IPLIGHT Creating an Intelligent Optical Layer

Bridging between ODU1 and ODU0 based OTN networks

Apodis

Application Note

Leon Bruckman

System Engineering

lbruckman@iplight.com

October 2009

Background.

OTN standardization efforts got under way seeking an optical transport technology that would replace the legacy SONET/SDH infrastructure prevailing in legacy TDM oriented networks.

SONET/SDH had been exceedingly successful in providing worldwide connectivity for predominantly voice services over fiber optic physical layers. However it exhibited a number of issues that were gradually affecting its viability as an adequate technology for high speed rates and packet based services. Some of these issues were:

- Absence of error correction capabilities.
- Non transparent transport.
- Carrier-of-carriers applications.
- Complex layering scheme.

First generation ODU1 based OTN addressed most of these issues:

- The OTN frame includes a dedicated embedded FEC (Forward Error Correction) area.
- OTN is asynchronous.
- OTN transports its client signals in their entirety (transparently).
- OTN supports paths traversing multiple independent carriers.
- OTN was originally designed with a single step mapping structure.

However, despite its numerous improvements over legacy SONET/SDH technology, OTN still lacked the ability to effectively transport the most popular sub-ODU1 signal - 1GE. Traditional OTN specified ODU1s, whose rate was optimized to transport OC48/STM16 signals (2.488320 MHz x 239/238). To resolve this issue OTN provided a procedure known as GFP-F (Generic Framing Procedure – Framing). GFP-F extracted the Ethernet Information Frames from the 1GE signals. The Information Frames of two 1GE signals could be multiplexed into a single ODU1 or the outputs of 8 or 10 1GE signals into ODU2 bearers. However, these mechanisms still incurred 2 significant issues:

- The GFP-F procedure is not transparent to the 1GE timing and overall data. As a consequence some Ethernet applications were being blocked by OTN transport.
- The 1GE signals could only be transported as a bundle to the same network destination since they were being jointly carried by the same ODU entity.

ODU0.

In recognition of the importance of the above issues the ITU-T addressed defined in Amendment 3 of ITU-T G.709 a new ODU type optimized to carry 1GE signals: The ODU0. The ODU0 payload rate is 1.244160 KHz and in conjunction with GFP-T (Transcoding) rate adaptation and GMP (Generic Mapping Procedure) processes provides character transparency and synchronous mapping of 1GE signals into their ODU0 bearers. Furthermore, since ODU0s are valid OTN entities they can be transported to separate destinations independently of each other.

Accordingly ODU0s constitute the new basic granularity for OTN multiplexing and switching. The ITU-T recommendations also specify single-step, flexible 1.25Gbps Tributary Slot (TS) multiplexing of ODU0 signals into higher order ODU1, ODU2, ODU3 and ODU4 containers.

Following these modifications to the G.709 standards in order to ensure interoperability in between ODU1 and ODU0 based networks appropriate gateway functionality was required.

Apodis.

In order to facilitate the introduction of ODU0 based OTN equipment and simplify the transition in between different OTN equipment generations, IP Light has incorporated in Apodis a number of ODU0 processing options:

- ODU0 based mapping of 1GE and 1GFC signals (see **Figure 1** for 1GE) providing timing and character transparency.
- Multiplex with 1.25Gbps TS granularity
    - Multiplex ODU0s into OPU1s which can be eventually multiplexed into OPU2s
    - Multiplex ODU0s directly into OPU2s
    - ODU1 multiplexing into OPU2

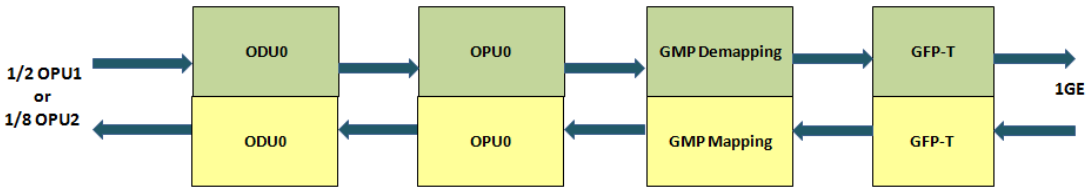

Figure 1: Mapping 1GE signals into OPU0s preserving data and timing transparency

GMP based mapping of 1GE and 1GFC to ODU0.

Figure 2 shows various Apodis OTN mappings.

1GE client signals can be mapped into OTN using either GFP-F over ODU1 or ODU2 bearers or using GFP-T Transcoding and GMP mapping over ODU0 signals.

ODU0s can be either mapped to OPU1s or to directly to OPU2s in 1.25G TS.

OPU1s can be either transported by OTU1 signals or be further multiplexed into OPU2 bearers to be transported by OTU2 signals.

Due to their lower bit rate 1GFC signals are directly GMP mapped into ODU0 bearers without requiring previous rate adaptation.

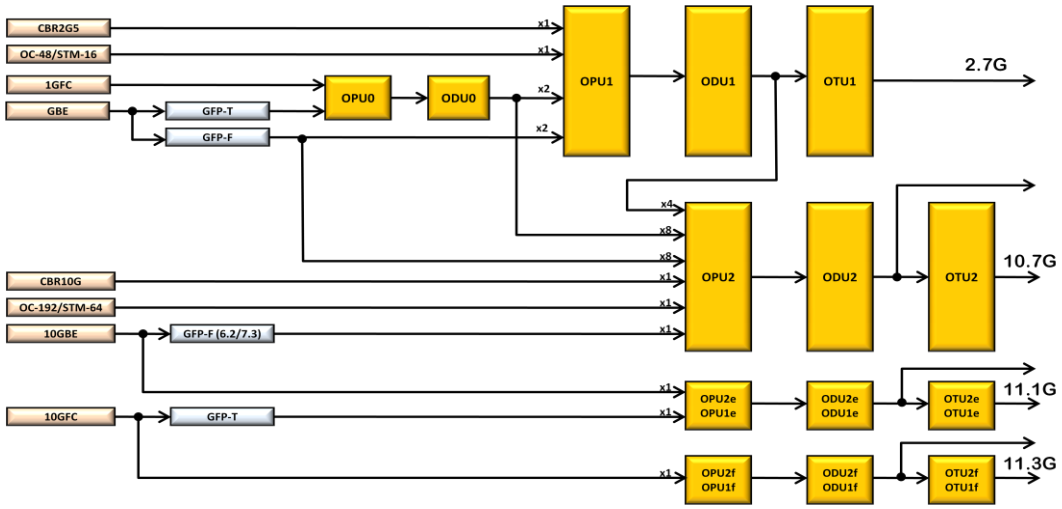

Figure 2: Apodis OTN Multiplexing

Apodis Flexibility.

The Apodis product line members (IPL4001M, IPL4101M, and IPL4201M) support OTN level links in between different types of OPU2s. **Figures 3.x** shows ODU0 and ODU1 level paths for both 1.25G TS structured and ODU1 based OPU2s. The dotted lines represent connections through the Apodis OTN switching fabric.

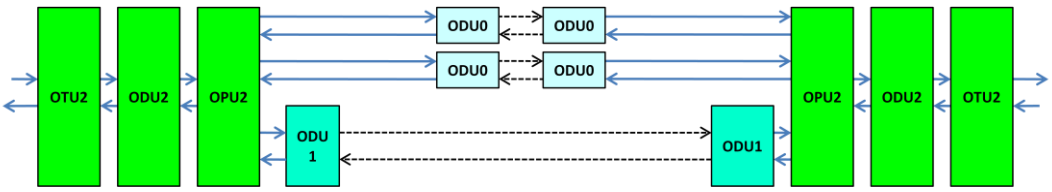

Figure 3.1: Paths between two 1.25G TS structured OPU2s

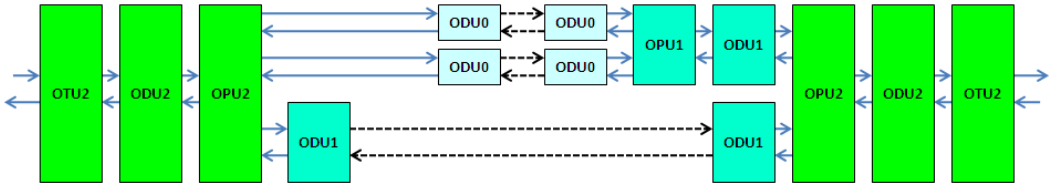

Figure 3.2: Paths between a 1.25G TS structured OPU2 and an ODU1 based OPU2

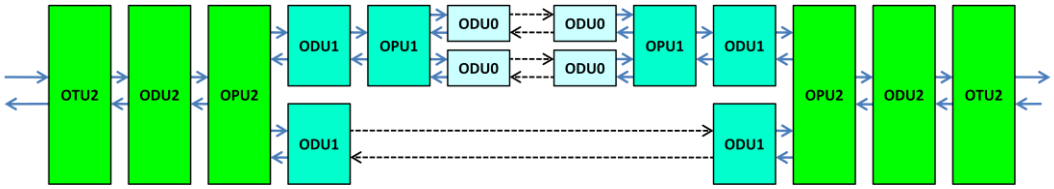

Figure 3.3: Paths between two ODU1 based OPU2s

Upgrading an OTN Network

Apodis product family members allow networks currently relying on ODU1 based OTN to gracefully transition to 1.25G TS technology while preserving ODU0 level granularity in switching and multiplexing. This capability ensures ODU0 level end-to-end path integrity. Furthermore, Apodis can also extract from OTN bearers 1GE signals which were GFP-F mapped into either ODU1 or ODU2 signals thus further contributing to its backwards compatibility.

Accordingly, as illustrated in **Figure 4** Apodis devices can provide a bridging function in between OTN network equipment generations.

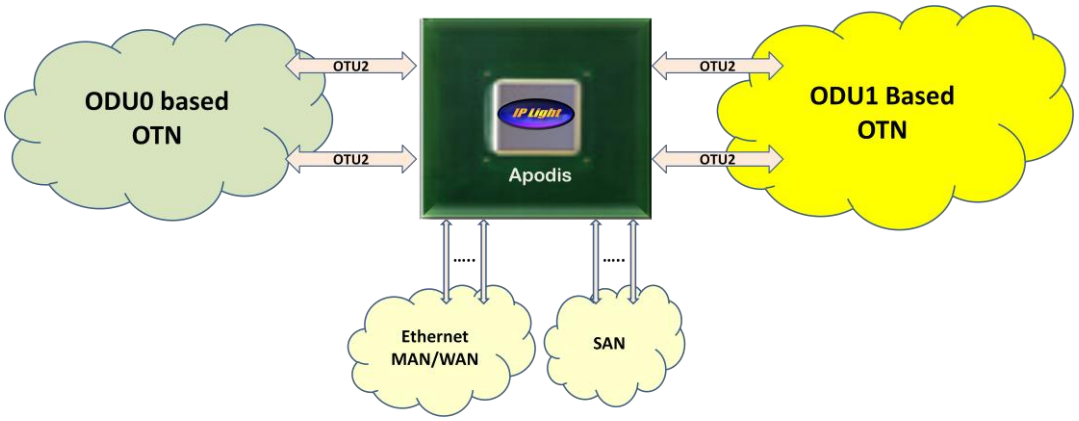

Figure 4: Bridging between networks

In this example Apodis OTU2 Line Interfaces are assigned to different types of OTN networks while Apodis provides seamless interworking between them. Each Apodis OTU2 port can carry up to eight 1GE client signals that can be presented to either the ODU0 switching capable network using ODTU02→OPU2 GMP based mapping or to the ODU1 switching capable network using ODTU01→OPU1→ODTU12→OPU2 processes.
Add/Drop of individual 1GE signals can be accomplished as well.

***About IP Light**:*
IP Light is developing Apodis, a product family of leading edge OTN processors designed to facilitate the introduction of new OTN capabilities and service applications.
IP Light is headquartered at 4 Hashiloach St. POB 7209, Petach-Tikva, 49520, Israel
Office: +972-3-7217810
Fax:+972-3-9215076
info@iplight.com