Design FTTH Networks For the Future

Deploying zero-water-peak fiber in an FTTH network will allow the use of additional wavelengths to meet future bandwidth demands.

By David Stallworth ■ *OFS*

Project yourself a decade into the future: The FTTH network you designed 10 years ago has been operating nicely, and you have been growing bandwidth and applications to match demand by adding more wavelengths. To meet increasing demand, you begin to use wavelengths in the 1360–1460 nm E-band, hoping to further boost consumer bandwidth and add new services, only to find that the new system will not work.

Upon investigating, you discover that there is too much optical loss for the system to function in the E-band, which you are using for the first time. Why did this happen? Could you have done anything to avoid this problem?

This situation may sound far-fetched, but it could occur if you are not careful about the specifications you use for fiber and network elements. In fact, this problem can happen today. Optical transceivers operating in the E-band are already widely available and can help today's networks cost-effectively support higher bandwidths and new applications – as long as the fiber in the network has low loss in the E-band. This article offers a solution for avoiding this potential problem.

THE 'WATER PEAK'

Fiber is capable of virtually unlimited bandwidth. In theory, it can carry multiple terabits of data, and if the optical loss of the fiber is low enough, high data rates can be supported over practical distances.

The difficulty is in the fiber's E-band, which includes the "water peak," where absorption of hydroxyl (OH-) ions into the light-carrying core of the fiber historically has caused high attenuation of up to and beyond 1 dB/km, a loss more than three times greater than is normal. Because the hydroxyl ion is a constituent of water, the added loss it causes is termed the water peak.

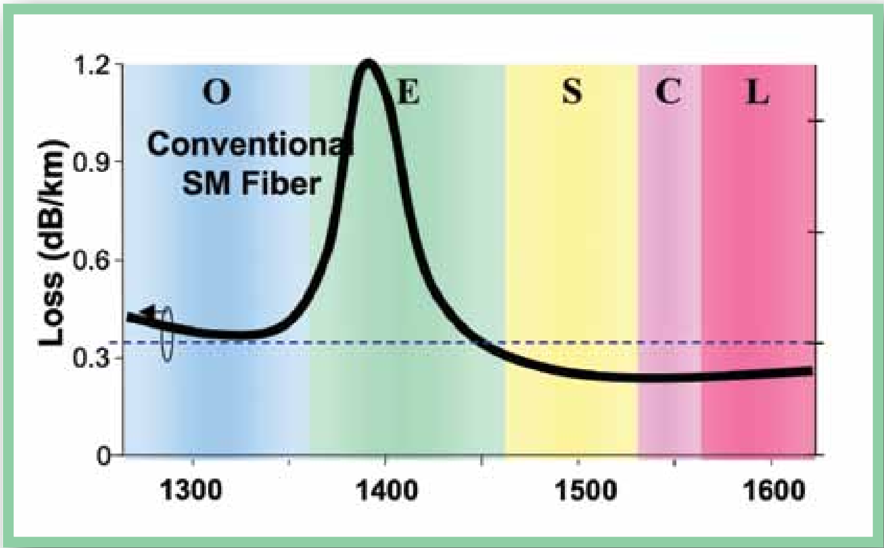

Chart 1: Water-peak loss in a single-mode fiber

Loss causes a signal to deteriorate as it travels along fiber. The farther a signal travels, the more it deteriorates. The amount of loss depends on how the fiber was manufactured and on the purity of the silica material used. With some manufacturing processes, hydroxyl ion absorption causes a continuing increase in fiber loss over time because of the chemical reactions between hydrogen and atomic defects in the fiber. Chart 1 shows this water peak for wavelengths of 1360 nm to 1460 nm.

The standards organizations are aware of this problem and try to avoid using the E-band spectrum when they assign wavelengths for new services such as 10G-PON. However, this avoidance scheme cannot work forever.

About the Author

David Stallworth is the design and product manager at OFS, a manufacturer of optical fiber and connectivity solutions. You can reach him at 770-798-2423 or by e-mail at dstallworth@ofsoptics.com.

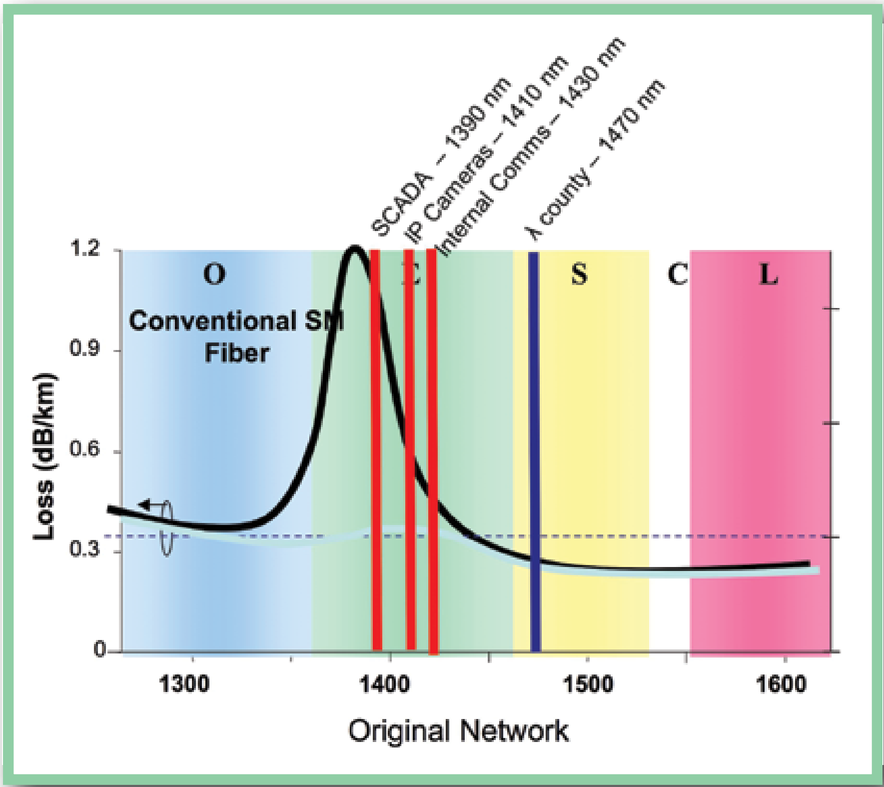

Chart 2: Possible service offerings in the E-band

The wise authors of the standards know that bandwidth growth and wavelength consumption in single-mode optical fiber will continue, and they have specified that E-band wavelengths may be used in metro or access applications. Examples of currently available E-band equipment are coarse wavelength-division multiplexing systems operating at the 1371 nm, 1391 nm, 1411 nm, 1431 nm and 1451 nm wavelengths. Future WDM-PONs or stacked TDM-PONs may also operate at these E-band wavelengths.

Manufacturers whose optoelectronics use the E-band include Cisco, Telco Systems, Transition Networks and many others. If these optoelectronics are connected by fiber that exhibits high and growing loss in the E-band, problems may occur. Chart 2 shows some of the services that can be offered using E-band wavelengths and the elevated E-band loss that makes standard single-mode fiber practically unusable at these wavelengths. Fortunately, there is a solution to overcome this limitation.

Several fiber manufacturers now offer a solution called zero-water-peak (ZWP) fiber. Fibers with ZWP performance have E-band loss of <=0.31 dB/KM at 1383 nm after the hydrogen aging test specified in the ITU standard. ZWP fiber is competitively priced and can help a service provider avoid the drastic situation of having to place new fiber cable to fully utilize the E-band wavelengths. In fact, compared with the total cost of building an outside-plant network, ZWP fiber costs are negligible. Chart 3 shows the typical low loss of ZWP fiber in the E-band and across the spectral bands used for single-mode optical systems.

A word of caution: Be very careful about the type of fiber you deploy in your network. Not all fiber is the same. If you do not specify fiber type in a request for quotes, the lowest bid is likely to be for a fiber whose cladding is made of natural quartz, a material that most of the industry abandoned in the 1990s in favor of synthetic silica, a purer form of glass. In addition, some manufacturers offer a low-water-peak (LWP) fiber and may imply it will stay low forever. Time can offer the only proof of this claim – and time is the problem. No one wants to find out 10 years down the road that fiber installed at considerable expense in the ground or on poles does not perform as expected.

Network owners should ensure that the fiber they put in place will support easy, cost-effective upgrades. They should not have to worry about whether the fiber will handle additional wavelengths. Zero-water-peak fiber helps put these worries to rest by offering between 12 percent and 22 percent lower loss in the E-band than LWP fiber, enabling 12 percent to 22 percent longer reach and 25 percent to 50 percent greater network coverage area. ❖

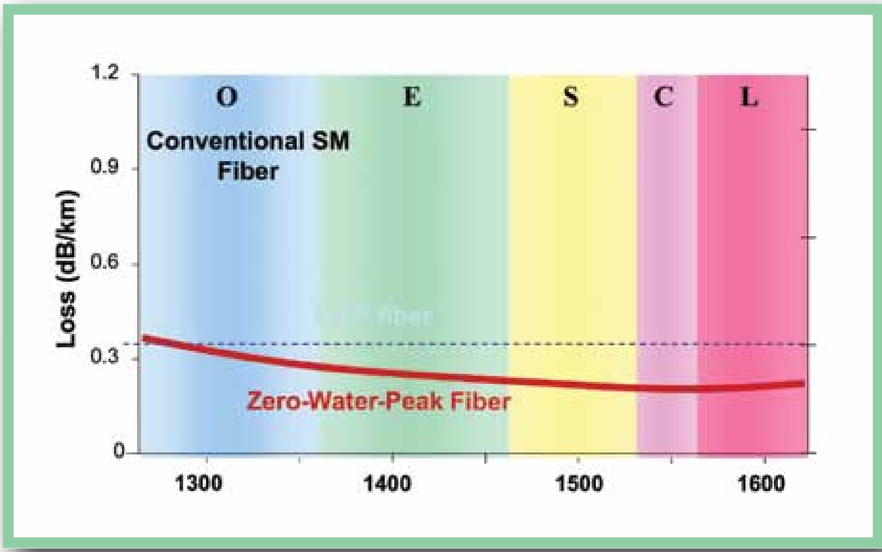

Chart 3: Zero-water-peak fiber has no additional loss in the E-band.