/VC-4

SONET/SDH resiliency schemes can also be combined with mTera packet and OTN resiliency schemes, including ODUk-level ASON/GMPLS protection and restoration.

MIGRATING WITH INFINERA PROFESSIONAL SERVICES

Infinera offers comprehensive professional services to assist with the migration of SONET/SDH networks. These professional services follow a four-phase process, as shown in Figure 13. The first phase provides a network audit that includes identifying the targeted network elements, conducting a field audit, and gathering each network element configuration and the physical and logical circuit assignments. This process enables Infinera Professional Services to determine the high-level project scope.

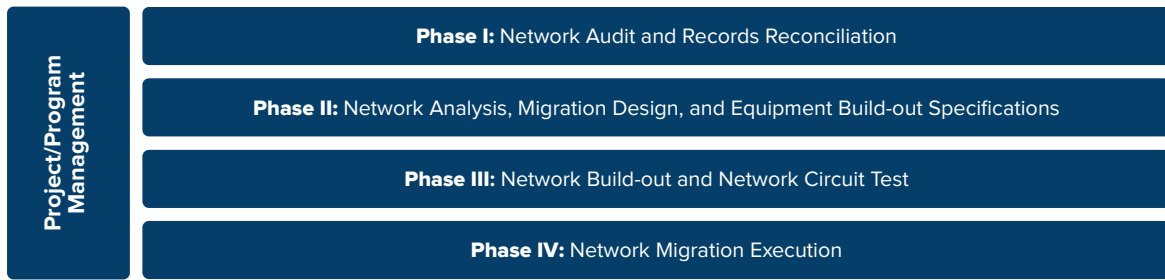


Figure 13: Infinera Professional Services process for SONET/SDH migration

The second phase in the migration of SONET/SDH networks includes network analysis, a migration plan and procedures, and equipment selection and deployment. The third phase consists of provisioning the new network elements, installing new facility wiring/optics, and testing the end-to-end circuits. The fourth and final phase includes executing the facility/service migrations, verifying the alarms, and updating the new circuit designs in the OSS and other support systems.

SUMMARY

Though SONET/SDH networks continue to deliver resilient services to risk-averse customers and perform useful network functions such as mobile network synchronization, they suffer from high operational costs and the threat of component obsolescence. The mTera UTP, sometimes with additional Infinera products including the 7090 CEM and the 7100 Pico, provides a range of options for migrating SONET/SDH networks to next-generation OTN/packet technologies and future-proof platforms while lowering operational costs and protecting SONET/SDH service revenues. These Infinera solutions can also deliver a wide range of additional services based on their OTN switching, packet switching, and DWDM/ROADM capabilities.