Introduction to Next Generation Optical Transport Network (NG-OTN)

White Paper

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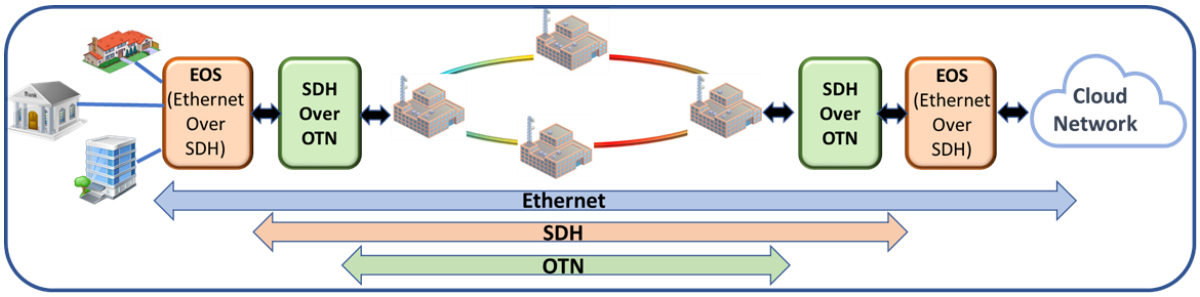
Introduction

OTN, Optical Transport Network, has evolved over time from a digital encapsulation "wrapper" to a network technology that supports multi-service transport. OTN is now expanding from the core and metro layers to the edge of the metropolitan area network. However, its current ODU (Optical Data Unit) structure is too coarse to handle the entire span of bandwidths of client-services. Due to the large differences in the size of their smallest transport containers (1.25Gbps for OTN vs. 2.3Mbps for SDH), telecom operators continue to deploy both OTN and SDH/SONET equipment.

This reliance on 2 separate networking technologies incurs unnecessary costs and complexity, requires maintaining 2 types of equipment and spare parts, adds complexity to OSS (Operations Support Systems), to network planning and to maintenance.



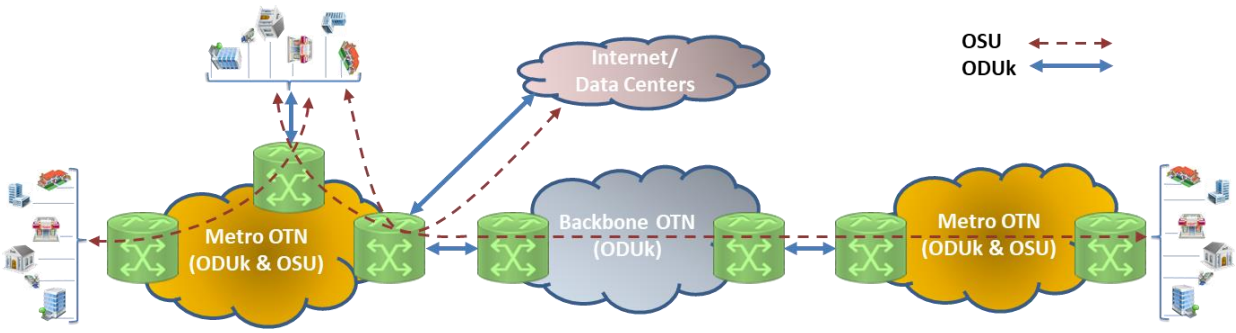
A superposition of OTN and SDH is currently required to support Ethernet client-services

The ITU-T SG15 is now developing the G.osu recommendations, or Next-Generation OTN. NG-OTN will be based on a new, fine-granularity, flexible bandwidth container named OSU, Optical Service Unit. NG-OTN will cater to all types and rates of telecom services.

China, under the auspices of the CCSA (China Communications Standards Association), has already committed to NG-OTN, as well as other countries.

NG-OTN (Next-Generation Optical Transport Network)

The key objectives of NG-OTN are to support all types and rates of telecom services, preserve compatibility with the existing OTN and eliminate the need for SDH/SONET.



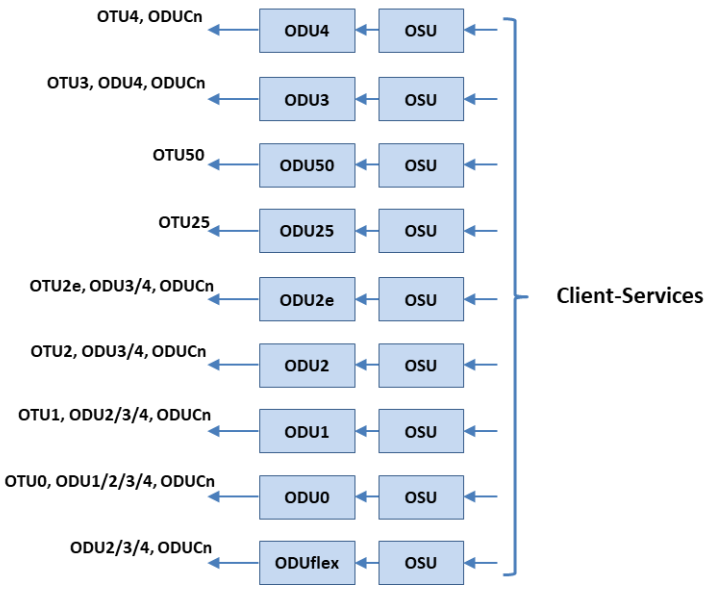
NG-OTN: Basic Networking Concept

NG-OTN OSU containers are always transported by current OTN ODUs

Metro and Access/CPE layers equipment will support NG-OTN

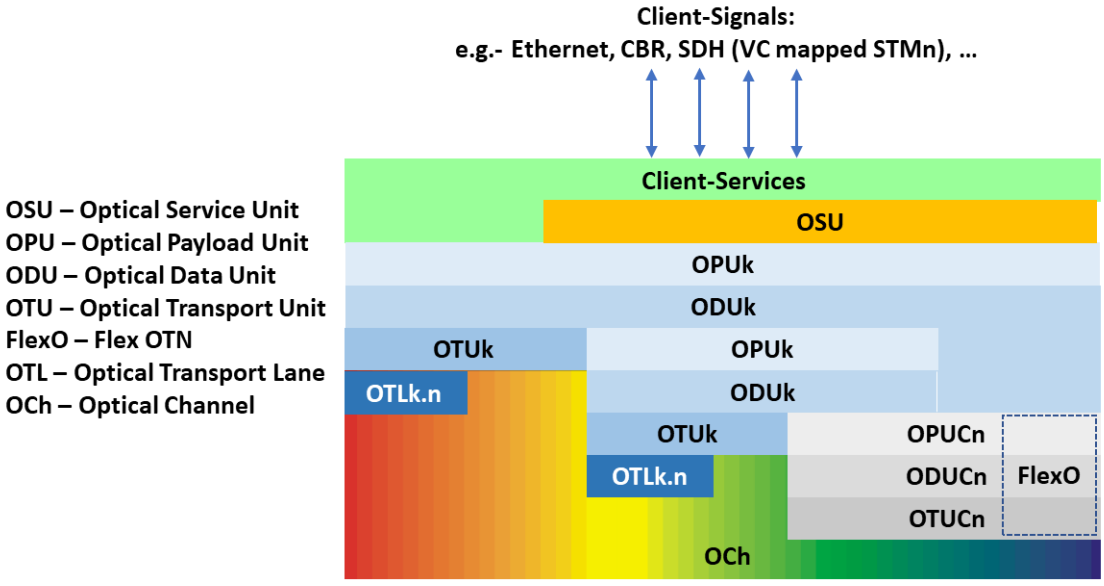
1. **OSUs (Optical Service Units)**

NG-OTN introduces a new, flexible type of container – OSUs.
OSUs support Packet (e.g.- Ethernet) and CBR (Constant Bit Rate) client-services.
An OSU bandwidth can be optimized to the bandwidth of its client-service in the range of 2.6Mbps-100Gbps (or more) in steps of 2.6/10.4Mbps.



OSU's bandwidth is optimized to their client-service, may be mapped into any ODU

2. **NG-OTN Structure**



NG-OTN Layers: OSU containers are transported by OPUs

In NG-OTN, client-services such as Ethernet, Constant Bit Rate (CBR, e.g.- E1/T1, STMn, …) signals, and virtual containers of SDH STMn signals, can be mapped into OSU containers. A multiplicity of OSU containers can then be mapped into OPUk containers and further transported by OTU signals.

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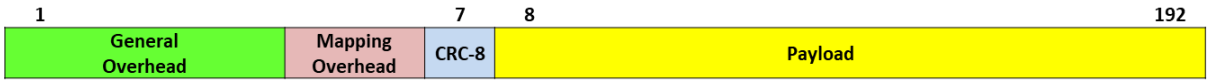
3. OSU Frame

An OSU frame comprises 192 bytes.

7 bytes comprise the frame overhead, 185 bytes are dedicated to the OSU frame payload field, where client-services are transported.



OSU Frame

General Overhead: The General Overhead field conveys information related to monitoring and administration of the OSU.

Mapping Overhead: The Mapping Overhead field includes the mapping information relevant to the client-service that is being transported.

CRC-8: The CRC-8 field provides an indication regarding errors that might have been incurred at the General Overhead and Mapping Overhead fields.

Payload: The payload field transports the client-service.

4. OSU General Overhead

The general overhead field of an OSU frame comprises various fields as is described below.

Byte	1								2								3								4								5		
Bit	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3
Field	VER		TPN												FT		RES	CV			TCM2				TCM1								PM			
	0	1	Tributary Port Number												Frame Type		0	Cont Verifi			Tandem Connection 2				Tandem Connection 1								Path Monitoring			

Structure of the General Overhead section of an OSU Frame

VER: The version number (VER) field specifies according to which version the OSU frame is constructed. Currently 2 versions have been specified.

Tributary Port Number (TPN): TPN is used to identify the mapping between tributary ports and the OSU frames. The TPN must be unique at the server layer to identify each tributary port which means that at each OSU node it needs to be regenerated.

Frame Type: There are 8 different types of OSU frames.

PKT: Packet client-services (e.g.- Ethernet) are mapped into PKT frames.

CBR: CBR (Constant Bit Rate) client-services such as E1/T1/T3 or SDH STMn signals are mapped to CBR frames.

VCn: STMn signals Virtual Containers (VC) are mapped to VCn frames.

PRBS: Provides Pseudo-Random Binary Signals for testing purposes.

OAM: OAM (Operations, Administration and Management) frames are used to support the hitless bandwidth adjustment protocol of PKT OSU frames.

Keep-Alive: Keep-Alive frames are inserted into an OSU frame when there is no valid packet client-service information to be transmitted.

Client-Fault: A frame that indicates faults in a client-service.

Maintenance Status: A frame that provides AIS/OCI/LCK maintenance indicators.

CV: Connectivity Verification (CV) monitors the continuity and bandwidth-matching of OSU frames at each section layer that an OSU link traverses. It can be used to check if OSU frames are lost in the link segment and whether the bandwidth of the client-signal at its origin and destination is consistent.

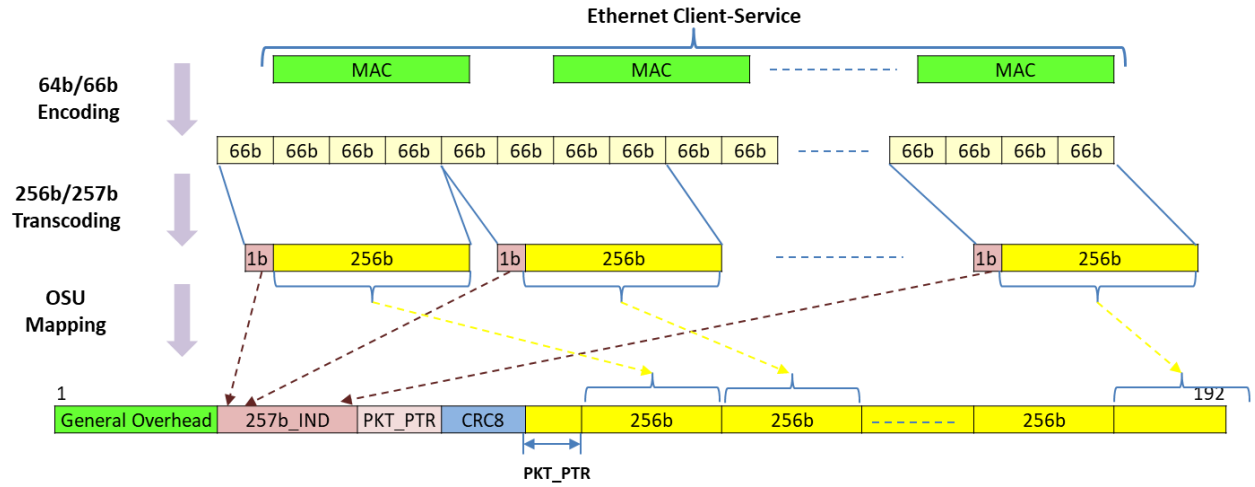
Tandem Connection Monitoring (TCM), Path Monitoring (PM): TCM and PM provide a mechanism to detect path-level errors in segments or the entire OSU transport path. These fields also convey backwards information on the number of errors and the fault status as well as administrative information. PM and TCM fields include the following indications:

- BIP-8 (Bit Interleaved Parity) mechanism.
- BEI (Backwards Error Indication).
- BDI (Backwards Defect Indication).
- TTI (Trail Trace Identifier).
- APS (Automatic Protection Switching) communications channel.
- DM (Delay Measurement). DM is carried out in 16 nSec granularity.

5. **OSU Mapping Overhead**

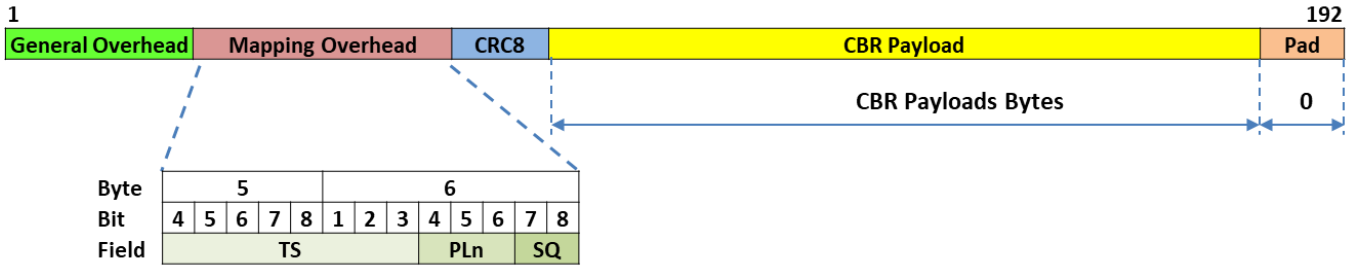
The mapping overhead field supports the mapping of PKT (e.g.- Ethernet), CBR (Constant Bit Rate, e.g.- SDH/PDH signals) and VCn (SDH Virtual Containers, VCs) client-services.

Mapping to PKT Frames: PKT frames are used to transport Ethernet/packet client-services. When mapping Ethernet signals, first the MAC frames are 66b encoded and then transcoded into 256b/257b codes. The 256b/257b code bit-streams are mapped to OSUs by a procedure called IMP+ or IMP-OSU.



General Structure for Mapping an Ethernet client-service to a PKT frame

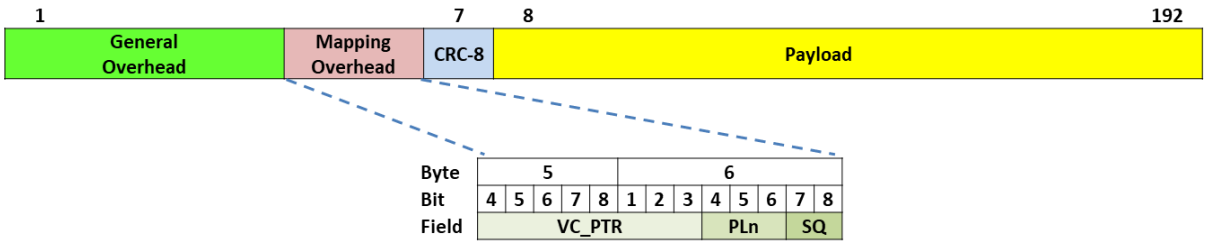
Mapping to CBR Frames: The mapping of CBR client-services is carried out by an asynchronous procedure called GMP+ or GMP-OSU.



Mapping Overhead and Structure of CBR OSU Frame

TS: Time Stamp
PLn: Indicates the Payload Length occupied by the CBR client-service.
SQ: Sequence Number for frame loss detection

Mapping to VCn Frames: STMn signals Virtual Containers (VCn) may be mapped to OSU containers.



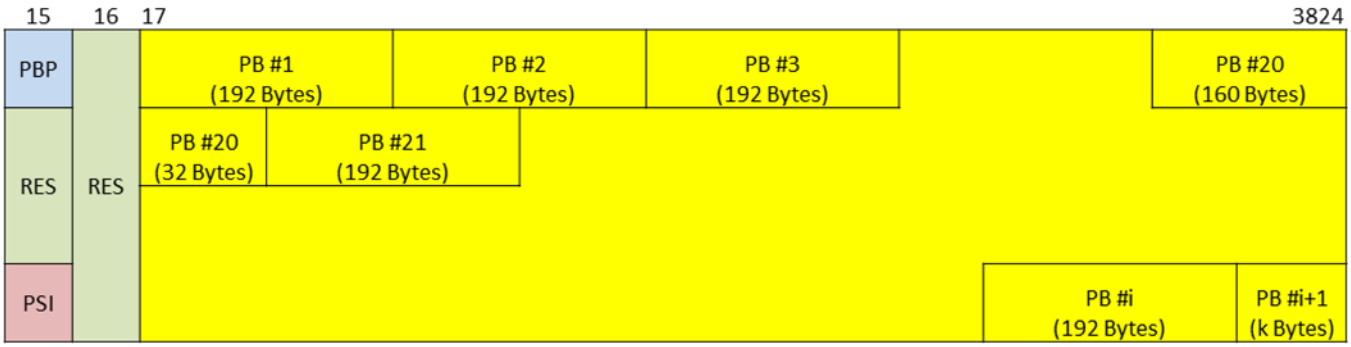
Mapping Overhead and Structure of VCn OSU Frame

VC_PTR: The VC_PTR value (1-185) is the position of the first byte of the AU-4/TU-3/TU-12 structure in the OSU frame payload.

PLn: Indicates the Payload Length occupied by the VC client-service.
SQ: Sequence Number for frame loss detection

6. **Mapping of OSUs into OPUs**

OSUs are mapped into 2.6Mbps OPU PBs. As an example, in a 6x OPU0 multi-frame there are 476 PBs. To achieve an even spread of OSUs and minimize jitter, the mapping of OSUs utilizes a Sigma-Delta algorithm.



OSUs are mapped into OPU PB mapping opportunities

Validation Testing of NG-OTN

Initial validation testing of NG-OTN was carried out by China Mobile.

Client-Services: NG-OTN successfully transported client-services ranging the entire bandwidth span of 2Mbps through 100Gbps.
Latency: Transporting Ethernet client-services over NG-OTN incurs a significantly lower latency than Ethernet-over-SDH (EoS).

Service / Bandwidth	EoS	NG-OTN
2Mbps	4,398µSec	1,289µSec
100Mbps	726µSec	471µSec

Testing demonstrates that NG-OTN incurs a much lower latency than EoS

NG-OTN Benefits

Client-Services Bandwidth Span: OSUs support client-services from 2.6Mbps up to 100Gbps (or more) in 2.6/10.4Mbps increments. This establishes a future-proof foundation.

Optical Network Efficiency:

Transport Container Bandwidth Optimization: The bandwidth of the OSUs matches the rate of any client-service, including instances when the Committed Information Rate of Ethernet client-services is only a fraction of the rate of the Ethernet physical interface.

Carrying Multiple Client-Services by OSUs: As an example, an ODU4 may carry more than 1,000 OSUs, while a current OTN ODU4 can transport a maximum of 80 ODU0s.

Eliminate SDH/SONET: NG-OTN eliminates the need for SDH/SONET.

Reduced Latency: NG-OTN offers better latency performance for Ethernet client-services as compared with SDH.

Hitless Bandwidth Adjustment: An OSU's bandwidth carrying packet client-services may be increased/decreased through a relatively simple step-by-step procedure.

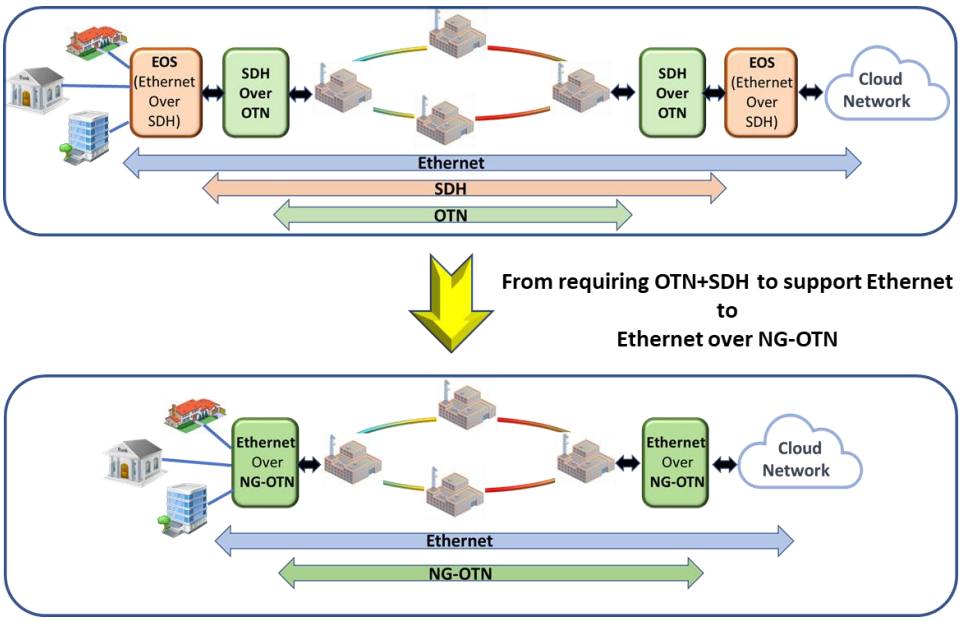
Simplify OSS: There is no need to manage a separate SDH/SONET layer. The OSS is not required to participate in real-time in the hitless bandwidth adjustment process.

Compatibility with Existing OTN: NG-OTN can be deployed seamlessly with OTN.

Conclusions

NG-OTN caters to all types and rates of client-services. NG-OTN improves optical network utilization, eliminates SDH/SONET, simplifies OSS and reduces inventories.

NG-OTN will enhance current OTN and significantly reduce CAPEX and OPEX.



From OTN with SDH to NG-OTN

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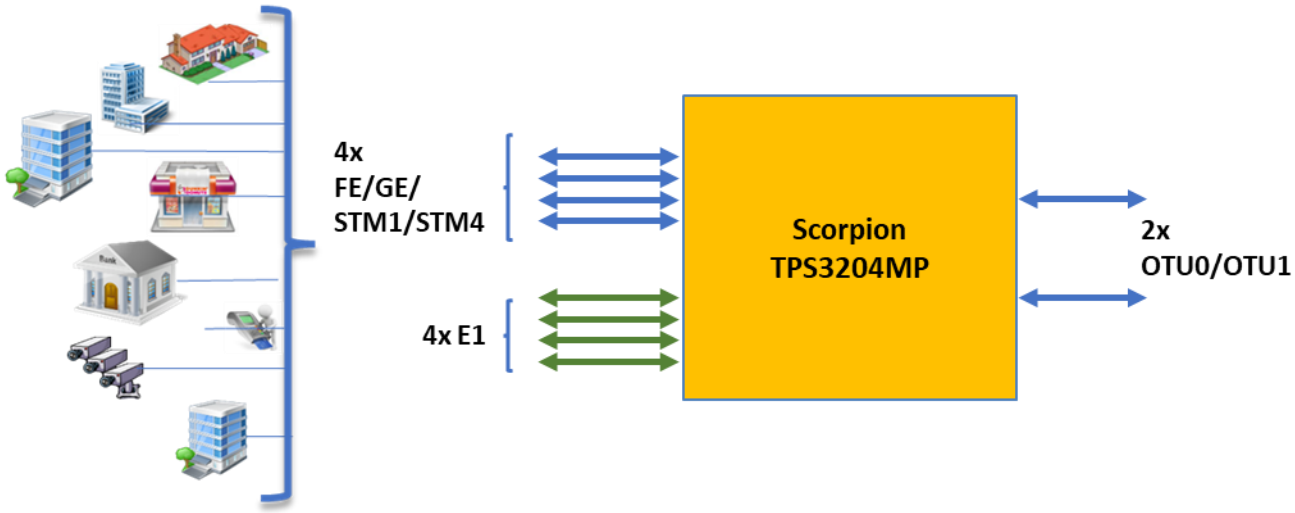
About Tera-Pass

Tera-Pass is a fabless semiconductor company that specializes in the design of OTN and NG-OTN processors. Tera-Pass' NG-OTN products portfolio currently includes the Scorpion and Taurus (under design) product families.

Scorpion NG-OTN Processors (IP Cores)**:**
Scorpion TPS3204MP IP Cores are an NG-OTN (Next-Generation OTN) processor that implements the mappings of client-services to ODU or OSU (Optical Service Unit) containers. Scorpion TPS3204MP supports a variety of applications.



Scorpion TPS3204MP NG-OTN Processor

Taurus NG-OTN Processors (ASIC)**:**
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.

Contact Info

For more information you may browse to our website at www.tera-pass.com or contact us at info@tera-pass.com