TeraWave Fiber

Fiber for the Long Haul™

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Long Haul Network Capacity Reaching Limits
Advanced Fibers Can Help Enable Cost Effective Capacity Growth

Backbone bandwidth demand growing 40% - 100% each year.

Growth driven by
- More video
- Higher definition video
- Software downloads
- Double the number of networked devices in the next 2 years.

New fiber overbuilds and Greenfield builds should use bandwidth scalable, cost effective fibers.
Next generation long haul networks are reaching the limits of standard SM Fiber

*Advanced fibers can help overcome these limits*

- Capacity will need to be increased to meet growing bandwidth demand.

- 100G adoption is growing fast and 400G is next, and both use sophisticated noise-sensitive encoding schemes with coherent detection.

- OFS TeraWave fiber uses Optimized Large Effective Area Technology to reduce amplifier noise and extend optical reach.

- TeraWave fiber can reduce system cost by avoiding $Ms in signal regeneration, compared to conventional G.652D and ULL G.652 SM fibers.
What is Signal Regeneration?

The short answer is – expensive

- Each amplifier adds noise to the optical signal.
- Transmission through fiber adds non-linear noise to the optical signal.
- Once the accumulated noise gets too large through many spans the signal must be regenerated to avoid bit errors.
- A regenerator is a receiver followed by a transmitter that together remove the amplifier noise – **one regenerator for each wavelength of the fiber**.
- Carriers want to avoid regeneration as it can cost **$Ms per fiber**
  - ~**$50K per wavelength** – and each fiber can carry 80 or more wavelengths!
TeraWave fiber exceeds the reach of conventional G.652.D fiber by 40% to avoid expensive regeneration at 400G*

TeraWave® fiber can go ~2000km

Expensive Regeneration

G.652.D fiber can go ~1400km

* Estimated reach for network with 100km spans with Hybrid Raman-EDFA
How do we improve regeneration distances to help reduce system cost?

• Improving the signal to noise ratio (OSNR) in the system increases system reach

• Closer amplifier (hut) spacing and Raman amplification are two ways to improve OSNR

• Advanced optical fibers can improve OSNR. Two approaches will be considered:
  – Lower loss G.652 fibers such as ULL
  – Optimized large effective area G.654.B fibers such as TeraWave® fiber
How far can I send a signal in an optical fiber?

*Farther with Terawave fiber*

Single span, EDFA shown case shown. Even greater improvement with RAMAN.

**Increase in distance Y km**

- TeraWave® fiber nonlinear Limit
- G.652.D fiber nonlinear Limit
- Noise floor

**Optical power**

- Increase in optical power X dB

- Conventional G.652.D fiber

- G.652ULL type fiber with lower link attenuation by X dB

**TeraWave fiber’s Optimized Large Effective Area provides more benefit than ultra low loss**
TeraWave fiber link results in less noise for greater reach without regeneration at 400 Gb/s

Relative 400G reach referenced to std SMF at 100 Gb/s using Erbium Amplifiers
Summary

• Longhaul network capacity will need to be increased to meet growing bandwidth demand, increasing by 40% or more per year.

• 100G adoption is growing fast and 400G is next, and both use sophisticated noise-sensitive encoding schemes with coherent detection.

• OFS TeraWave fiber uses Optimized Large Effective Area Technology to reduce amplifier noise and extend optical reach.

• TeraWave fiber can reduce system cost by avoiding $Ms in signal regeneration, compared to conventional G.652D and ULL G.652 SM fibers.

• TeraWave fiber is recommended for long haul overbuilds and greenfield long haul networks.
TeraWave ® Fiber – Fiber for the Long Haul ™

More fiber will be deployed

And that fiber should be optimized for 100 and 400 G