Taking Fiber Deep into the Network:

Guaranteed Performance Quality Does Not Have to Cost You

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In the past 15 years, I have assisted hundreds of customers with their network design, planning, and associated fiber management needs. These networks have ranged from the booming CATV HFC days of the mid-90's through fiber exhaust scenarios of the telcos to the gargantuan bandwidth needs of the various FTTH deployment strategies. One of the constants in all of them has been the consideration of link loss budget planning: How far out can I get with my current optical power before I have to terminate or amplify? I have always been amazed that more often than not, the first answer to distance limitation is to plop in more optical power in the way of EDFA's, transmitters, and amplifiers. Optical transmission and having the power to get it where you want it to go can be an expensive affair. However, boosting power is not the only way to gain distance.

Perhaps the most overlooked element of a network design is the quality performance of a simple item: the fiber patch cord. A quality patch cord not only improves performance and reliability of the network, but it also stretches the dollar value of current active optical equipment already installed in the network. The key to optimizing the value proposition of your network is to require a low .dB loss on every installed patch cord.

During my years in the industry, I have often seen mated pair (two connectors or endfaces mated through an adapter) loss budgets of .6dB per pair. In a logical fiber run that included 10 mated pairs end to end, I had to assume 6dB (.6 multiplied by a factor of 10) of loss in connectors alone – that's before I calculated the loss associated with fiber length, active equipment, optical components, and splicing.

In recent years, Telcordia has established that the standard for dB loss should be no more than .4dB. If you could achieve an insertion loss improvement on all your patch cords of 50%, think about what that could do for your optical budget . . . . .

Using the same example of 10 mated pairs in a logical fiber run; you can gain 2dB of optical power. Think about the cost difference of moving from an optical launch power of 19dB to 21dB versus improving your performance standard of patch cords to .2dB insertion loss -- with no increase in price. Calculating .20 dB of loss for every kilometer at 1550nm (without any splice loss), the increased performance of the patch cord allows you to extend your existing power almost another 10 kilometers. At the very least, it gives you some optical headroom for insurance against other attenuation events that come post-installation.

Guaranteed vs. Typical?

When Telcordia re-set the standard to .4dB of loss, most patch cord vendors reported performance levels “typical” of the Telcordia standard. As “typical”, the process to build the patch cord was capable of delivering .4dB performance, but each individual patch cord that came off the line may or not meet the standard – did 51% of the cords match the standard? 75%? Few patch cord vendors were “guaranteeing” the .4dB loss as it required extensive quality control measures in their production process and very tight tolerances in their test metrics. These changes were perceived by the vendor as expensive and cost prohibitive. Achieving a “guaranteed” performance level was expected to result in extensive production floor “scrap” as patch cords that didn’t meet the guaranteed number were either set-aside as “seconds” or re-polished to achieve the desired results. With no certainty to what they were getting, network designers needed to allow for variation in patch cord performance. As a result, their network designs were not able to fully benefit from the reported performance enhancements.

Setting a New Standard

Fiber in the outside plant has made guaranteed performance critical to network design. Reach of the fiber, guaranteed for immediate and on-going performance for the life of the network, is critical to delivering the user experience that FTTp networks promise. As a result, a new class of patch cords is emerging which guarantees performance deep into the fiber network. Vendors who have built their production floors for optimal performance are delivering ***guaranteed .2dB loss***.

Guaranteed loss of no more than .2dB lowers the cost of FTTp network deployment by extending the network reach, minimizing the need for amplification in out-ports or EDFA’s, and allows the network designers to concentrate on other elements of their network design. What’s more, manufacturers of this new class of patch cord are delivering this level of connectivity without a significant cost premium because of the repeatable processes that have been established within their world-class factories.

FTTp network designers now have a lot to be excited about!

So how do you know if you're getting the patch cord quality you need for your network?

Step 1 - Demand 100% of .20B or better. Period.

This requirement alone will weed out the wanna-be's from World Class.

Step 2 - Ask a few simple, yet critical, questions about processes, systems, and personnel to ensure that a repeatable and quality-driven manufacturing environment exists.

Can you tell me the types of automation that you have incorporated into your termination process?

While terminating fiber requires many manual processes that should be performed by skilled technicians, there are many things you should look for in your manufacturers processes that automate critical steps in the fiber termination process.

Examples

Epoxy - What kind are they using? Mixed, pre-mixed? How do they de-gas? This is critical for termination used in uncontrolled environments such as the outside plant. Some will cheat this step. They might give you great performance data. But will it perform properly in harsh environments?

Epoxy dispense - How is the volume rate controlled? Often a simple syringe is used and dispensed to visual criteria of the personnel doing the work which can result in variability in volume of epoxy dispensed. Look for control here with manufacturers that use pneumatic syringe dispensing equipment that are also equipped with timers. Epoxies exposed to oxygen are curing and become unacceptable for use over time. Again, performance data may look good but long term reliability can be affected if epoxies are not handled and dispensed correctly.

Hackle removal - a very critical part of the process as a good or bad hackel removal is not discovered until the end of the termination process at test and visual. Most manufacturing environments use a manual process whereby a scribe is used to score the glass next to the ferrule and break it away. A better process is to score the glass on two sides 180 degrees apart and pull the stinger away rather than break it away. This minimizes the change for cracks only found at test. The best way is to use automation by the way of a laser cleaver. This process uses a controlled laser to cut/melt the stinger away from the ferrule at very tight tolerances eliminating a hand epoxy removal step that can also cause cracks.

End Face Inspection – This is the process of reviewing an end-face for pits, scratches, cracks, and particulates. Do they have one? Many do not. If they can get the connector to meet performance, they will call it good. While there is no recognized industry standard for end face condition and cleanliness, there is no question that, in a dynamic connector, long term reliability is greatly compromised as pits and scratches can accumulate particulates that can contaminate other connectors. For those that do have an end-face standard, ask if it is subjective to an operator or if automation is used with a digital image of the end-face, magnified at 400x, is compared to a profile that has been pre-loaded into the equipment and only delivers a pass or fail condition. Ask to see this profile which tells you exactly what

kind of defects they will allow. No pit or scratch should be allowed in contact zone 1 or 2, a area 8 times the size of the core. This kind of process ensures reliability long after the performance data is measured in the factory.

Performance testing - At what wavelengths do they measure against? Performance is more sensitive at high wavelengths. I.e. 1550 and 1625. Insertion loss should be equal to or better than x. It not not be "typical" results. Loss should be measured at each termination and not be a sum total or average of the patch cord.

Endface geometries - The interferometer is an absolute necessity for developing a polishing process and then to ensure that the process remains capable. Anyone who tells you they don't have one you should walk quickly away from. Ask if any of their geometry standards exceed the industry standards of Telcordia. If you really want to get into the process, ask to see the spread of key geometry data such as radius of curvature, apex offset, and fiber undercut/protrusion. Is the mean on the fringe or right in the middle of the standard. In short, are they passing but "living on the edge." You could plot your own histogram and review.....ok, I'm getting carried away here and these are supposed to be quick.

Are you ISO certified?

This is another "weeding out" out question. While a "no" answer does not necessarily mean they can't deliver a quality termination, a "yes" tells you they have quality systems in place for documentation, processes, training, and a variety of controls for a quality manufacturing environment.