The Future of Fiber

Does glass still have class>?

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People are always looking for the next "big thing". Although fiber technology has been around for over quarter of a century, this article suggests that it still has potential. The "bandwidth glut" may not be such a big deal if we take a long-term and global perspective and there are still technology improvements and service opportunities in the pipeline. Perhaps the next big thing will just be more fiber?

Fiber optical technology has been in routine commercial use for almost 25 years: GTE claimed a first by sending live telephone traffic over a fiber system on April 22, 1977. Other companies including Bell and the British Post Office (later to become BT) followed within weeks.

Since then, we've seen the Internet revolution, an explosion in the use of wireless technology, satellite broadcasting, and a dramatic increase in the performance of computers and computer-driven devices. So in the search for the "next big thing", fiber may look more like an "old big thing" to many people. But fiber is still big and not likely to be supplanted soon.

One reason for the lack of enthusiasm of (some) investors is that they hear analysts talk of a glut of bandwidth in the world. A glut would mean a smaller market for optical technology, and a suppression of revenue opportunities for carriers. These thoughts make investors unhappy.

Is there really a glut? Yes, in the backbone networks – if by glut we mean that the potential capacity of all installed fiber is greater than current traffic carrying needs. We have seen estimates that 85% of the capacity of installed networks is not in use.

This figure may be true – in parts of the network. Such estimates are generally based on the potential capacity of all the fiber in the ground – whether it is lit or not. And estimates of potential capacity are regularly upgraded, as the technology itself advances. These two factors – increase in fiber capacity and over-supply of fibers – deserve a little more examination.

GTE's 1977 system ran at 6Mbps. Current commercial DWDM systems are capable of carrying around 2 Tbps per fiber, so in around a quarter of a century, the technology has increased the carrying capacity of a single fiber by a factor of more than 300,000.

As the technologists were increasing our expectations of what was possible, carriers were boldly implementing this new technology. Multiple fibers were installed along every route – a deliberate policy of over-provisioning driven by simple, practical economics: it is expensive to dig trenches and lay cables, but a few extra fibers are relatively cheap, and

they don't need to be lit until they're needed. The economics supported this approach, and to do otherwise would have been financially irresponsible.

However – suppose both sides of this industry had failed to deliver. What if vendors had increased the capacity of systems by only, say a few percent, instead of by a factor of many thousands? What if carriers had assumed modest demand and installed a threadbare network? Then the huge increases we have seen in both voice and data traffic would not have happened. Vendors would be working flat out to deliver large volumes of inefficient products to service providers who would be working flat out to install them. Customers would be paying many times more for much less bandwidth. Our current situation therefore is actually an indication of success, not failure.

Some people might conclude that with only 15% of capacity being used, it might be as well to forget about the fiber industry for a few years. Let's list some reasons why this assumption could be wrong.

First, potential capacity is not actual capacity. Where suitable fibers exist, we will not need to install additional fibers in a hurry. But we will need to install the hardware to light unlit fiber or upgrade hardware to squeeze more traffic onto working fibers – by replacing transmission electronics with optical devices to avoid the bottleneck caused by electrical-optical conversion.

Second, there is not really over-capacity everywhere in the networks. Many established fiber routes have reached 60% average utilization – this is approaching the level at which replenishment is likely to be needed to carry traffic at a performance level that customers expect.

Also, in the access network, customer needs for access bandwidth are not necessarily directly related to traffic volume. Two companies may generate the same volume of traffic, as measured by bits sent or received in a day. A video production company may only transfer a few very large files each day. A bulk emailing service sends the same number of bits but spread over the entire day. Same average *traffic*, widely different *bandwidth* requirements.

Third, the access network is still full of gaps even in the most developed countries. Globally, there are many parts of the world where telecom growth, and deployment of fiber networks, has hardly started. More than half the people on this planet have never made a phone call.

Along with the additional fiber construction both in the backbone and the core, will come a need for the associated routers, switches and terminal equipment. Optical devices will help to make better use of the available bandwidth than the older electronic devices. Customers will demand higher capacity routers at the edge, terminating multiple OC192 (10GBps) circuits and Gigabit Ethernet connections, and maybe even higher rates to meet peak bandwidth requirements.

There are already circumstances in which in building fiber-to-the-desk can work out cheaper than Cat 5 copper cabling. High bandwidth availability to homes and offices will generate demand for new devices and software for display, communication, security and encryption.

We have seen significant improvements in management systems for fiber networks to automate service provisioning and improve trouble management: there's more to come.

The quest continues to improve the architecture of fiber networks, replacing multiple layers of protocols with simpler structures.

And technology enthusiasts persist in trying to squeeze even more bits down each fiber: Bell Labs' (Lucent Technologies) latest estimate is that the theoretical limit is around 100 Tbps over a single strand.

So does fiber have a future? Does glass still have class? Yes. Despite the uncertainties of regulation, politics, terrorists and global climate change, we are prepared to make some assertions with confidence. Fiber technology is the best method we have at present for transporting large volumes of data around the planet. People are finding many new ways of employing more bandwidth if the price is right – video streaming, interactive video, remote storage and backup, multimedia web pages... the list goes on. While the technology is more than a quarter of a century old, the light is not about to dim. If we're looking for the next "big thing" maybe we shouldn't overlook fiber – more fiber.

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