Deployment and Service Activation at 100G

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The road to 100 Gbps (100G) transport was a long one that began around 2006, just as the first commercial 40 Gbps (40G) networks were being deployed.

I would like to look at the market for 100G with a focus on the testing requirements, challenges, and solutions for deploying and activating the technology. The 100G market is progressing in two directions:

- Long-haul applications down to metro and regional networks, and
- 100G lines rates to 400G and beyond.

Two key enabling technologies that made 100G transport a success:

Advanced Modulation Formats

Advanced modulation formats were the trigger that enabled commercially viable long-haul transmission at 40G and higher. While multiple modulation formats were developed and used at 40G, 100G has been developed in a much more cohesive fashion, and suppliers have agreed upon DP-QPSK as the modulation format of choice.

As a result of these modulation advancements, 100G standard transmission at 112G total has become achievable using optics and electronics built for 28G transfer rates.

Coherent Detection with Digital Signal Processing

Coherent detection is another key technology enabler for 100G. Like QPSK modulation, coherent detection was also borrowed from radio communications and applied to optical communications. A coherent receiver is able to access the amplitude, phase, and polarization of the incoming signal in the electrical domain. Digital signal processing (DSP) then compensates for CD and PMD impairments – again, all electronically.

The primary benefit of coherent detection with DSPs in 100G is the ability to maintain both high performance, including 2000+ km transmission distances, and high spectral efficiency – a combination of benefits that is not possible when using direct detection.

Considerations for Testing 100G

The commercialization of 100G transport heralded new technology innovations, including coherent detection, DSPs, and advanced modulation formats. These innovations overcame CD and PMD sensitivities that imposed crippling distance/reach limitations on early direct-detect 100G designs. Coherent 100G with DSPs also changed fiber plant requirements dramatically by eliminating the need for costly dispersion compensating fiber spools and their associated amplifiers, as the high CD and PMD tolerances of coherent detection make this type of dispersion compensation unnecessary. Eliminating dispersion compensating fibers (DCFs) from the line also adds a significant side benefit by lowering latency in transmissions. System vendors estimate that DCFs contribute 8 to 10 percent of latency in long-haul networks.

The tradeoff in moving to coherent 100G is that the required technologies add complexity and costs to the transponders.

Key Challenges

In a perfect world, operators would migrate their networks from 10G to coherent 100G simultaneously with new systems and fiber plants, but real-world practice is very different. Although data shows that 2/3 of new long-haul capacity shipped in 2014 was on 100G ports, this does not take into account the massive installed base of 10G systems and transmission cards worldwide. Operators do not rip and replace their 10G systems when they add 100G, so coherent 100G must coexist in a hybrid world.

Primary Tests for 100G (Fiber Characteristics)

- Inspection, attenuation, and reflectance
- CD and PMD
- Optical signal-to-noise ratio (OSNR)

Conclusion

After a long road to commercialization, 100G transport is here now, in both long-haul and metro networks. While coherent 100G removed a host of technical barriers that had plagued the commercialization of direct-detect 100G, operators are mistaken to believe that deployment and service activation testing are not needed for coherent 100G. Critical fiber characterization tests at the deployment phase of 100G are: connector inspection, insertion loss, optical return loss, CD, PMD, and spectral attenuation profile. In addition to fiber characterization tests, accurate OSNR readings are required to predict the overall health of the optical signal. ■