Broadcast video transport over OTN networks, C/DWDM and Dark Fibers

As we are witnessing the rapid evolution of the optical transport networks for high capacity data transport, it is time to pay attention to the needs of video Broadcast market and address its unique requirements (such as copper based interfaces, pathological pattern encoding schemes and various video rates) while enabling it to share the same fiber and OTN (Optical Transport Network) infrastructure as other common telecommunication protocols such as Ethernet, SONET/SDH and Fibre Channel. PacketLight’s video transport solutions treat the variety of video interfaces such as SD-SDI, HD-SDI, 3G-SDI and DVB-ASI as a common part of the optical and fiber network solution, seamlessly integrating it without the need for external convertors. Thus, PacketLight’s solutions enable the utilization of the existing optical transport network and/or dark fiber for cost effective, managed video transport for Broadcast companies and carriers.

This white paper explores two video transport methods:

- **Muxponder based solution**: aggregating multiple video service and rates into single standards based 10G OTU2 OTN uplink, either over Metro/long haul optical network or dedicated dark fiber.
- **Transponder based solution**: coloring each video service to different wavelength and multiplexing them over the same fiber

Both solutions enable the reduction of the number of fibers needed for the video applications and data transport between the sites, thus reducing the infrastructure costs as well as enabling carriers to add video services on top of their existing OTN metro or long distance back bone infrastructure.

Video Interfaces and Feature Set
Before further elaborating on transport solutions for broadcast video, the next section will explain in detail different Video Interfaces and rates supported by PacketLight equipment and the capabilities of the client facing copper video module within different PacketLight products. The standards based supported video rates are described below in Table-1:

<table>
<thead>
<tr>
<th>Video Protocol</th>
<th>PL-2000</th>
<th>PL-400E</th>
<th>PL-1000E</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVB-ASI 270 Mbps</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SMPTE 259M SD-SDI 270 Mbps</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SMPTE 292M HD-SDI 1.485 Gbps</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3G-SDI 2.97 Gbps</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table -1
PacketLight’s video interface is based on a small form factor, pluggable, copper SFP plugged directly into either the PL-400 or PL-2000 client side ports. The video SFP module provides extremely small footprint O2E (Optical to Electrical) and E2O (Electrical 2 optical) conversion without the need to support multiple, external bulky converters each with its own power source. In addition, integrated into PacketLight’s transponder and Muxponder solutions is the network management module which provides full monitoring and control (3rd party SNMP, Web Based or NMS) for the conversion process, alarms and other diagnostic capabilities. Figure-1 shows the small form pluggable video interface module.

The same video interface module supports the commonly used DVB/SDI signals up to 2.97Gbps with embedded re-clockers, cable drivers, equalizers and monitoring capabilities. Solution expansion is extremely easy and done just by adding SFPs without the need for costly network infrastructure changes such as putting additional fibers between sites. Solution maintenance and spare parts are minimal since the same pluggable SFP module that supports both Tx and Rx, covers the entire spectrum of video rates mentioned above by auto detecting the video rate and user configuration.

**Muxponder Based Solution**

Muxponder technology, as a part of WDM technology, electrically aggregates multiple low rate services into a single wavelength which are then multiplexed along with other wavelengths into the same fiber.

PacketLight’s Muxponder family of products is designed to provide efficient and flexible aggregation layer of multiprotocol/multirate sub-10G services into common optical transport layer using 10G OTU2 uplink trunks. The multiprotocol/multirate Muxponder capability further reduces the number of wavelengths needed for a sub-10G solution by a factor of 8 on average. Increasing fiber utilization and spectral efficiency of data transport further reduces the solution cost and operation complexity. Figure-2 shows how different video and other network protocols are all mapped in and share the same 10G OTU2 standards based uplink. The Muxponder solution is very flexible and enables network manager to assign up to 16 different types and rates of client interfaces over single 10G wavelength uplink. Among the supported services are:

- 3G HD-SDI, HD-SDI, SD-SDI, DVB-ASI
- FE/GbE
- 1/2/4G FC/FICON
- SONET/SDH: OC-3/STM-1, OC-12/STM-4, OC-48/STM-16
With this aggregation method, the Muxponder technology increases each wavelength capacity and maximizes the fiber usage. This translates to less colored optics, less optical filters and reduced network management and maintenance complexities. Therefore, Muxponder technology is the most effective, low cost, and easy to operate solution for today’s multirate, multiprotocol optical transport networks.

PacketLight solution is high density transport solution with high spectral efficiency which can map up to 16 multirate, bidirectional video copper SFP interfaces such as DVB-ASI, SD-SDI and HD-SDI into an aggregated 10G or 20G OTU2 within 1U carrier grade PL-2000 product. As an example, 16 SD-SDI/DVB-ASI signals are utilizing only a single wavelength within the fiber for the 16 client interfaces.

As the example, a single 10G OTU2 uplink can support:
- 16 services of SD-SDI/DVB-ASI 270M
- 4 services of SD-SDI 1.485G + 12 services of SD-SDI/DVB-ASI 270M
Transponder Based Solution

There is an increasing need to transfer more and higher capacity traffic between sites effectively without the need to add additional fibers for each additional service or data channel. To comply with this need, two main technologies are commonly used: CWDM (Coarse Wavelength Division Multiplexing) and DWDM (Dense Wavelength Division Multiplexing). Utilizing these technologies can increase the fiber capacity by a factor of almost 100 and transfer additional client signals/protocols over the same fiber by assigning different spectral wavelength for each service. Therefore, rather than deploying 100 fibers between two sites to satisfy transport application needs, WDM equipment can be placed at both ends of the existing fibers and accommodate the need for the increased capacity without any intersite infrastructure changes.

In the heart of the C/DWDM technology lays the Transponder module. The function of Transponder is to convert client NON colored optics (gray) or electrical copper interface into CWDM or DWDM colored wavelengths. The Transponder colors the services into different wavelengths as demonstrated in Figure -4. The functionality of the Transponder is to perform protocol transparent bi-directional 3R (re-timing, re-amplifying, re-shaping), and provide Performance Monitoring. In this manner, Transponder serves as a full demarcation point between the client and the dark fiber WDM layer. The transponder has low latency performance and is transparent to the protocols passing as well as agnostic to client equipment vendor.

Figure-4: Transponder Illustration

All PacketLight’s Transponders are Multirate and multiprotocol and are user configurable to provide the highest flexibility to the user for the service mix over dark fiber and CWDM DWDM optical networks. Figure-5 shows an example of mixing different video broadcast protocols such as HD-SDI, SD-SDI, 3G-SDI and DVB-ASI along with other data, storage and SDH/SONET protocols using the PL-400 device. Each of the video interfaces is attached to copper SFP plugged into the client interface side and is converted to a CWDM or DWDM wavelength. The different wavelengths of the different services are Muxed into the same fiber.
Using the PL-1000E Transponder based device, the different video copper interfaces such as SD-SDI, HD-SDI, 3G-SDI and DVB-ASI will all be supported and will be able to be mixed with other data, storage like 1G/10G Eth and 1/2/4/8/10G Fibre channel.

Summary

PacketLight solution set enables the reduction of the number of fibers needed for the video and data transport between the sites thus reducing the infrastructure cost as well as enabling carriers to add video services on top of their existing OTN metro or long distance back bone infrastructure. The Video solution is integrated seamlessly into the optical transport equipment without the need to use dedicated equipment for its transport thus significantly reducing the solution cost.

PacketLight’s solutions above have a very small foot print using the same SFP based pluggable video interface module that can support the commonly used DVB/SDI signals up to 2.97Gbps video interfaces with embedded re-clockers, cable drivers, equalizers and monitor capabilities.

About PacketLight Networks, Ltd.
PacketLight Networks offers a suite of Leading 1U CWDM/DWDM and OTN based solutions, for transport of data, storage, voice and video applications, over dark fiber and WDM networks, featuring high quality, reliability and performance at affordable prices. Our products are distinguished with low power consumption ideal for CLE (Customer Located Equipment) allowing maximum flexibility as well as ease of maintenance and operation and providing real Pay-as-you-grow architecture. PacketLight customers are carriers, service providers, data centers, IT integrators and enterprises who are active in meeting the demands for metro Ethernet, business continuity, Triple Play solutions and enterprise data sharing applications. For product and reseller information, Please contact info@packetlight.com