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MSO | Case Study

integra optics

Maximizing the value of new fiber assets

MSO | Case Study

Customer Profile

Our customer is a leading hosted communication and connectivity provider in the Northeast and provides services to more than 1,500 organizations. They provide cloud-based services to clients that elect to forgo the expense of operating and maintaining their own premise-based equipment. With 30,000 users of voice, video, and internet primarily relying on PBX services, our customer is one of the largest hosted communications providers in New England.

Customer Challenge

The challenge was to turn up service on a recently acquired 125 km span of single mode dark fiber between two large cities in New England. The initial deployment consisted of turning up Juniper compatible dense wavelength division multiplexed DWDM pluggable transceivers connected to passive DWDM mux/demux equipment with a plan to add additional waves at a later time.

During the planning phase of their network build, the customer had five basic requirements.

1. The design must be capable of operating error-free over 125km without the use of forward error correction (FEC).
2. The network must provide for future wavelength capacity as service volumes grow.
3. Equipment of minimal complexity that accommodates for ease of operation.
4. Hardware must be hardened and all active components are required to deliver performance and status reports.
5. The useful life of the network must be 15 years or greater.

Integra Optics Solution

Through an extensive review of the fiber optic distance and condition using OTDR, it was determined that the power budget was outside the reach of transceiver based optics. Amplification would be essential. In addition, the excessive length created dispersion, making compensation necessary.

The final design was comprised of Integra Optics SFP+ ZR DWDM transceivers, Pre and booster erbium doped fiber amplifiers (EDFAs), DWDM mux/demux devices, and dispersion compensation modules.

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Background:
Typically, a 125km transmission span requires the network operator to be cognizant of several design factors that primarily include dispersion compensation, amplification, and error correction. Pluggable transceivers when installed in certain hosts are limited in their ability to recover and correct error free data streams and as a result it becomes necessary for the designer to account for dispersion and attenuation.

Modulating any light source results in spectral broadening, chromatic dispersion is this spreading of optical light pulses as they travel across an optical fiber. When a digital pulse spreads, distinct digital pulses begin to overlap and interfere with each other at the receiver. If the receiver cannot recover the original data, the bit error rate (BER) will increase. While an amount of chromatic dispersion is tolerated, receivers have a limited ability to detect and correct bit errors caused by dispersion. However, as data rates and distance increase, dispersion will cause progressively worse signal degradation. This is a direct result of the shorter bit times associated with high speed circuits as well as the distance the pulse must travel in the fiber. Therefore, dispersion compensation must be tailored to the individual span and data rate.

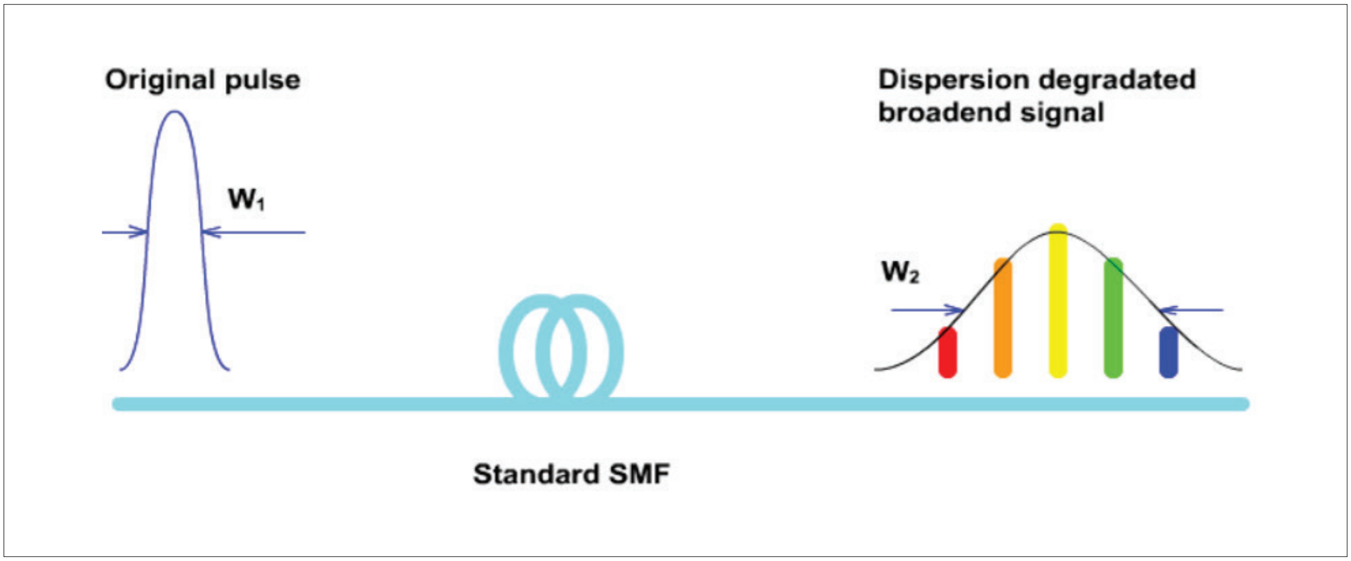

Figure 1. Before and After: Pulse Broadening due to dispersion

Dispersion management is the use of compensation elements to keep the total dispersion to a small number. In many cases this can be done passively. Transmission wavelengths in the 1550nm window undergo significant chromatic dispersion (expansion) over standard fiber and require dispersion compensation, particularly at 10-Gbit/s or higher data rates. One method to compensate for dispersion is to use DCF (Dispersion Compensating Fiber) which is a length of specially designed fiber that causes the pulse to undergo compression. In a properly designed network, DCF is used in alternating spans with standard fiber, the end result is minimal dispersion at the far end. In cases where it is cost prohibitive to run DCF spans, compact spools of DCF can be used in the form of modules. Although an effective dispersion solution, modules have the drawback of lengthening the span and adding significant attenuation.

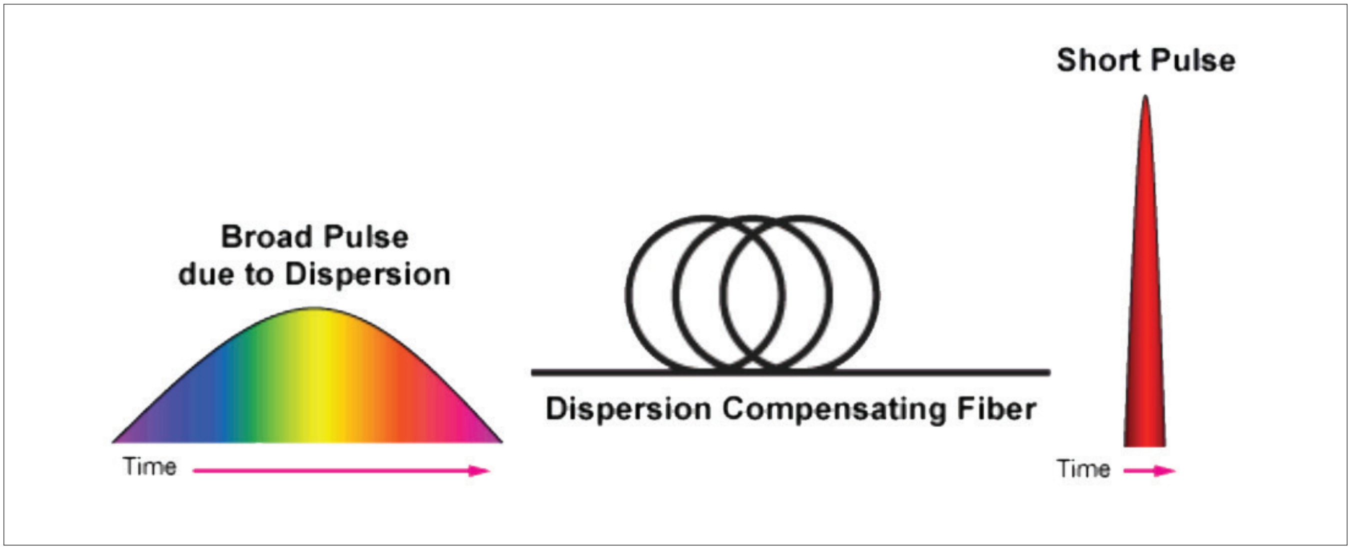

Figure 2. Before and After: Pulse compression due to the use of dispersion compensating fiber

Design Criteria #2, Power Budget and Amplification

In addition to dispersion, transmission fails when the attenuation on the circuit accumulates enough to cause the receiving signal to be too weak for the far end to receive. Long haul ZR 10Gig transceivers are manufactured with link budgets of approximately 24dB. While sufficient for transmitting 80km and below, they do not have the optical power to drive error free transmission across a 125 km span. More importantly, the use of DCF adds significantly to the overall loss of a span. Amplifying the optical signal at various points in the network is one way to overcome excessive fiber loss. EDFAs are a very efficient solution for this as they amplify the incoming optical signal without converting the signal to the electrical domain. EDFAs can be designed with various specifications so they can be used at different points in the circuit. Booster EDFAs accept a high power optical signal and boost to an even higher value to drive across a long span, while pre-amp EDFAs are designed with a very low sensitivity and can be used to amplify a weak incoming signal to a level that can be detected by the receiver.

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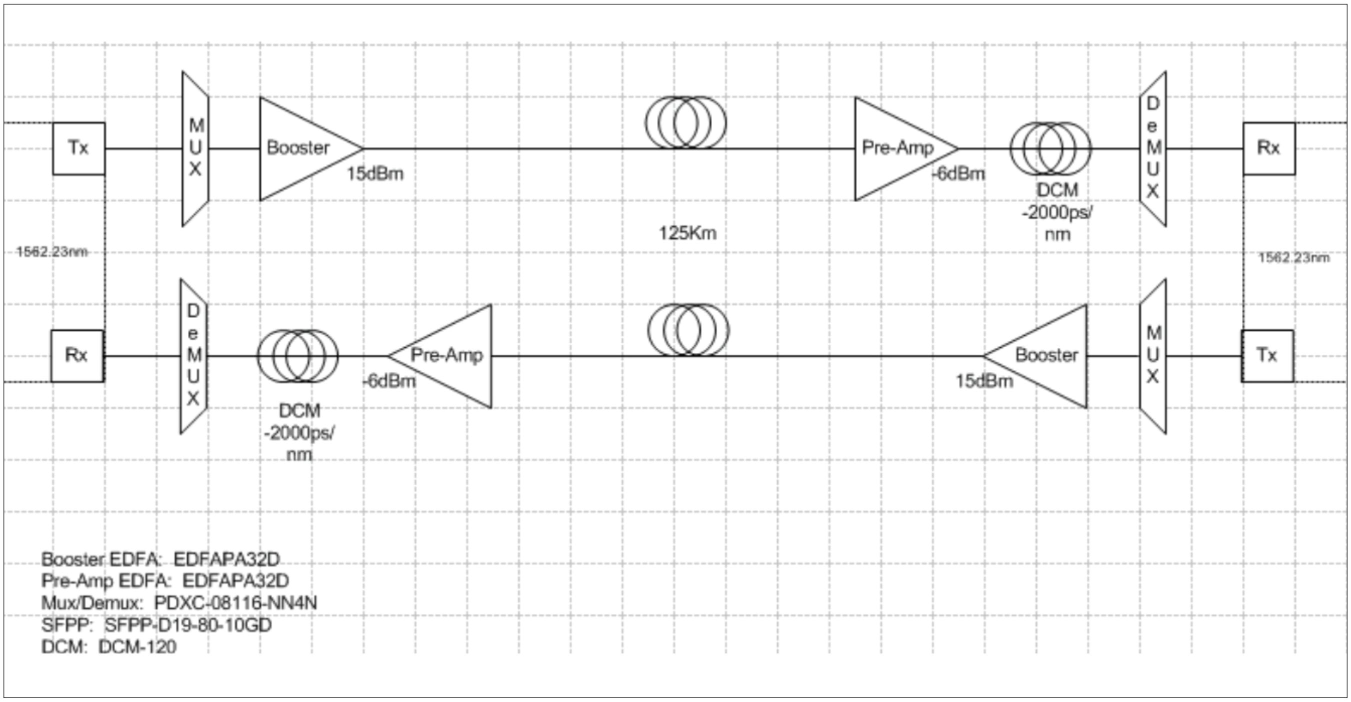

Figure 3. Point to Point Circuit Design using Integra Pre-amp and Booster EDFAs

Lab Trial and Analysis

Internal lab verification was completed to confirm the design would function in the real world. Using Integra SFP+ DWDM optics, EDFAs, and dispersion compensation modules, the span was set up according to Figure 3. A digital sampling oscilloscope was used to generate an eye pattern which provides extensive detail involving signal integrity where the center of the "eye" can be used as an indicator of a distinguishable high or low bit at the far end. No measurable signal could be detected without the use of amplification, and excessive bit errors (<1E-11) occurred without the use of dispersion compensation. Figures 4a and 4b show the observed lab results both with and without dispersion compensation, both scenarios included pre and booster EDFA amplifiers. Upon review of the data it was clear that eye width (jitter) and eye height (P-P voltage) were improved through the use of dispersion compensation. Note that the pre-amp was required as the DCMs added 8dB of attenuation, which brought the final signal very close to the transceivers minimum Rx sensitivity. Additional verification was completed using an optical sampling module which eliminates the transceivers post amplifier and displays the eye height as optical amplitude. Based on this testing, the network in Figure 3 was chosen as the final solution.

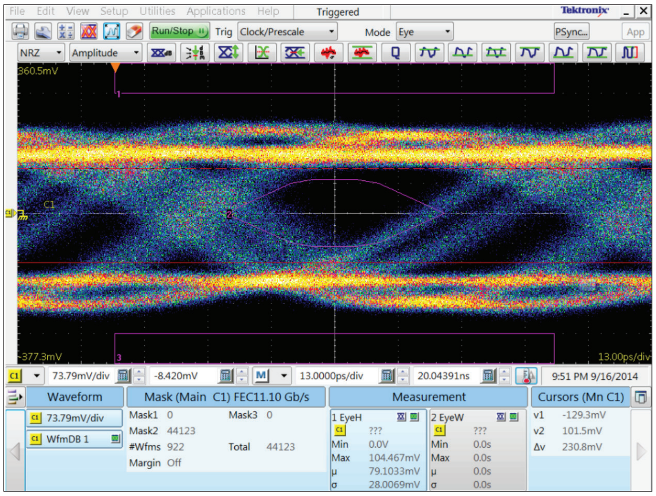

Figure 4a. Receiver eye pattern from an 80KM DWDM SFP+ over 120Km Fiber. Near End Booster EDFA Output - 15dBm. No Dispersion Compensation. Far end Pre-Amp Output -11.25dB. BER 1E-11.

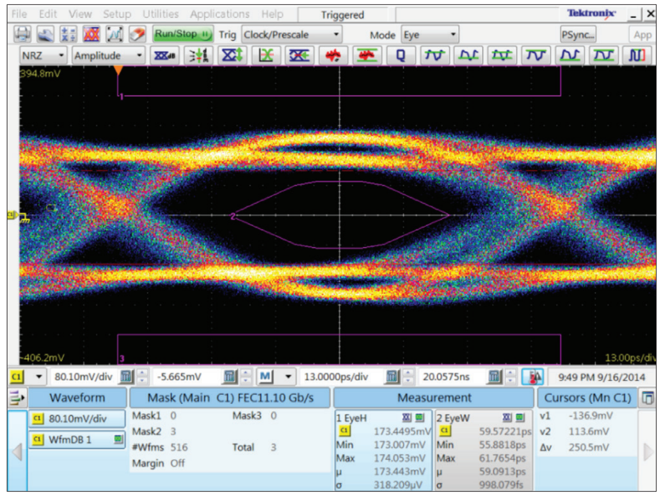

Figure 4b. Receiver eye pattern from an 80KM DWDM SFP+ over 120Km Fiber. Near End Booster EDFA Output - 15dBm. -1365ps/nm Far End Dispersion Compensation. Far end Pre-Amp Output -11.25dB. BER 0E0.

Conclusion

Since the customer had not previously used long haul hardware, Integra anticipated as part of its support model that they would provide day 1 turn-up support. However, after the products shipped, the Integra sales manager received an excited call from the customer, who was thrilled to report that everything was installed and turned up by their internal support staff.

Another factor that made the Integra EDFAs the right choice for this network was Integra's ability to provide support on a national scale. Integra's systems engineering team made network design and installation simple and problem free. Because of Integra's ability to provide in-stock components, the customer was supplied immediately with the necessary hardware and did not have to wait the normally exhaustive lead times.

Integra Optics Equipment Used

- **EDFABA15D / EDFAPA32D:** Integra EDFAPA and EDFABA are Integra's cost-effective low noise EDFA products for full C-Band amplification. They offer full remote management support and monitoring with dual power supplies in a hardened case in 1 RU.
- **PDXC-08116-NN4N:** Integra low IL 8 channel DWDM mux/demux accept LC connectorized fiber and are available in a wide range of packaging options and drop options.
- **SFPP-D19-80-10GD:** Integra SFP+ DWDM ZR optical transceivers are MSA industry standard, and Integra customizable to virtually operate in almost any platform or environment.

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