Taking Metro 100G to the next level

*Industry leading low power 100G metro solution*

It is well documented that bandwidth in networks is rising rapidly driven by video, mobile and cloud computing traffic. This is putting huge demands on all aspects of optical networking but especially in metro networks where current 100G solutions are typically too expensive for the majority of application.

100G solutions for metro networks need to be more economical to address this demand and also cater for the specific challenges of metro networks, such as low power consumption, small footprint and support for the latest packet-optical architectures found in metro networks.

To address these challenges, Transmode has introduced the industry’s first all-pluggable Metro 100G Solution with support for coherent optics. Uniquely, the solution also supports Layer 1 WDM transport and Layer 2 packet-optical applications.
**Introduction**

In recent years 100G technology has been at the forefront of innovation within the industry and has brought rapid change to optical networks, bringing a quick migration to high speed 100G transmission in some parts of the network.

The adoption of advanced modulation schemes and coherent detection has enabled optical systems to increase network capacity ten-fold over the majority of previously deployed networks.

Furthermore, these methods of modulation and detection have brought beneficial advantages by reducing the impact of some of the previously limiting factors that could affect a network, such as Chromatic Dispersion, leading to simplified network build outs and easier optical switching with Reconfigurable Optical Add Drop Multiplexers (ROADMs).

However, the initial implementations of this technology came at a cost both in terms of component cost and power/space requirements. This has led to the vast majority of 100G deployments being concentrated within long haul networks with limited deployment in metro and regional networks.

The industry is now ready for the next step with 100G migration with the extension of pluggable optics options to include new coherent variants that allow 100G line side WDM operation.

Transmode has introduced the industry’s first all pluggable 100G metro solution for Layer 1 and Layer 2 with support for coherent optics. This application note will discuss the drivers behind the needs for solutions of this type, Transmode’s new solutions and the benefits they can bring to network operators as metro networks continue to evolve to hybrid Layer 1 and Layer 2 packet-optical networks.

**Drivers for 100G in the Metro**

The vast majority of 100G deployments to date have been in the long distance segment of optical networks. This is because the initial implementation of this technology works equally well in long haul and metro networks, and as such the economics are more suited to the longer distances than shorter metro distances where 10G pricing is more aggressive.

Furthermore, long haul networks typically connect a smaller number of nodes with higher capacity generating earlier demand for high speed connections. Basically, once the economics work for 100G on a long distance route then typically all future traffic will be 100G.

**10G is the new 1G**

Metro networks in contrast are significantly different to long distance networks with more nodes, varying traffic flows and a mix of services and bit rates. Space and power consumption are important in all network locations but especially so in the metro.

To date, metro networks have been typically supported with 1G services that are aggregated to 10G and transported to the core of the network.

This bandwidth growth is driving a shift from some 1G services to 10G within metro networks that then could benefit from aggregation to 100G if the 100G economics are good enough. As optical networks push deeper into access networks in applications such as business services and mobile backhaul there is also an opportunity to aggregate new 1G services to 10G and then again to 100G, if the economics are right.

Current 10G pricing in metro networks is more aggressive than 10G in the long haul and therefore 100G metro pricing needs to be comparably more aggressive before there is widespread deployment of the technology. However, once the economic barrier to 100G in metro networks is lifted by technology advances, then the migration to 100G will be rapid as the demand is there.

**The move to packet-optical**

One further significant difference between long haul /core and metro networks is the migration to Packet-Optical Transport Systems (P-OTS) technology. This is a significant change that is driven by the rapid rise in Ethernet based traffic over the last few years.

Research by the Metro Ethernet Forum and Vertical Systems showed that Ethernet traffic surpassed legacy data back in 2012. Andrew Schmitt, Principal Analyst for optical networking at Infonetics Research states that “Packet-optical is the greatest architecture change that is happening in the metro network”.

P-OTS is the fastest growing segment within the optical networking industry and specifically within metro optical networks with a Compound Annual Growth Rate (CAGR) of 20% (2012-2017).
Native Packet Optical 2.0 continues the packet-optical evolution

Packet-Optical technology combines the usual transport layers of the OSI stack, Layer 0 (optical wavelengths) and Layer 1 (additional framing technology to manage bandwidth, such as OTN) with Layer 2 Ethernet services and sometimes also higher layer functions.

Transmode addresses this via the Native Packet Optical 2.0 architecture, which combines these technologies in a Transport Ethernet approach that gives MEF compliant CE2.0 services with low latency, zero jitter and superior synchronisation performance.

As Ethernet services continue to become more prevalent within networks then the economic and performance advantages of P-OTS systems become more useful to network operators as a means to differentiate their services, reduce cost and to simplify networks. Today, these networks are used in applications such as advanced mobile backhaul services, video distribution networks and business Ethernet services.

Any move to 100G technology within metro networks must also consider these P-OTS applications.

Recent advances in 100G technology

The 100G optics industry can be viewed in two separate groups of technologies, client side optics; those for shorter reach interoffice connections and line side optics; those for longer distance transmission over optical networks.

Client side 100G optics have used pluggable technology based around the CFP specification for some time. These are available in a number of options that usually use a number of lower speed wavelengths to carry 100G over the interface. Options include a short reach 10x10G interface (SR10) that supports low cost transmission over 100m and a long reach options using 4 or 10 wavelengths that support transmission over 10km (LR4). In the future these client units will also be available in smaller CFP2 and CFP4 formats.

Line side 100G optics have been standardized around PM-QPSK modulation with coherent detection to help drive better economics in the industry as a whole. Components for this technology have previously used standardized module formats defined by the Optical Interworking Forum (OIF). These modules are mounted directly onto 100G line cards and provide tuneable optics over the full range of WDM wavelengths with a typical reach of a 2000 km or more, supporting long haul optical and some metro/regional applications.

Pluggable CFP optimized for metro

The introduction of line side 100G WDM optics in the pluggable CFP format supports up to 1200km transmission, which is ideal for metro and regional applications. This presents the opportunity for a step change in reducing cost, space and power consumption of 100G transmission.

Integrated CFPs has key values over loosely coupled CFPx

Within the industry there is a small debate as to how much integration is required within the CFPx modules (CFP, CFP2 or CFP4). The main question revolves around whether the Digital Signal Processor (DSP) should be included in the CFPx or not. If it is avoided and located on the motherboard instead, then there is the opportunity to potentially take advantage of the smaller pluggable optics formats slightly earlier in their lifecycle.

But the DSP is closely related to the rest of the optics components and putting the DSP on the motherboard (loosely coupled CFPx) greatly reduces the flexibility and choice of CFPx optics modules once the DSP is chosen. Furthermore, to keep flexibility of the board to use any of the available CFPx optics options; client side SR or LR optics or WDM coherent optics, then the board has to absorb the cost and power consumption of the DSP for every port in every application regardless of if it is needed or not. For these reasons, Transmode believes the best approach is to use highly integrated CFPx units with the DSP integrated into the CFPx. This keeps the motherboard as flexible as possible and able to use a broad range of optics without a DSP price/power penalty when the port does not require coherent optics. It also keeps the interface between the CFP and the motherboard as a simple digital interface common to all CFP types rather than a complex analog interface that can only be used for coherent CFP units.
Today, fully integrated optics are becoming available in the CFP format and it is anticipated that in the future these could possibly migrate to the smaller CFP formats as technology advances, but this is likely to be many years away.

The industry’s first all pluggable 100G metro solution for Layer 1 and Layer 2 with support for coherent optics

Transmode is leading the industry in the introduction of a 100G metro solution based on all pluggable optics. Transmode has developed a small range of highly flexible plug-in units that support both Layer 1 and Layer 2 services. Supporting P-OTS capabilities with the Native Packet Optical 2.0 architecture is of critical importance to Transmode and the company’s customers and this approach is unique within the industry.

Using pluggable optics in all units makes the range extremely flexible. Using coherent CFP units that meet the highly-integrated criteria and contain the required DSP within the unit ensures that the complete range of both client side and line side CFP optics can be used in any port. This helps keep total cost of ownership as low as possible and enables the solution to support the broadest possible range of distance options. It also future-proofs the solution, enabling easy adoption of new longer reach CFPs as they become available in the future.

Leading low power capabilities

Not only does the range of 100G boards drastically bring down the power consumption of 100G transport through the use of Coherent CFP optics, but they also enable highly dense deployments with a small footprint.

Transmode’s 100G solution uses as little as 70W per 100G, an industry leading low figure.

Introducing the range with Layer 2 packet-optical

The first of this group of new plug-in units for the TM-Series is a new member of the EMXP family. Transmode’s EMXP units are the primary building blocks of the Native Packet Optical 2.0 architecture.

The range extends from units that support Gigabit Ethernet and 10 Gigabit Ethernet ports to a higher capacity 12x 10G unit. They support services directly from the EMXP or from a range of customer premise units, namely Ethernet Demarcation Units (EDU) and Network Interface Devices (NID).

The range has now been extended to include a new EMXP 220 Ile which supports the same software suite and Ethernet/MPLS-TP capabilities as the rest of the family. This new unit has 12x 10G ports plus one 100G port. Each port supports full transponder functionality, so the device is effectively a 220G switch with 13 transponders fully integrated into a single unit. Each port can also operate in native 10G/100G Ethernet “LAN-mode” or use OTN framing (OTU2e/OTU4) in “Transponder-mode”.

Adding Layer 1

To support Layer 1 services and networks, Transmode has also introduced an OTN based 100G Transponder and an OTN based 10-port 100G Muxponder. These units also support complete flexibility of optics options, so any 100G port can use any available CFP option.

The units also support full OTN operation, with OTN framing on the 100G Transponder and OTN multiplexing on the 100G Muxponder. The 100G Transponder can also support native 100G Ethernet to interwork with the EMXP.

As with the EMXP, the units are highly dense and require the minimum possible power consumption. For example the
100G Transponder uses just 70W, including all optics, and a TM-3000 chassis can support up to 8 of these plug-in units.

100G in action
As described earlier, there is pent-up demand in metro networks for economic 100G transport. This is both in packet-optical (Layers 1 and 2) and pure optical (Layer 1 only) networks. The examples below show a P-OTS network using both Layer 2 and Layer 1 100G units and two Layer 1 only examples.

- The P-OTS example shows a network collecting 1G services on an EMXP62, which has 22x 1G ports and 4x 10G ports and aggregates these onto 10G wavelengths. These in turn are aggregated to 100G by an EMXP220 located at an aggregation point deeper in the network.
- Both the 10G and 100G wavelengths use the integrated OTN framing transponder-mode within the EMXP units. Using these capabilities the 100G Ethernet wavelength can be carried over a significant distance to a remote core node location where it is handed over to a core router or switch using a Layer 1 transponder.
- The Layer 1 examples show point to point connections which could be running over a ROADM based Flexible Optical Network, using the muxponder for 10G services and the transponder for 100G services. By way of example, they also show the transponder being used as a regenerator with coherent optics in both ports to allow support for even greater distances.

Bringing it all together
In summary, Transmode provides a pluggable optics based metro / regional 100G solution with support for both Layer 1 and P-OTS networks.

With industry leading low power capabilities as low as 70W per 100G, it offers a highly dense and cost efficient solution for metro and regional applications.

For further reading:
- Packet-Optical the Transmode way
- WDM the Transmode way
- Native Packet Optical 2.0 Application Note
- EMXP1le datasheet
- 100G OTN Muxponder datasheet
- 100G OTN Transponder datasheet

The specifications and information within this document are subject to change without further notice.
All statements, information and recommendations are believed to be accurate but are presented without warranty of any kind. Contact Transmode for more details.

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