FIBER AND BANDWIDTH

Q: What is bandwidth?
A: In a network, bandwidth (what engineers call bitrate) is the ability to carry information. The more bandwidth a network has, the more information it can carry in a given amount of time. Networks with high bandwidth also tend to be more reliable because fewer bottlenecks disturb the flow of information.

Q: Can’t copper carry high bandwidth?
A: Yes, copper can support high bandwidth, but only for a few hundred yards. The longer the signal travels on copper, the lower the bandwidth. Optical fiber is unique in that it can carry high-bandwidth signals over enormous distances. Fiber uses laser light to carry signals. Under some circumstances, a signal can travel 40 miles (60 kilometers) without degrading enough to keep it from being received. Another difference is that fiber is better able to support upstream bandwidth – that is, from the user out to the network. High upstream bandwidth is important for video communication and for many business applications.

Q: How much bandwidth – or information delivered by bandwidth – do we need?
A: A standard-definition television signal requires a bandwidth of about 2 Mbps – two million bits (zeros and ones) per second. HDTV requires as little as 2.5 Mbps if the image is rather static – a person being interviewed, for instance. But fast action, such as in some sporting events, requires more – as much as 8 Mbps, even with new compression technology such as MPEG-4. Now, full-frame 3D is hot. While it can be delivered at 2.5 to 3 Mbps, a high-quality experience requires closer to 5 Mbps. 3D immersive HDTV – a technology already being used in some academic and industrial settings – will require between 50 and 300 Mbps.

Q: What about data?
A: Bandwidth requirements for many kinds of data are exploding. For example, the digital cameras that consumers buy can create larger and larger images. In health care, the medical images produced by equipment such as CT scanners are orders of magnitude larger than camera images – a hundred times larger, and more.

Q: What exactly makes fiber “future proof”?
A: The equipment necessary to send light signals keeps getting better. So equipping an existing fiber network with newer electronics and lasers that pulse light faster, or lasers using different wavelengths of light, can vastly increase available bandwidth without changing the fiber itself. The new electronics are very cheap compared with the original cost of laying the fiber. Therefore, once fiber has been deployed, network operators can keep increasing bandwidth at very little cost.

Q: How long has fiber optic technology been in use?
A: Fiber optic cable has actually been used in communications networks for more than 30 years. Fiber first delivered a signal directly to an American home (in Hunter’s Creek, Fla.) more than 20 years ago. Before that, fiber was – and still is – relied upon to carry communications traffic from city to city or country to country. The first trans-Atlantic fiber cable was laid in 1988. Almost every country on earth has some fiber, delivering services reliably and inexpensively.

Q: All providers seem to claim they have fiber networks. What’s different about fiber to the home?
A: Don’t be fooled! It is true that most cable and DSL networks use fiber. In these networks, the fiber carries the signal close enough to a home so that copper can carry it the rest of the way. However, this approach requires expensive, difficult-to-maintain electronics at the point where the fiber meets the copper. The available bandwidth is far less than an all-fiber network. And these halfway approaches do not allow symmetrical bandwidth – existing cable and DSL systems can download much faster than they can upload information.

Q: Isn’t that good enough?
A: That depends on what you want to use your bandwidth for. If all you want is to send emails, download songs or share family photos, the bandwidth provided by today’s cable modems and DSL lines may be good enough. If you want to log on to the corporate LAN from home and work effectively, you’ll need more. And what about uploading a high-def video of the school play, or sitting down to dinner with family members a thousand miles away?

Q: Why does it matter how close to the home fiber comes in DSL and cable systems?
A: With copper cable, there is a marked relationship between distance and available bandwidth. For example, the latest commercial versions of DSL can carry a signal of more than 200 Mbps for about 750 feet. Over a distance of a mile, DSL can deliver only about 30 Mbps. That’s the theoretical limit. In practice, the real bandwidth is less.

Q: With cable and DSL, there’s often a difference between advertised
and actual bandwidth. Is that true for fiber?
A: Cable, DSL and even wireless networks are usually more heavily oversubscribed than fiber – that is, providers promise users more than the total amount of available band-
width because they know all users aren’t going full throttle most of the time. As a result, copper-based networks slow down during peri-
ods of heavy use – such as when teenagers come home from school. Fiber has enough bandwidth that providers can guarantee high speeds with little or no oversub-
scription. If a fiber network is de-
signed properly, users will always get the speeds that are advertised. The Federal Communications Com-
mission now insists that carriers de-
liber the bandwidth they advertise.

Q: Is FTTH technology expensive?
A: In new construction, fiber costs about the same as copper to build, and it costs much less to operate and maintain. Building fiber to the home is expensive only when compared with not building any-
thing – that is, with adding new electronics to an existing copper network or building fiber only part of the way to the home. The prob-
lem is that these less-expensive solutions don’t always meet users’ needs. In the last few years, the flood of video content has outrun the ability of older technologies to handle bandwidth demands. Pro-
viders are shutting off or slowing down service or imposing prohibi-
tive fees for customers who exceed monthly bandwidth caps. Custom-
ers don’t like these restrictions, and they don’t appreciate being called “bandwidth hogs” for using services they have paid for. In addi-
tion, it’s not clear that providers save money by failing to meet users’ needs, because limiting band-
width means limiting revenue po-
tential as well.

VISUALIZING FIBER-BORNE BANDWIDTH

BANDWIDTH COMPARISONS

Only the Beginning
In a few years, even 1 Gbps will look small. Soon, most content will be 3D and ultra-high-definition.
THE INEVITABILITY OF BANDWIDTH GROWTH

Increased bandwidth lets us do familiar things faster. Send an email. View a website. But its real value is that it lets us do entirely new things with our computers, cameras, televisions – with our network. Today, the network is often called the “cloud,” which is a way of saying, “I don’t even have to think about where data is stored or where processing is happening.”

Things we talk about in everyday conversation today would have been bewildering a decade ago. In the past few years, we have seen such dazzling innovations as

- **Tablet computers** for easy access to games, ebooks, TV programs, email, shopping, banking and an ever-expanding suite of new “apps.”
- **Smartphones** that aren’t just for mobility anymore but are increasingly used for personal media consumption in the home.
- **Internet-connected televisions**, radios, set-top boxes, Blu-ray Disc players, cameras and picture frames that receive or deliver movies, TV and photos via the Web.
- **Voice over Internet Protocol telephones** that direct incoming callers to any line and take messages in text and video as well as voice.
- **Social media** that keeps people continuously in touch and up to date – who needs phone calls anymore?
- **Two-way video communication** whose quality is good enough to bring the illusion of “being there” to teleconferencing. It’s called “telepresence.” High-definition video communication has even reached the home market; telecommuting workers can send **telepresence robots** in their offices to sit in for them at meetings while they watch from their home TVs.
- **Easy distribution of user-created video** that lets grandparents see children, musicians develop audiences and manufacturers demonstrate new products.
- **Digital media lockers** that let consumers store music, TV, videos and services in the cloud and access them from many devices.
- **Telehealth devices and applications** that bring medical services to remote areas and to the home-bound elderly.

YouTube appeared in February 2005 and quickly became one of the five largest users of bandwidth on earth and the largest single user of internet bandwidth. The social networking platform Facebook, the world’s most visited site, has more than 600 million active users who share photos and videos, play games and use half a million other embedded applications.

The least expensive netbooks today come with 160 GB hard drives, because users need the file space. And if they need the file space, they also need to transmit large files and back them up online. Users become annoyed when network speeds lag behind local connection speeds – and USB transfer rates have now reached 5 Gbps.

Internet-connected TV sets and set-top boxes let viewers watch high-definition online video on the big screen as easily as they can watch video from the local cable or phone company. Users don’t have to “think Internet” to put Internet video on the TV. They just check out what’s available, using their TV remotes. Internet-capable TV models are today’s standard offering.

New services let people access health care and take classes from their homes. With home automation, residents can take care of their homes while they’re away, using Internet-connected security cameras and remote energy monitoring devices.

Telecommuting and home-based businesses are on the rise, too. In October 2010, market researcher Michael Render reported that new businesses created by fiber-connected residential users had pumped more than $40 billion into the economy in just the previous 12 months, the largest source of new jobs in 2010. Owners and managers of multifamily communities are turning social rooms into fiber-connected business centers and concierge offices.

We have every reason to believe that innovation will continue, that bandwidth needs will keep on growing – and that only fiber to the home, with its superior reliability and plentiful upstream capacity, will be able to keep delivering the bandwidth we need.