TODAY'S THIN ROUTES

Mark G. McGilvray

mmcgilvray@tycotelecom.com

Tyco Telecommunications, 60 Columbia Road, Morristown NJ 07960 USA

Abstract: The majority of undersea telecommunications systems implemented during the past few years have been Thin Route projects addressing niche markets. Initially, the equipment used on many of these projects was an amalgamation of excess inventory held by the system suppliers after the downturn that was re-engineered to fit a specific application. Although these projects were all successful, the engineering and implementation of some proved interesting given the design and configuration of the available inventory. Today, the introduction of new technologies and equipment for both the undersea plant and the cable stations allows the design of Thin Route systems to be customized for specific applications. From new transmission and power-feed equipment with very small foot print requirements and very low power consumption, to new network management equipment designs and techniques, to specialized undersea multiplexing devices, this paper will overview some of the latest products and configurations tailored for the Thin Route market. From re-engineering left over inventory to "fit" a specific system application as well as possible, to designing with latest generation products to customize a system for a specific application, Thin Route systems of today offer Purchasers many new features and benefits.

1. INTRODUCTION

Undersea telecommunications systems constructed during the past few years have been predominantly Thin Route systems; that is systems having a point-to-point or a small trunk-and-branch architecture, being of short to medium length, with low initial capacity requirements (1 or 2 wavelengths), and minimal upgrade needs (ultimate capacity requirements usually less than 16 wavelengths). Many of the Thin Route Systems built during this time were made affordable by use of excess inventory held by the system suppliers after the downturn that was re-engineered to fit a specific application. Some of the Thin-route systems constructed by Tyco Telecom during this period used cable with 8 fiber-pairs, when only two fiber-pair cable was needed; used undersea repeaters with optical designs tailored for trans-continental transmission; or, power feed equipment that was originally engineered for long haul systems. The transmission equipment, albeit state-of-the-art in 2000 and 2001, was larger and more power hungry than today's gear. The engineering of these systems using the inventory was unique, creative, and most importantly successful.

Although the demand for undersea systems was minimal during the past few years, there were important technical developments in both dry plant and wet plant technologies during that time period. The purpose of this paper is to overview some of these new technical developments and how they may enable the design of Thin Route systems to be better customized for specific applications.

2. IMPORTANT DEVELOPMENTS

2.1. SLTE, significantly smaller, with new features

Tyco Telecom's Gen-3 SLTE (Submarine Line Terminating Equipment) is significantly smaller and consumes less power than earlier generations of 10Gb/sec SLTE gear. Only a few years ago all necessary SLTE equipment (Transceivers, Amplifiers, WDM (wave division multiplexing) equipment, and Dispersion Compensating Fiber) required to support 40Gb/sec of transmission (4 x 10Gb/sec waves) required 0.63m^2 of space. Today, all SLTE equipment (Transceivers, Amplifiers, WDM equipment, and Dispersion Compensating Fiber) required to support 120Gb/sec (12 x 10Gb/sec waves) requires only a 0.18m^2 space. Please see Figure 1 below for a graphical comparison. Thus, the Gigabit density has increased 10 fold from 63.5Gb/m^2 to 666.7Gb/m^2.

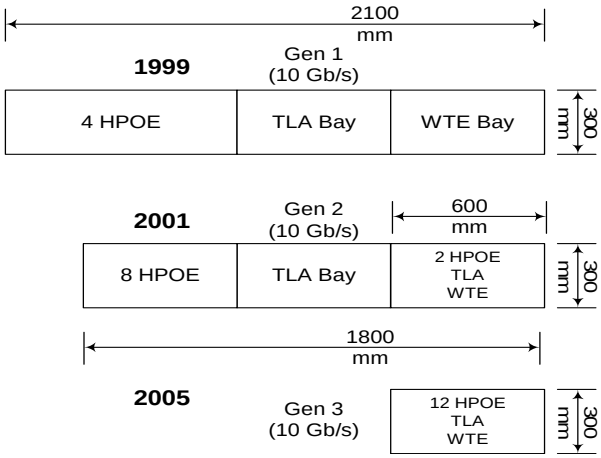

Figure 1 – Footprint reduction in 10Gb/sec SLTE

Another feature of the Gen-3 SLTE is the "Compact Bay" design which features a flexible backplane design that allows all elements of SLTE to mount into a single 600 x 300 mm bay. The flexible backplane can be configured as a self-contained terminal, housing all necessary SLTE elements transceivers, WDM components and line amplifiers, to support an initial

equipage of up to 12 10Gb/secchannels on a fiber pair. Alternatively, the Compact Bay can be configured to support as many as 32 10Gb/sec transceivers.

Another important development of Tyco Telecom's Gen-3 SLTE is more client-side interface options. In addition to the standard STM-64 handoff, the Gen-3 SLTE can provide 4xSTM-16 handoffs, or 8 x Gigibit Ethrnet handoffs. Finally, the transmit lasers in the SLTE are tunable over the entire band, thus minimizing sparing needs.

2.2. PFE, smaller, lower power

Tyco Telecom's Gen-3 Power Feed Equipment is now contained in a single bay. Earlier PFE vintages, some used in recent Thin Route Systems, needed between 3-5 bays. Also, the power consumption is lower as well. Additional features built into the new Gen-3 PFE include an integrated power line induction filter and an integrated ocean ground protection. Both are provided as simple plug in modules as opposed to an additional rack or bay of equipment.

2.3. Line Monitoring Equipment

Tyco Telecom's Line Monitoring Equipment (LME) monitors the undersea equipment performance on a fiber-pair via a loopback path in the undersea amplifiers. The LME is capable of detecting fiber breaks, span degradation, and Laser Pump failures. The size of the LME has been reduced from a bay of equipment to a rack. Additionally, an OTDR feature has been incorporated into the LME that will allow cable station staff to detect fiber beaks from each station obviating the need for an OTDR. Additionally, the LME software has been improved to provide a simpler graphical interface to Cable Station and NOC personnel. The automatic signature analysis feature of the software detects changes to the undersea segment and indicates likely cause.

2.4. Optical Add-Drop Multiplexing Branch Unit

Optical Add-Drop Multiplexing (OADM) technology has been important in terrestrial applications for many years. Recently, Tyco Telecom has developed an undersea sea OADM branch unit for specific applications in the oil and gas industry that has been the topic of other papers. The ultra-high reliability filtering technologies developed for this undersea unit allow for wavelength multiplexing and demultiplexing in the undersea plant.

3. IMPACTS ON THIN ROUTE SYSTEMS

3.1. Smaller, Less expensive cable stations

The reduced footprint of all the Gen-3 dry plant equipment, including SLTE (Transceivers, amplifiers, and WDM components), PFE, and LME allows the initial floor space requirement for Cable Stations built for today's Thin Route systems, to be significantly smaller. Additionally, the smaller initial footprint may lead to a postponement or elimination of future cable station expansion. The reduced per consumption allows the size of the HVAC, Battery Plant, and Generators to be similarly reduced. Both the reduced size and power consumption minimize Thin Route owners Capex and Opex – important for the commercial realization of new Thin Route systems.

3.2. Increase feature set

The new client-side interface options in the Gen-3 SLTE allows Thin Route owners to inexpensively tailor their systems to specific customer needs. For instance, one 10Gb/sec wavelength on a Thin Route system could have a standard STM-64 handoff to SDH gear. A second 10Gb/sec wavelength could offer 8 Gigibit Ethernet interfaces, while a third 10Gb/sec wavelength could offer 4 x STM16 clear channel interfaces. The built in OTDR function in the Gen-3 LME enables Thin Route owners to detect fiber breaks more quickly and without expensive stand-alone OTDR equipment.

3.3. Modified Trunk-and-Branch

The filtering technologies developed for the OADM Branch Unit can be modified to route specific wavelengths or channels into and out of a specific undersea segment while other channels are allowed to pass through. One could imagine applications in a trunk and branch configuration where all Owners wanted to communicate to the two terminus points of the trunk. However, certain owners might not want to communicate to other landing points due to political or security concerns. Using the previously developed OADM Branch Unit techniques, the filtering technology can be tailored to provide express wavelengths (from all Owners to the terminus points) and local wavelengths (between selected landing points), and/or a combination of the above. This may provide for trunk-and-branch Thin Route systems to be comprised of only 2 fiber-pairs but include many smaller owners and allow all to participate without security or political concerns of the larger participants. Please see Figure 2 below for an example of this type of architecture.

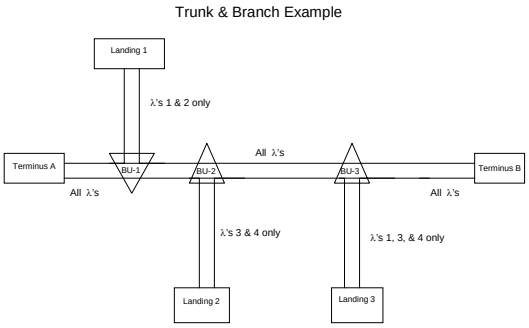

Figure 2

4. CONCLUSION

Technical developments made in the past few years will benefit all new undersea systems during this resurgence of the market. However, potential Thin Route system owners should examine these latest developments as they will minimize the initial investment in Thin Route systems and make them less expensive to operate on an ongoing basis. Furthermore, the new features offered will allow Thin Route systems to be uniquely tailored for different customers having different applications. In a resurging undersea cable system market in which new technologies are providing significant benefits to Long Haul operators, there are specific products and technologies now available that enable system designs that are a good fit with the smaller budgets of Thin Route purchasers. Now that the days of low budget systems resulting from excess inventory are behind us, potential owners of Thin Route systems should examine these new technologies and developments as they may find that the case to support their investment, both Capex and Opex, is easy to make.