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CORNING

Single-mode. Double power. Triple play.

Corning's NexCor™ optical fiber solves a critical technical limitation for network operators delivering triple play – video, voice and data – to the end user

By Claudio Mazzali, Market development, engineering and analysis manager, Corning Optical Fiber

nex•us (nek'ses) *n.*
A means of connection; a link or tie; a connected series or group; the core or center.

When considering an access network, the focus often rests on the physical connection between the end-user and the central office. While this connection is clearly critical, Corning believes that true last-mile success is measured in terms of nexus: connection to customers, convergence of services and linking of today's network technologies with future network plans.

As service providers seek to offer customers the "triple play" of voice, data and video, many have chosen to build on the current base of analog video technology. In both passive optical networks (PONs), which limit active components to the central office and the customer's premises, ensuring no electronics in the field, and cable television networks, analog video transmission currently defines the system limitation for these networks.

NexCor fiber is a state-of-the-art, single-mode fiber optimized for applications that require high power, such as the FTTx PON and cable TV networks. It's both technologically innovative and reassuringly familiar. Compliant with the G.652.D international standard, NexCor fiber is also fully compatible with Corning® SMF-28e® fiber, the industry standard that enjoys widespread use across the globe. NexCor fiber's attributes are equivalent to SMF-28e fiber's and carefully designed to provide performance improvement and network savings without impact on network resources or training.

And it is specifically designed to address the technical barrier that analog video transmission creates – exploiting today's analog technology investment for as long as it's needed – while offering an advantaged, broader coverage path to digital transmission in the future.

Adding Up Your Analog Investment

Originally a telecommunications format, the continuously modulating format of analog transmission became the standard medium for visual data as well, i.e., broadcast video. Digital transmission is increasingly replacing analog transmission in communications networks, given its robustness and flexibility, and analog will undoubtedly, over time, become obsolete as the delivery medium for video transmission. (See Figure 1 for more information on analog versus digital transmission.)

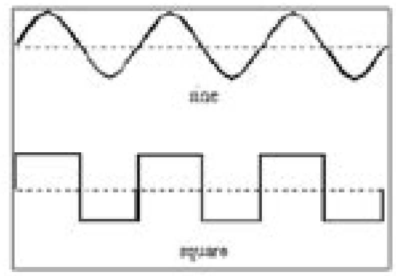

Figure 1: An analog signal is continuous, rather than pulsed or discrete. The data is transmitted as electronic signals of varying frequency or amplitude that are added to the carrier wave at a speci_c frequency. Analog signals are typically represented visually as a series of sine waves.

Digital signals are discrete and concrete, with data expressed in one of two states: "on" (1) or "off" (0). This binary format is usually represented as a square wave.

However, for most network operators planning to deliver video to the end-user as part of a "triple play" (voice, video and data) service package, it is impractical to simply write off analog transmission today. The U.S. Television Bureau of Advertising estimates 250 million televisions nationwide, with an average of 2.4 televisions per television household (about 69 percent of those TV households subscribe to cable television). Finally, according to the National Cable Telecommunications Association, about 75% of all U.S. cable subscribers are subscribing to analog-only services regardless of digital availability.

With the minimum price on set-top boxes for analog-to-digital conversion estimated at around $100, the costs to the network – or to the customer – to go straight to digital transmission are daunting.

The Addition of Power on Performance

Again, both PONs and cable television networks are most limited by analog video transmission. PONs are the leading architecture for FTTx in North America today.

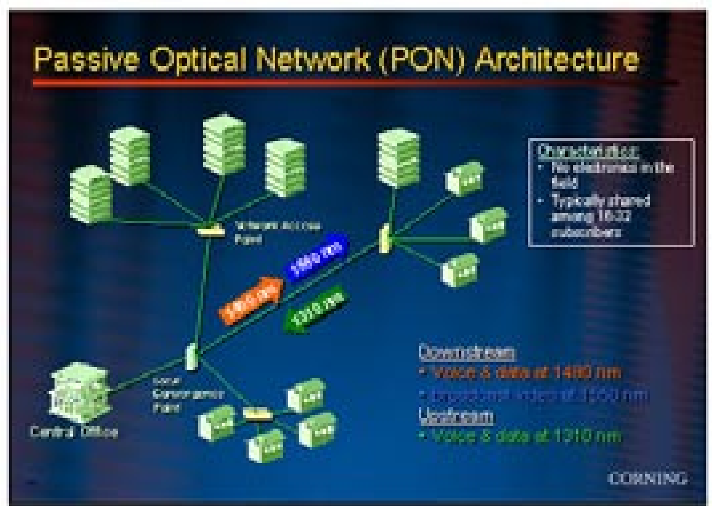

Figure 2: Transmission of data over PON.

In a passive optical network, data is transmitted over three wavelengths simultaneously. Digital voice and data travel upstream at 1310 nanometers and downstream at 1490 nanometers, while broadcast analog and/or digital video travels downstream at 1550 nanometers (see Figure 2).

At each wavelength, power loss occurs due to fiber attenuation, splices and connectors, but primarily via splitters – passive devices used to "split" the signal among several subscribers. Using a simple analogy, similar to the way that wavelength division multiplexing (WDM) technology increases a fiber's capacity by using different wavelengths, a PON allows bandwidth-sharing (by power and time division multiplexing), splitting high optical power among many subscribers through passive splitter devices. This architecture, coupled with the demands of analog video, requires transmission power levels far beyond that of typical networks, in many cases, around 20 dBm.

At 1310 and 1490 nm, the available power in the system and low received power required are usually sufficient to compensate for typical power losses. But at 1550 nm, the analog video signal requires significantly higher received power. And this power level crosses an intrinsic fiber limitation called the Stimulated Brillouin Scattering – or SBS – threshold. If the launched power is higher than the SBS threshold, a large portion of the signal is reflected back, resulting in reduced video quality for customers. This problem can be addressed by maintaining power levels below the SBS threshold, but with the penalty of reduced network reach or inefficient utilization of central office equipment.

The Threshold Principle

Stimulated Brillouin scattering (SBS) is named in honor of French-American Leon Brillouin, the physicist who predicted the phenomenon of light scattering from thermally excited acoustic waves in 1922. Simply put, SBS is the interaction of light with sound waves.

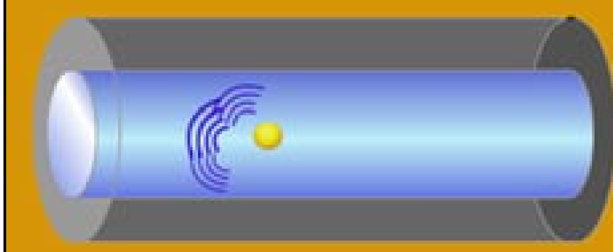

Figure 3: Stimulated Brillouin Scattering is the interaction of light with sound waves, wherein light waves reflect, or scatter, back toward their source.

SBS occurs when a high-powered electric field, such as that encountered in optical analog video transmission, generates a high-frequency acoustic wave in the fiber. This acoustic wave, well outside the range of human hearing, causes variations in the fiber's refractive index, which in turn scatter the transmitted light in the reverse direction. As power levels increase, the nonlinear effect becomes increasingly stronger, and the transmitted signal loses power and becomes distorted. In analog video transmission, this results in very noticeable signal degradation. (see Figure 3).

Every optical fiber has an inherent threshold for SBS. Transmit power above the fiber's SBS threshold and you produce the non-linear effect of light scattering. Increase an optical fiber's built-in SBS threshold, and you increase its tolerance for power. In other words, an optical fiber with a higher SBS threshold can handle more power without a CNR penalty.

That's where Corning's NexCor fiber comes in.

Fast Addition: NexCor Fiber's Direct Savings

Clearly, the way to improve the effectiveness of power-hungry analog video transmission is the ability to launch more power without running into that SBS threshold limitation. NexCor fiber makes it possible, with an innovative design that doubles the allowable launch power compared with other standard single-mode fibers. By increasing the fiber's SBS tolerance by an additional 3 dB, network operators can launch *twice* the power of any other standard single-mode fiber on the market, resulting in longer reach, higher split ratios and, consequently, better customer coverage with excellent video quality. This translates directly into extended network coverage, reducing overall costs per subscriber.

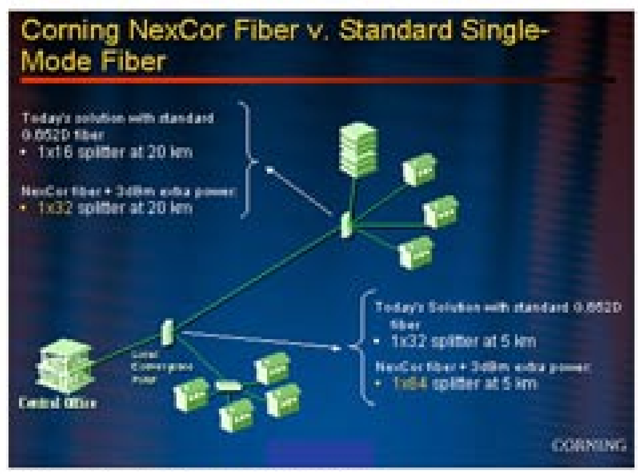

Figure 4: In a standard PON application, NexCor Fiber allows for greater network coverage, close to the central office and 20km away!

Take, for example, the passive optical network shown in Figure 4. In a PON using standard single-mode fiber, the SBS threshold limits power to the point that, at a typical distance far from the central office, only a 1x16 splitter can be deployed without unacceptable losses. NexCor fiber doubles the number of subscribers served, with a 1x32 splitter, at the same long distance.

The extra power enabled by NexCor fiber can also be leveraged closer to the central office, where the advantage translates to even higher split ratios – a 1x64 splitter, for example, a significant expansion of subscriber coverage, though one not currently being considered in the ITU-T G.983 standard.

"When you can significantly extend your network coverage like this, through reach, through split ratios, or both, the impact on the overall cost per subscriber is substantial," said Klaus Kammermeier, product line manager for single-mode fiber, Corning Optical Fiber.

Solving Over Time: Long-Term Savings

In addition to immediately enabling a more cost-effective outside plant and delivering better video service today at lower costs, NexCor fiber offers compelling long-term benefits. NexCor fiber's long reach and higher split ratios can help providers build a path for a potential PON equipment consolidation and, ultimately, central office consolidation, reducing associated operational expenditures.

Today, most established cities and communities with telecommunications networks have a significant number of central offices located very close to one another, serving similar numbers of customers. The reason for it is "ancient history," at least in telecommunications terms: connections from the central office to the customer were historically copper, which has significantly shorter reach than optical fiber spans. With fiber-to-the-x a reality, there is a tremendous opportunity to reshape access networks as we know them today.

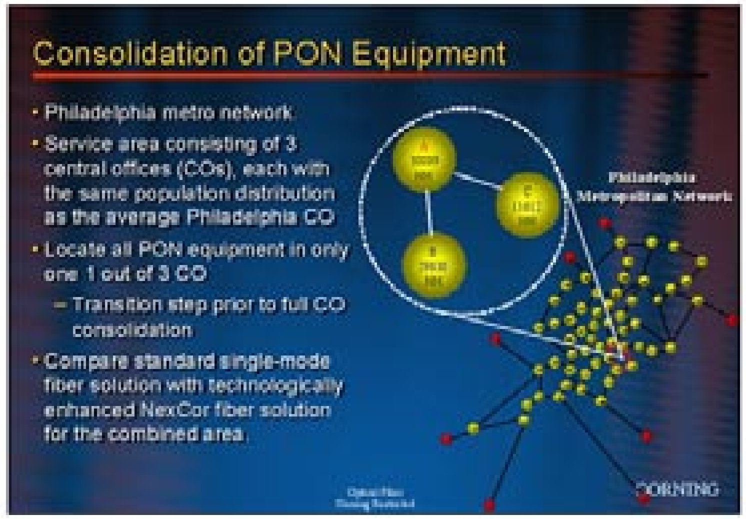

FIGURE 5: OPPORTUNITY FOR INCREASED NETWORK EFFICIENCY THROUGH NEXCOR FIBER-ENABLED CENTRAL OFFICE CONSOLIDATION.

With the deployment of optical fiber – particularly NexCor fiber and its power-enabled broader coverage capability – into last-mile networks, the equipment that would have been required in three central offices can be relocated to reside in one central office and serve the same number of subscribers. Ultimately, this would allow carriers to consolidate central offices, a major cost savings. (See Figure 5.)

NexCor fiber also enables a single design rule throughout the network because its high power capacity allows network planners to design all parts of the network based on the worst-case loss scenario. This simplification of design reduces the cost and complexity of network implementation compared with customized designs.

Further, when providers who deploy NexCor fiber move to digital video, which has less demanding power requirements over distance, their outside plant will already be more efficiently designed for extended reach to serve customers seamlessly. (See Figure 6.) And because NexCor fiber is fully compatible with SMF-28e fiber, it integrates seamlessly with existing legacy networks.

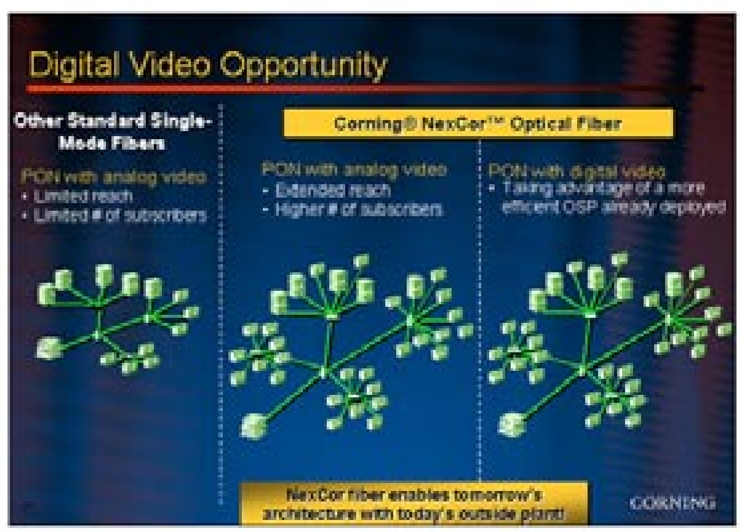

FIGURE 6: TRANSITIONING TO ALL-DIGITAL VIDEO TRANSMISSION, COST EFFECTIVELY.

Like all Corning® optical fibers, NexCor fiber delivers unsurpassed performance, economic value and compatibility with current and emerging networks technologies. After all, when you're looking to get the most out of your optical network, it makes sense to rely on the company that invented optical fiber for communications. Achieving nexus means creating reliable connections: to your customers, with your services, through your technologies. Create the power of reliable connections with NexCor® fiber.