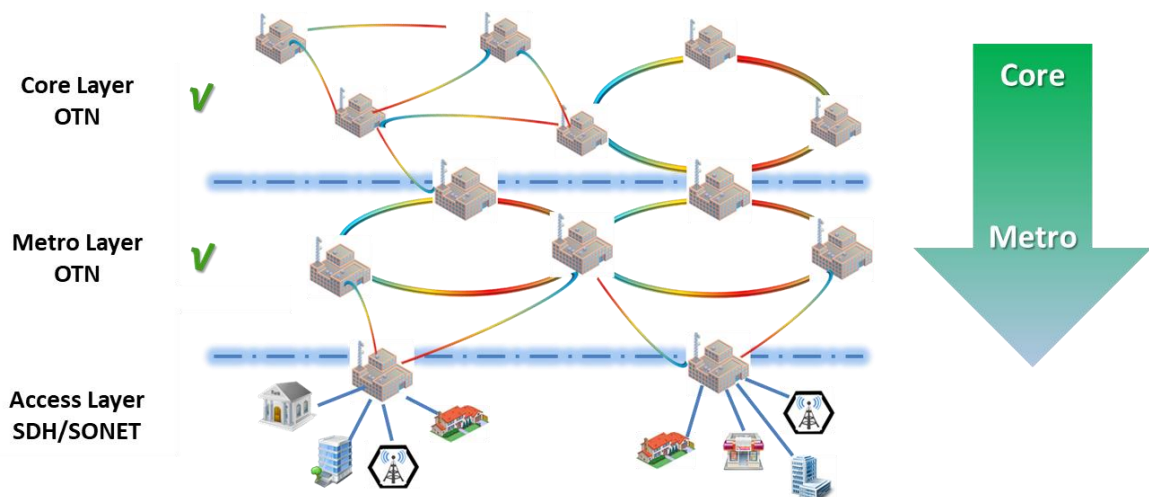


Network-Edge/Access Layer Applications

Background

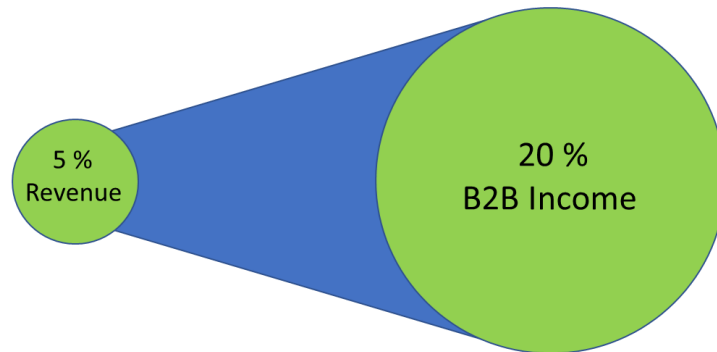
Client-services' generated telecom traffic is on the growth, driving an increase in the demand for telecom bandwidth. Telecom operators worldwide have completed the transition of their Core and Metro network layers to OTN technology. However, SDH/SONET has remained as a transport technology at the Network-Edge/Access Layer.



OTN at the Core and Metro Layers. SDH/SONET remains at the Access Layer

Modern and Legacy Telecom Services & Private Line Services (PLS)

Modern telecom services, mainly connectivity to the Cloud, PON, Enterprise/Business, Gaming, and other services, including legacy services, are mainly delivered over Ethernet. However, the transport network establishing the end-to-end connections is currently based on 2 networking technologies: OTN and SDH/SONET. The reason for the coexistence of these 2 technologies is simple: the smallest OTN transport container is 1.25G, while for SDH it is 2Mbps. Since there are many client-services whose required bandwidth falls in between, network operators continue to deploy a combination of OTN and SDH equipment. This has created a patchwork of Ethernet/SDH/OTN technologies that require to be separately maintained, serviced, and enhanced to assure end-user services. In addition, an important market segment for telecom operators are enterprise services that require dedicated (or virtual) "pipes". A characteristic of PLS is that an ~80% of PLS customers will also buy from the operator Cloud and additional value-added services. B-2-B services represent a major profit segment for telecom operators worldwide, and in many cases still rely on SDH/SONET to provide quality, fail-safe services.



PLS represent only ~5% of an operator's revenues but drive 20% of their B2B income

Backhaul and Fronthaul Networks

A major cost element of cellular networks is their RAN, or Radio Access Network. Cellular operators strive to provide these links in a cost-effective way. In addition, cellular operators deploy newer cellular technologies while the previous generations continue to be in service. In 2G the connectivity to the cell sites is provided by E1/T1 lines, in 3G Ethernet signals, in 4G it is with CPRI signals and in 5G with Ethernet at higher speeds. Telecom operators providing the RAN optical infrastructure have to support a combination of 2G, 3G, 4G and 5G cellular technologies.

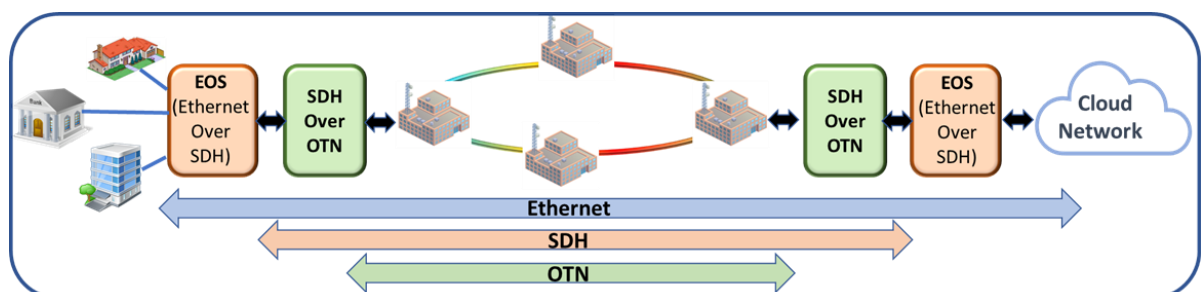
Network-Edge/Access Layer Systems.

Network-Edge/Access Layer systems need to support both wireline and wireless end-users.

Network-Edge/Access systems, accordingly, should support a range of customer services: Ethernet (FE/GE/10GE/...), SDH (STM1/4/16/64), PDH (E1/T1/E3/T3) and others. Additional capabilities supported by these systems require value-added Ethernet and SDH functionality.

The "Sandwich" Dilemma.

A patchwork of networking technologies (OTN, SDH/SONET) is used to deliver end-user services.

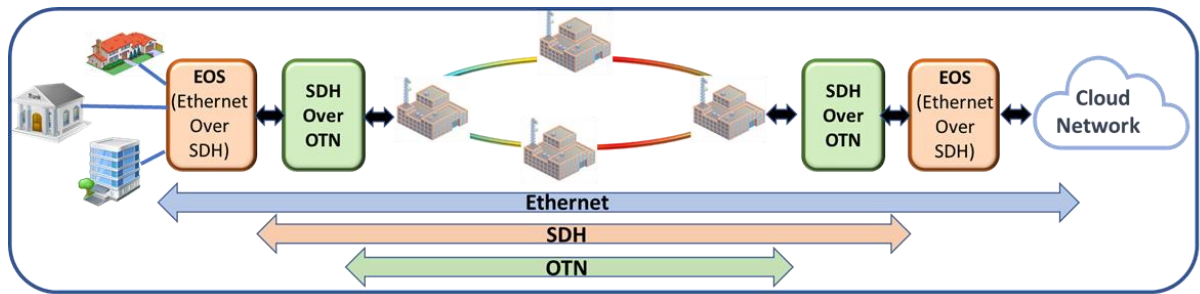


The Technology "Sandwich": Ethernet services transported over SDH over OTN

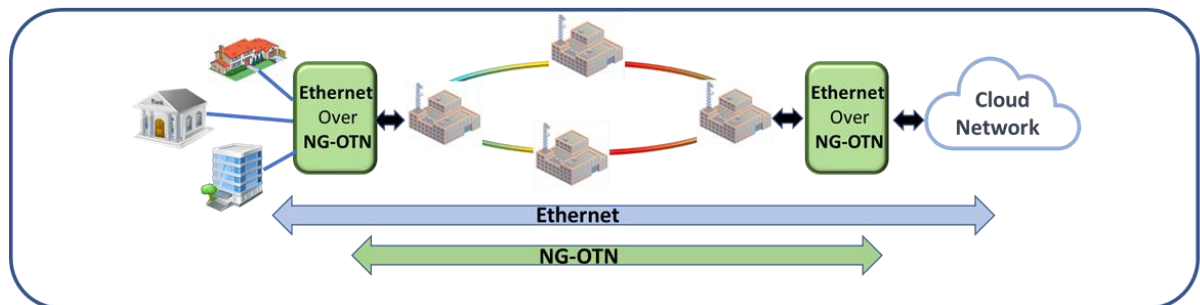
The “Technological Sandwich” has posed over time several issues: First, it still makes use of SDH/SONET veteran, aging technology. The associated issue is the need of telecom operators to continue to support multiple networking technologies in parallel. Each technology requires its separate types of spare parts, technological proficiency, different OSS (Operations Support Systems) and network planning tools. In addition, operators face the obvious, increasing incompatibility of veteran, voice-optimized technologies designed in the twentieth century with the types and needs of modern telecom services.

NG-OTN Based Systems at the Metro and Network-Edge/Access Layers

NG-OTN, or Next-Generation OTN, is being developed by the ITU-T SG15 to address both modern and legacy client-services, while establishing a future-proof solution. NG-OTN will enhance the current OTN and eliminate the need to continue to use SDH/SONET equipment. The key element of NG-OTN is a new type of container, OSUs (Optical Service Units). OSUs are of variable size: The basic granularity is of 2.6Mbps, that is optimized for the efficient transport of an E1 client-service, and they can grow to up to 100Gbps and beyond in 2.6/10.4Mbps steps. OSUs support both Packet (such as Ethernet) and CBR (Constant Bit Rate, such as SDH or PDH signals) client-services. OSUs are always mapped into ODU containers, transporting over ODUs multiple client-services. In example, an ODU4 may transport more than 1,000 OSUs (client-services), while in current OTN, an ODU4 may transport only up to 80 ODUs (client-services). The combination of flexible, optimized bandwidth OSU containers and the much larger number of client-services that may be transported by ODUs greatly improves the utilization of the optical network. NG-OTN will also eliminate the need for SDH/SONET equipment, leading to a simplification of Operations Support Systems (OSS). The deployment of NG-OTN at the Network-Edge/Access and Metro Layers will eliminate the technological “sandwich”, improve optical network utilization, reduce inventories, and simplify network planning and OSS maintenance, thus reducing operators’ CAPEX and OPEX. Since the bandwidth of OSU containers can span the entire range of 2Mbps-100Gbps (and beyond), NG-OTN is a future-ready solution to optical networking. NG-OTN supports Ethernet, SDH/SONET and PDH client-services, while providing forward looking bitrates scalability. All OTN signals (OTU) capabilities such as FEC (Forward Error Correction) TCM, Tandem Connection Monitoring etc. will be preserved. NG-OTN equipment will also help operators to reduce the amount of fiber required for backhaul/fronthaul networks.



From requiring OTN+SDH to support Ethernet
to
Ethernet over NG-OTN



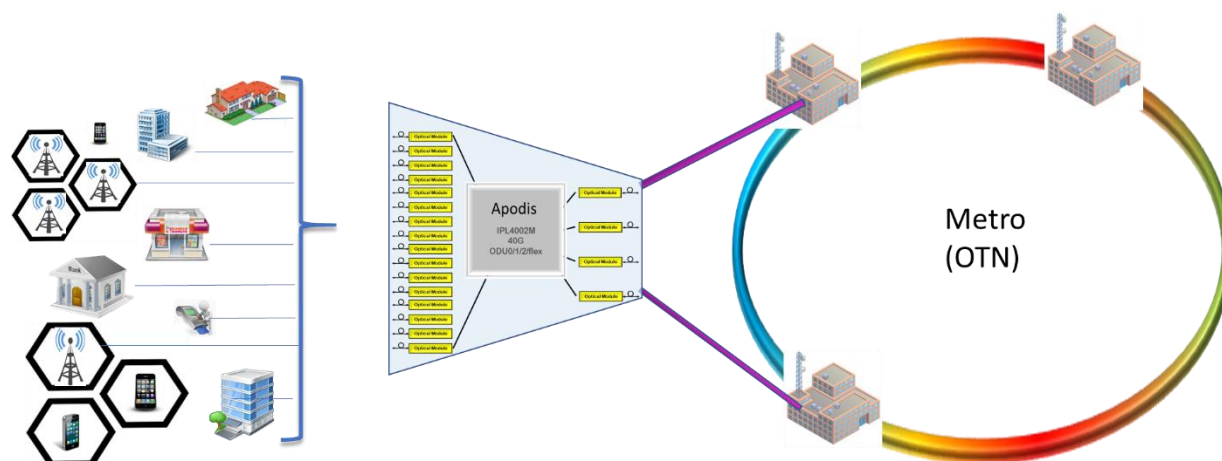
NG-OTN at the Access/Metro Layers: Enhancing OTN, Eliminating SDH/SONET

OTN and NG-OTN Processors for Access and Metro Optical Networking Systems.

Tera-Pass offers 4 OTN and NG-OTN processor product families: Apodis OTN processors ASICs, Scorpion NG-OTN IP Cores, Orion OTU2r IP Cores and Taurus ASICs.

Apodis:

Apodis is an OTN processors ASIC (Application Specific Integrated Circuit) product family. Apodis processors support up to 16 client-services and present them to up to 4 OTU2/OTU1 lines. Apodis processors incorporate additional value-added functions beyond G.709 OTN.



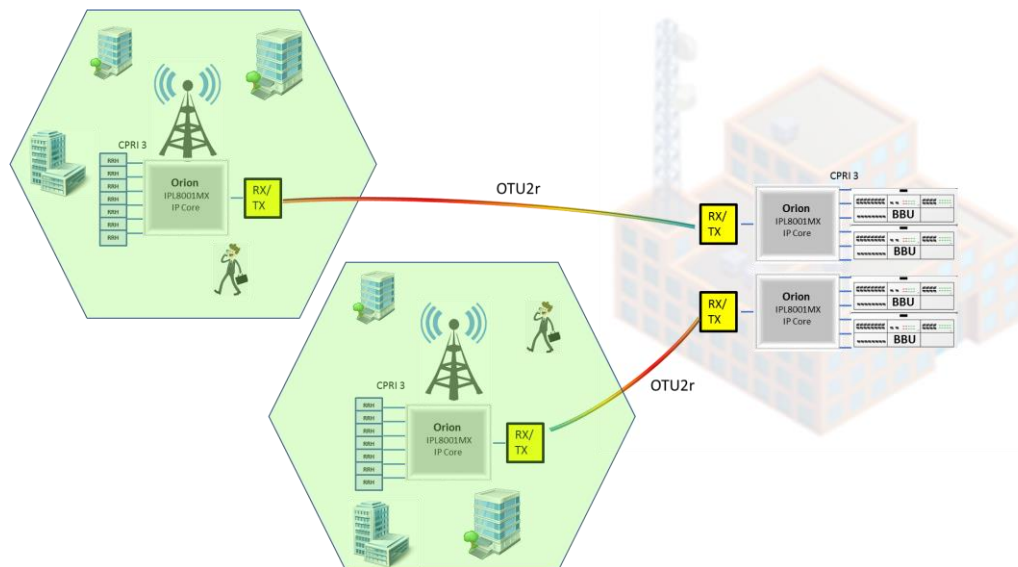
Typical Network-Edge application of Apodis IPL4002M OTN Processors

Part Number	Application	Line Signals		Client Signals					
		No. Of Ports	OTU2 / OTU1	No. Of Ports	Ethernet	SDH	OTN	FC	CBR
IPL4002M	Muxponder/ Transponder	4	✓	16	✓	✓	✓	✓	✓
IPL4102M	Muxponder/ Transponder	2	✓	16	✓	✓	✓	✓	✓
IPL4102A	Muxponder/ Transponder	2	✓	8	✓	✓	✓		
IPL4202M	Muxponder/ Transponder	1	✓	8	✓	✓	✓	✓	✓
IPL4302F	Transponder	4	✓	4	✓	✓	✓	✓	✓
IPL4402F	Transponder	2	✓	2	✓	✓	✓	✓	✓
IPL4402A	Transponder	2	✓	2	✓				

Apodis product family of ASIC OTN processors

Orion:

The Orion IP Cores product family is optimized for the transport of CPRI signals over OTU2r bearers. Orion IP Cores are offered as complete solutions, including transceivers programming and jitter attenuation filters for Xilinx FPGAs.



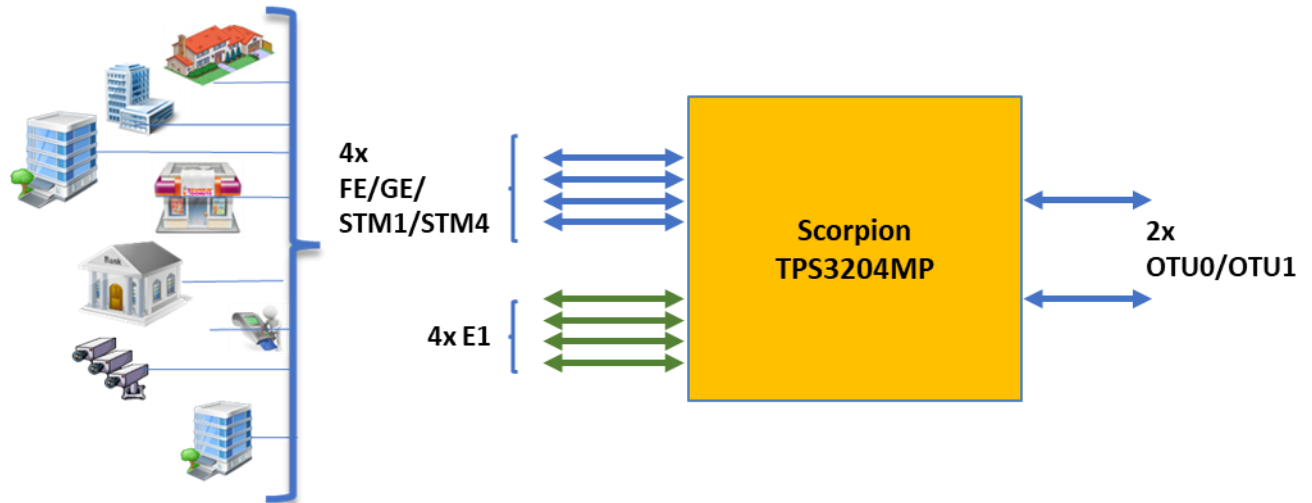
Typical Orion application for Mobile Fronthaul Optical Transport Systems

Part Number	Application	Line Signals		Client Signals		
		No. Of Ports	OTU2r	No. Of Ports	CPRI-3 CPRI-4 CPRI-5	CPRI-7 CPRI-8 CPRI-9
IPL8001MX	Muxponder	1	✓	6	✓	
IPL8021MX	Muxponder	2	✓	6	✓	
IPL8101TX	Transponder	1	✓	1		✓
IPL8141TX	Transponder	4	✓	4		✓

Orion IP Cores: OTU2r Processors Product Family for Xilinx FPGAs

Scorpion:

Scorpion IP Cores are a novel product family of NG-OTN (Next-Generation OTN) processors that implement the mappings of client-services to ODU or to OSU (Optical Service Unit) containers. OSUs are a new, flexible, variable bandwidth type of container whose bandwidth spans from 2Mbps up to 100Gbps in 2.6/10.4Mbps increments. NG-OTN optical networking systems will enhance current Access and Metro OTN and eliminate the need for SDH/SONET.



Scorpion TPS3204MP NG-OTN Processor: OTU0/1 Line-Side Application

Taurus:

Taurus ASIC NG-OTN Processors are now under development. Taurus processors will support a variety of Ethernet, SDH and PDH client-services. Taurus processors will support the mapping of client-services to OSU (NG-OTN) or ODU containers and will also provide additional, powerful Ethernet L2 and SDH functionality.

Contact Information:

For further information please browse to our site at www.tera-pass.com or contact us through info@tera-pass.com.