Undersea (Submarine) Cables

State of the Art: Planned Pacific Light Cable Network from Hong Kong to LA
to move 144,000 Gbps (or 144 Terabps) for 8,000 miles (13,000 km).
Main purpose is to connect Facebook/Google data centers in East Asia
with US.

History

Undersea cables originally carried telephone calls and faxes (and in the 19th century telegraph signals).

Until recently traffic between users and Internet Service Providers (ISP's).

Now undersea cables mostly carry traffic content and cloud computing offerings of a small number of tech giants
(77% of Atlantic traffic and 60% of Pacific traffic).

For more than three decades the growth of fiber optic data rates has outpaced Moore's Law (i.e. doubling of performance every 18 months). Google for instance needs to double its transmission capacity every year.

By 2000 with all optical amplifiers and new optics one could pack dozens of 10Gbps streams in closely spaced wavelengths in a single fiber for thousands of kilometers.

By 2010 new sophisticated modulations schemes could boost the capacity of each wavelength ten times.

Technology

Optical amplifiers needed every 50 km (powering them is an issue). Why not just pack more fibers per cable? Because there is a limit in terms of powering the amplifiers form each end of the cable. Not a problem with terrestrial cables.

Amplifiers add noise. Can extract signal from noise but data rate goes down as cable length goes up.

Best so Far

Current traffic record by Faster Cable made by NEC and owned by Google and 5 Asian telecommunication companies.

Faster cable goes 9,000 km from Oregon to Japan with an extension to Taiwan.

Six fiber pairs each with 100 Gbps signals at 100 different wavelengths. Thus two way capacity of 60 Terabps.

New Approaches to Boost Capacity

(1) New optical bands (use L band as well as C band).

(2) Make fiber cores big enough for light to follow different paths so multiple physical light signals in a core (injection/extraction is tricky) but they don't interfere with each other.

(3) Use fibers with many light guiding cores so many paths in parallel.

(4) Divide cable into shorter island hopping segments to allow more power injected at junction points – but this creates delay which Internet companies don't want – they want low delay paths between their data centers,

(5) Space amplifiers further apart, trading bandwidth a bit for reduced power consumption which would allow more fibers in the cable.

Reference

J. Hecht, "Undersea Data Monster", *IEEE Spectrum,* Jan. 2018, pp. 36-39.