mTera SONET/SDH Migration

**Evolving TDM Networks to OTN/Packet with the Infinera mTera UTP**

Although spending on SONET/SDH infrastructure has declined over the past decade, the technology persists in many networks and reliably performs valuable network functions while delivering high margin revenues. 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 entire Infinera packet optical portfolio, provides a range of options for lowering operational costs without losing the high margin revenues generated by legacy SONET/SDH.

**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 in the 2000s. And despite continued attempts to displace SONET/SDH over the last fifteen years, the technology remains in the networks of many network operators as it reliably performs functions such as mobile network synchronization and delivers highly profitable services to risk-averse end customers.

However, network operators with traditional SONET/SDH networks face a number of 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 Gbps (OC-192/STM-64), which limits the ability to scale bandwidth cost effectively.

**BENEFITS OF INFINERA MTERA SONET/SDH MIGRATION:**

- **Scale** STS-1/VC-4 switching to 1.68 Tbps and 100G+ interfaces
- **Protect** high margin SONET/SDH service revenues with Infinera mTera STS-1/VC-4 and OTN switching, the Infinera 7090 CEM for TDM Circuit Emulation, and the Infinera 7100 Pico for OTN ADM
- **Deliver** end-to-end services with SONET/SDH to OTN and SONET/SDH to packet interworking
- **Avoid** high maintenance costs by replacing legacy SONET/SDH equipment with future-proof next-generation platforms
- **Reduce** power consumption with less than 3 W per Gbps for STS-1/VC-4 switching, less than 0.7 W per Gbps for OTN switching, and less than 0.9 W for packet switching
- **Minimize** the number of 100G+ line interfaces with efficient STS-1/VC-4 grooming for SONET/SDH
CONVERGING OTN, PACKET, AND SONET/SDH ON A SINGLE PLATFORM

The mTera UTP provides a number of 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 CapEx and footprint. Hybrid operation also enables different switching types to share the same high speed line interfaces, thereby reducing interface costs and decreasing the number of wavelengths on the optical network.

Figure 2: Infinera mTera UTP High Level Overview

LIMITATIONS OF TRADITIONAL SONET/SDH:
- Limited scalability
- No 100G interfaces
- High power consumption
- Large footprint
- High maintenance costs
- Challenges replacing failed parts
- Manufacturers discontinuing platforms and/or specific modules

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The DWDM layer can be provided by the Infinera 7100 Packet Optical Transport Solutions, Infinera hiT 7300 Multi-Haul Transport Platform, or third-party DWDM equipment. Alternatively, with its optional ROADM-on-a-blade modules, the mTera UTP can provide a converged packet optical system with both electrical switching and DWDM.

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

One simple migration option, as shown in Figure 3, is to keep the SONET/SDH ADM rings and replace the core switches/DCSs 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 Tbps of STS-1/VC-4 switching in 19RU, and the mTera 8-slot shelf can provide up to 960 Gbps in 10RU (23-inch rack) or 12RU (ETSI or 19-inch rack).

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

<table>
<thead>
<tr>
<th>mTera UTP Benefits:</th>
</tr>
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<tbody>
<tr>
<td>✓ Up to 1.68 Tbps STS-1/VC-4 switching</td>
</tr>
<tr>
<td>✓ Reduced power consumption</td>
</tr>
<tr>
<td>✓ Reduced footprint</td>
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<tr>
<td>✓ Future-proof platform</td>
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**Figure 3: Replace Core SONET/SDH Switches with the mTera UTP**

**Table 1: Legacy SONET/SDH vs. mTera UTP**

<table>
<thead>
<tr>
<th></th>
<th>Legacy SONET/SDH</th>
<th>STS-1/VC-4 Switching</th>
<th>Packet/OTN Switching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Switch Capacity</td>
<td>320 Gbps “ 640 Gbps</td>
<td>1.68 Tbps</td>
<td>12 Tbps</td>
</tr>
<tr>
<td>Maximum Line Interface</td>
<td>10 Gbps</td>
<td>200 Gbps</td>
<td>200 Gbps</td>
</tr>
<tr>
<td>Footprint (Gbps per RU)</td>
<td>15 to 20</td>
<td>Up to 96</td>
<td>Up to 400</td>
</tr>
<tr>
<td>Power (W per Gbps)</td>
<td>5 to 10</td>
<td>&lt; 3</td>
<td>&lt; 0.7 (OTN), &lt;0.9 (Packet)</td>
</tr>
</tbody>
</table>
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 flexi-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 to 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/SDH 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 and DCSs, network operators have the option to extend the benefits of universal transport to the SONET/SDH rings by replacing either entire rings or individual nodes with either the higher capacity 14-slot mTera or the more compact 8-slot mTera. The 8-slot mTera provides 960 Gbps of STS-1/VC-4 switching and up to 4 Tbps 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 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.

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

The mTera UTP supports STM-1/OC-3, STM-4/OC-12, STM-16/OC-48, and STM-64/OC-192 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, and OC-48/STM-16 interfaces, as shown in Figure 7.
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 HGTM-MS2 100G muxponder/ADM modules. Alternatively, a 10G ADM option is available with the 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.

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 STM-1s/OC-3s, rather than 80 OC-3s/STM-1s when OC-3s/STM-1s are carried in ODU0s, as shown in Figure 9.

Figure 8: OTN to the Edge with STS-1/VC-4 Grooming in the Core

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.

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.
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 twenty-four SFP ports for OC-3/OC-12/OC-48/STM-1/STM-4/STM-16. 120 Gbps 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. The SSM-2S therefore is designed to enable up to 1.68 Tbps of STS-1/VC-4 switching in the 14-slot mTera and 960 Gbps in the 8-slot mTera.

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

- **SONET/SDH to OTN interworking**: 60 Gbps 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 Gbps 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**: 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 the 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.
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 high margin 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, together with the 7090 CEM and 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.