bandwidth • reliability • economic development • future-proofing
sustainability • affordability • symmetry • standards-based • security

WHAT FIBER BROADBAND CAN DO FOR YOUR COMMUNITY

11th Edition • Fall 2015

A Fiber-To-The-Home Primer
from the Editors of
BroadbandCommunities

FTTH
FIBER TO THE HOME
COUNCIL
AMERICAS

Contents

Reliability…

Bandwidth…

Affordability…

Future-Proofing…

Symmetry…

FTTH FIBER TO THE HOME COUNCIL AMERICAS

Security…

Economic Development…

Sustainability…

New Broadband Content & Services…

Higher Revenue…

This primer was originally written by Steven S. Ross and updated by him and Masha Zager. It summarizes research commissioned by the FTTH Council Americas and ***Broadband Communities*** *as well as independent reporting by* ***Broadband Communities*** *staff. In addition, the case study of Charles City County is based on a* ***Broadband Communities*** *article authored by Andrew M. Cohill and and Matt Rowe, and the case study of Sandy, Ore., is based on a* ***Broadband Communities*** *article authored by Christopher Mitchell and Hannah Trostle.*

Cover photo credit: Kansas City, Kansas Public Schools

Why Fiber?

WELCOME TO THE INFORMATION AGE

This is the age of fiber optics.

The information and communications revolution is being brought to you by glass – long, thin, pure strands called optical fibers. So much data zips around the world today in commerce, education, entertainment and personal communication that copper wires and radio waves could carry only a tiny fraction of it. Because fiber optic cable has so much capacity, it now forms the backbone of the Internet, cable TV networks, telephone (including cellular) networks, private business networks and even data center networks. Without fiber optic cable, none of these systems would be cost-effective. Most would not work at all.

Fiber optics was developed for communications in the 1960s. (One key inventor, Charles K. Kao, received a Nobel Prize in 2009.) By the late 1980s, fiber optic cables were being strung across ocean floors. Those early fiber trunks grew branches hundreds of millions of miles in length, extending deep into most of the inhabited world.

The final step is to build fiber optic cables all the way to homes and businesses and replace the old copper networks entirely. Yes, many individual premises now send and receive so much data that their copper connections, built originally for telephone and analog cable TV, are

70%
of FTTH customers are satisfied with their service.

62%
of non-FTTH broadband customers are satisfied with their service.

< 1%
of any cellular phone call actually travels through the air.

> 98%
of cellular calls are carried at least partially on fiber.

Photo courtesy of Adena Health System

One of the new services enabled by fiber networks is telemedicine, which can improve the health care available in smaller communities.

35-PLUS MILES
is the distance a gigabit signal can travel over fiber to a home.

300 FEET
is the distance a gigabit signal can travel over copper to a home.

196 FIBER STRANDS
each thinner than a human hair, in a bundle not much thicker than a pencil, could carry all the world's Internet traffic.

struggling under its weight. Worldwide, network operators agree that only fiber to the home, or FTTH, can meet the exploding demand for bandwidth and deliver next-generation services. Everyone agrees that fiber will meet the world's needs for the foreseeable future. The only debates involve the speed of the transition.

The reason for this striking degree of unanimity is simple: FTTH offers far more bandwidth, reliability, flexibility and security and a longer economic life than alternative technologies, even though its price is comparable. On average, it is slightly more expensive to build, but it is far less expensive to operate and maintain than copper.

Consumers who subscribe to FTTH rate it as the fastest, most reliable broadband technology. They appreciate that fiber networks can deliver broadband services for medicine, education, home-based businesses, home automation, video and games.

Businesses are now making a massive shift to cloud services. For economic efficiency and for redundancy, critical business systems now operate at huge data centers rather than on local computers. The speed, reliability and security of fiber connections make cloud services viable for consumers as well.

In the United States, almost one-fourth of households have fiber connections available. That's less than the average for the rest of the developed

ALMOST 1 OF 4
U.S. households have access to fiber-to-the-home services.

ALMOST 1 OF 9
U.S. households subscribe to fiber to the home.

48%
of U.S. households with access to FTTH sign up for services.

world. American broadband providers have finally begun to catch up. The target is moving, however. China alone expects to have 100 million FTTH subscribers by 2017, with gigabit speeds already available in some larger cities.

WHO IS BUILDING FTTH NETWORKS?

Most of the FTTH connections in the United States come from large telephone companies. Verizon, which started offering services on its Fios network in 2005, was the first major company to deploy fiber to the home and now accounts for more than half of FTTH connections. AT&T and CenturyLink have built FTTH in new communities for nearly a decade and are now deploying gigabit FTTH services in multiple U.S. cities. Frontier is inheriting more than 1 million FTTH customers from Verizon.

The large franchise cable companies have also experimented with fiber to the home, especially in new communities. Their pace quickened in 2015. As the demand for gigabit services grows, they have begun to build FTTH on a larger scale.

However, that doesn't tell the whole story, because more than 1,000 entities (listed at www.fiberville.com on the **Broadband Communities** website) are providing FTTH services in the United States today, and most are small. Nearly all were in the telecommunications business to begin with – they are independent telephone companies, franchised and private cable companies, local Internet service providers, wireless ISPs and cellular providers.

In addition, new companies have formed specifically to build fiber optic infrastructure in underserved areas. Other nontraditional providers include cooperative electric utilities, property developers and technology companies.

It makes sense for these forward-looking organizations to build FTTH networks. Most property developers can enhance the value of their real estate by putting fiber into new properties or upgrading existing properties. Some small electric companies built fiber optic networks to manage their own facilities and can extend these networks to serve their customers as well.

Local governments are attracted to FTTH because it positions their

1 OF 7
households worldwide can be served by fiber to the home or fiber to the building.

NO. 18
U.S. rank among 34 OECD nations in percent of broadband connections that are fiber

200 MILLION
Chinese households can be served with fiber to the home or to the building.

GBPS
Gigabit per second – can transmit a typical 2-hour movie in 16 seconds.

ESTONIA, SLOVENIA, SLOVAK REPUBLIC AND TURKEY
are among the 17 countries that outrank the U.S. in percentage of FTTH connections.

The copper and wireless last-mile connections to customer premises have inherently limited capacity, unlike fiber connections.

communities for tomorrow's jobs and economic growth. In 2010, when Google announced that it planned to build community fiber networks, more than 1,100 local governments proposed their communities as suitable locations. In areas where no private cable or telecom companies have taken the initiative, many communities reach out to nontraditional providers; and many have built their own systems – over 170 systems (including about 15 public-private partnerships) serving more than 200 cities and towns. There are also about a dozen FTTH networks built by Native American tribal authorities. Some community networks serve only businesses; most serve households as well.

There is growing interest in the newest model for FTTH deployment, public-private collaborations, in which both public and private entities take significant ownership stakes in a network.

FTTH IS THE ONLY UNLIMITED BROADBAND TECHNOLOGY

Remember that customers typically are served by networks that are already largely fiber-rich. Cable providers have historically used fiber to get close to homes and then coaxial cable for the last 100 to 2,000 feet. Many phone companies also bring fiber to within a few thousand feet of homes and use existing copper wire for the rest of the trip. Fourth-generation wireless broadband, which is widely deployed today, typically requires fiber connections at cell sites.

But the copper and wireless "last miles" to customer premises still have inherently limited capacity. Tweaking more bandwidth from them becomes increasingly difficult and expensive as time goes on. This isn't true of optical fiber, whose capacity is effectively unlimited.

The technologies for transmitting data over fiber are well understood, and the upgrade path for the electronic components that send and receive signals has been defined for years into the future. If anything, increasing fiber bandwidth will become less expensive rather than more expensive.

NO. 1
The amenity most desired in multifamily buildings is fast Internet.

At the Noblis Center for Applied High Performance Computing, Danville, Va.'s fiber network enables always-on videoconferencing.

90%
of seniors who own condos demand fast Internet.

THE PAYOFF

FTTH providers enjoy much greater revenue than traditional broadband providers. FTTH subscribers today often spend 30 to 40 percent more per month than DSL subscribers – not because basic services are more expensive (they aren't) but because more and better premium services are available.

For example, the new 4K TV and high-definition video communications are challenging to implement well over any medium but fiber, and 8K is already on the horizon. Taking pay-TV services on the road (true TV Everywhere) requires high upstream bandwidth at home. On average, FTTH offers three times the upstream bandwidth of its closest competitor. Home energy management services, home security and medical monitoring services all benefit from fiber's high reliability.

In general, access to utilities makes private property more valuable, and FTTH is among the utilities that owners and renters especially value. Fiber connections make single-family homes easier to sell and multiple dwelling units easier to rent – in fact, according to recent surveys of residents by RVA LLC and actual real estate prices by the FTTH Council, buyers of houses and condominiums are willing to pay a 3 percent premium for a fiber-connected home, and renters are willing to pay an 8 percent premium.

Renters and buyers both know they can get the most attractive services available on the market today – and that if an exciting new service is introduced in a few years, they'll be prepared for that as well. In addition, working from home – either as a telecommuting employee or a home-based entrepreneur – is far easier with FTTH than with other types of broadband connections.

FTTH communities have an advantage in attracting everything from advanced manufacturing to contact centers to data centers. They can nurture the tech startups and home-based businesses that will provide tomorrow's jobs. They can provide better education and health care for residents, deliver government services more efficiently and engage citizens in government.

This publication explores these issues, and more, in detail. It's written in nontechnical language so you can understand the value of next-generation infrastructure – and what it means to you – without a degree in optical engineering.

In these pages you'll see… *the advantages of fiber to the home.* ❖

42%
is the annual increase in Internet traffic – year after year, for decades.

9X
The new fiber lines that Verizon used to replace the copper that Hurricane Sandy destroyed in lower Manhattan are nine times as reliable as the average for all New York State, which includes both copper and fiber.

1000+
U.S. entities are deploying FTTH.

150+
U.S. communities have gigabit Internet speeds or higher available to some residents.

200+
U.S. localities offer FTTH to residents or businesses.

Fiber and Bandwidth

Q: What is bandwidth? And, by the way, what's a gigabit?

A: In a network, bandwidth (what engineers call bitrate) is the ability to carry information. The more bandwidth a network has, the more bits of information it can carry in a given amount of time. (Each "bit" is a 0 or a 1 – the smallest unit of information.) Networks with high bandwidth tend to be more reliable because fewer bottlenecks disturb the flow of information and because the information flows through the network in less time, reducing the chance a disturbance will happen during the trip. These days, many fiber networks are being designed to provide a gigabit (one billion bits) per second to users who need it. In fact, some 2 gigabit per second (2 Gbps) and 10 Gbps systems are deploying now. In a 1 Gbps network, a two-hour video can be downloaded in as little as 16 seconds, and the images will be perfect.

Q: How much bandwidth – or information delivered by bandwidth – do we need?

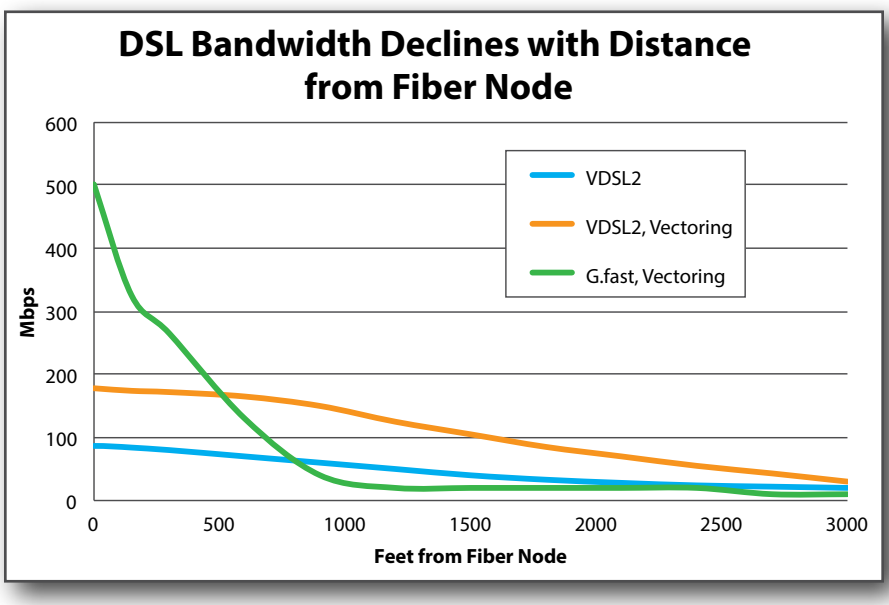
A: The amount of bandwidth we need grows every year. Worldwide Internet traffic roughly doubles every two years and has increased even faster lately because of smartphone use. The biggest growth has been for video – traditional pay TV, over-the-top or Internet-based video, and video communications. By the end of 2013, network equipment vendor Cisco noted that traffic had reached levels not expected until 2020 – seven years ahead of schedule.

Video requires not only extra bandwidth but also extra reliability. The smallest delay in data transmission can result in distorted views. More video is available than ever before, and people are watching video on more screens at once. In addition, video formats are becoming more bandwidth-intensive. HDTV can require 8 megabits per second (Mbps) or even more for fast action, such as in sporting events, with MPEG-4 compression technology. So-called 3D immersive HDTV – already used in some academic and industrial settings for telepresence – requires between 50 Mbps and 300 Mbps. 4K video, which has four times the pixels of today's best-quality HDTV broadcasts, requires 16 to 32 Mbps even with new HEVC compression technology, depending on how fast the screen action is and how much of the screen is taken up by fast-moving objects. Virtual-reality (VR) video is now becoming readily available, not just for movies but on Internet news sites. VR adds visual information to each frame, making possible multiple alternative views, and thus can vastly increase file sizes and bandwidth requirements.

Q: What about other kinds of data?

A: Bandwidth requirements for many kinds of data are exploding. For example, think about uploading photos to a cloud storage facility such as iCloud. Digital cameras can create larger and larger images; 30 megabytes is not uncommon. Amateur HD video cameras use about 10 gigabytes per hour of video – the equivalent of 300 of those 30 MB still images. Voice-activated searches on Siri, Google Search and Cortana take more bandwidth than text searches, and they require near-perfect transmission to be decoded by supercomputers at data centers (no, Siri doesn't live on your phone). When voice search becomes the norm, as it soon will, upstream bandwidth will be saturated quickly.

In health care, the medical images produced by equipment such as CT scanners are easily a hundred times larger than camera images. Business and science



The bandwidth of a DSL signal declines with distance from the fiber node. VDSL2+, the most advanced form of DSL in general use, can deliver about 30 Mbps download speed at 3,000 feet, depending on the quality of the copper. Vectoring and bonding (combining the VDSL signals among multiple copper wires) can increase the speed. G.fast, a new technology, can reach 500 Mbps for 100 feet when copper is high quality, dropping to 325 Mbps download speed and 325 Mbps upload at 150 feet. VDSL has very poor upload speeds (typically a fifth of download speed), but G.fast achieves symmetrical speeds by adding a sophisticated transmitter at the customer end.

Fiber: The Light Fantastic

The equipment used to send light signals over glass fiber keeps getting better.

have both entered the era of big-data applications that collect and analyze data on massive scales. Today's big-data applications range from consumer pricing models to DNA sequencing to particle physics to control of electrical grids. Big data doesn't work without big bandwidth. A DNA sequencer produces enough data to monopolize a 3 Gbps connection.

Q: Can't copper carry high bandwidth?

A: Copper's capacity is far less than fiber's. It can support high bandwidth for only a few hundred yards. The longer a signal travels on copper, the lower the bandwidth. That's true for even the newest copper-based technologies such as G.fast and vectored/bonded VDSL. G.fast starts out with more bandwidth over very short distances, but older technologies such as DSL catch up within 1,000 feet.

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 60 kilometers (36 miles) without degrading enough to keep it from being received. The international minimum standard is 20 kilometers (12 miles). Fiber is also far better able to support upstream bandwidth – that is, from a user to the network.

285
undersea fiber cables tie the world together – double the 2012 total

Fiber optic cable is made up of hair-thin (or thinner) strands of glass that carry information by transmitting pulses of light, which are usually created by lasers. (Copper cable, by contrast, carries low-voltage electrical signals.) The pulses are turned on and off very, very quickly. A single fiber can carry multiple streams of information at the same time over different wavelengths, or colors, of light. Fiber has many advantages over copper wire or coaxial cable.

1 **Great for rural areas.** Signals travel long distances inside fiber cable without degradation – 35 miles or more in some real-world networks and 65 miles or more in the laboratory.

2 **Easy to deploy.** Fiber cable is thin and flexible. An individual fiber can be thinner than a human hair. Thin fibers can be packaged in a cable or a narrow ribbon or inside a hollow plastic microduct less than 1/8 inch in diameter. Fiber cable can be hidden easily on the surfaces of walls in old buildings. There are even hair-thin fiber products that can be attached to walls with adhesive and painted over.

3 **Future-proof.** Once installed, fiber is upgraded by changing the electronics that create and receive the light pulses, not by replacing the cable itself.

4 **Rugged and weatherproof.** Fiber cable has a longer life than copper because it does not corrode, is not easily affected by water and generates no heat. Lightning doesn't damage it. Nothing hurts it except a physical cut or the destruction of the building it is in.

5 **Low-cost and high-environmental-benefit.** Fiber networks cost less to operate than copper. The most common FTTH network technology, GPON, uses no electronics – and therefore no power – between the provider's central office and the customer premises, which minimizes operating costs. Even optical networks that require electronics in the field use far less power than copper networks do. Glass is easily made from sand, an abundant resource.

6 **Reliable.** Fiber is far more reliable than copper. Surveys by market researcher Michael Render of RVA LLC show that a typical DSL modem has to be reset by a user about once a week. For fiber, it is once a month or less. This is critical for telemedicine and for distance learning, but it is also important for businesses. We have all sought to pay for an item by credit card only to find that the card reader is not working. This is usually because the DSL or cable modem connection has been lost. A few lost sales per month can cost a retailer more than the monthly fee for the connection!

Fiber and Bandwidth

In a properly designed fiber network, users will always get the speeds that are advertised – or better.

Q: What's the difference between upstream and downstream bandwidth, and why is it important?

A: In the debate about FTTH versus copper-based broadband, people tend to argue in terms of downstream bandwidth because most users have needed more downstream bandwidth than upstream – especially for bringing video entertainment into their homes. But emerging consumer uses such as voice-activated search and dictation, home video uploads, cloud storage, distance learning, video communication and telemedicine may require as much upstream bandwidth as downstream. Small businesses, often home-based, may need upstream bandwidth as well – consider a wedding photographer sending proofs by email to clients. Businesses now often copy all their working data files to a remote computer center for safekeeping.

Q: What about wireless? I hear 4G wireless can provide 54 Mbps. In Singapore, there's a wireless carrier boasting 300 Mbps!

A: That's the potential bandwidth shared by all users connected to a cellular antenna. A wireless user might get high speeds for a moment or two if no one else is around, but average wireless speeds, even for 4G, are similar to those for DSL. Wireless broadband depends on fiber to move information to and from cell towers. Even so, each antenna can support only a finite number of cellular signals. Cellular data traffic grew 300-fold from 2006 to 2013 and will grow another sixfold by 2017.

Providers severely limit wireless data, encouraging or forcing customers to use Wi-Fi connections instead of cellular networks for data. Those Wi-Fi connections, in turn, work best when they can quickly offload data to a fiber network. A typical cellular data plan allows 3 to 5 gigabytes per month. Use your phone to view video, and you quickly run over the limit. Over a gigabit fiber line, 5 gigabytes would take just 40 to 50 seconds to download! So a typical phone's monthly data limit is 1 minute peak usage on an FTTH connection.

On the other hand, point-to-point wireless links, typically using so-called "millimeter wave" antennas, can be very useful to extend a fiber network to serve a specific neighborhood or building. That kind of wireless is not cellular. Each user gets much of the total bandwidth potential of the transmission link. Once bandwidth needs require an upgrade to fiber, the wireless link can often remain in place as a backup.

Q: What exactly makes fiber "future proof"?

A: The equipment used to send light signals over optical fiber keeps getting better. So equipping an existing fiber network with new software and electronics, and with lasers that pulse light faster, or lasers that use different wavelengths of light, can vastly increase available bandwidth without changing the fiber itself.

New electronics are very cheap compared with the

3.4X
Growth of busy-hour Internet traffic from 2014 to 2019

64X
Growth of global Internet traffic from 2005 to 2019

2.8X
Growth of all Internet traffic from 2014 to 2019

The FCC published data in June 2014 showing that, on average, fiber-to-the-home services delivered 113 percent of their advertised speeds.

Is It Really Fiber To the Home?

When service providers advertise "fiber rich," "fiber deep" and "fiber optic" networks, how do you know whether you're really getting fiber to the home? In 2006, the FTTH Councils for Europe, Asia and North America standardized the definitions for fiber to the home and fiber to the building (also called fiber to the basement). They are as follows:

FIBER TO THE HOME (FTTH) A fiber optic communications path that extends from an operator's switching equipment to at least the **boundary of a home living space or business office space**. The definition excludes architectures in which the optical fiber terminates before reaching either a home living space or business office space, with the access path continuing over a physical medium other than optical fiber. Also called fiber to the premises (FTTP).

FIBER TO THE BUILDING (FTTB) A fiber optic communications path that extends from an operator's switching equipment to at least the **boundary of a private property that encloses homes or businesses**. The optical fiber terminates in the basement or, in larger buildings, in a closet on each floor, but not in home living spaces or business office spaces. The access path then continues over another access medium, such as copper or wireless, to subscribers. Only FTTH is truly unlimited, but FTTB can provide as much capacity as most households and small businesses can use today. Also called fiber to the basement. Often used in multiple-dwelling-unit buildings.

SOME "FIBER" NETWORKS ARE NOT FIBER TO THE HOME

Other network architectures, such as FTTN, FTTC, FTTdp and HFC, do not fit the FTTH Councils' definitions. Their capacity depends on how far users are from nodes and on the number of users on each node.

FIBER TO THE NODE OR FIBER TO THE NEIGHBORHOOD (FTTN) In an FTTN network, fiber is extended to a street cabinet or an on-pole cabinet an average of 1,000 to 5,000 feet from users. From there, copper, or occasionally wireless, serves users, typically through a variant of DSL.

FIBER TO THE CURB OR FIBER TO THE CABINET (FTTC) FTTC is similar to FTTN except that the fiber is brought closer to user premises – typically closer than 1,000 feet and often closer than 300 feet. Service continues over copper (rarely wireless), using a DSL variant or Ethernet. G.fast, a newer DSL technology that also uses copper, is also employed, usually when the gap between the user and where the fiber ends is less than 300 feet.

FIBER TO THE DISTRIBUTION POINT (FTTdp) In this emerging architecture, fiber is brought very close to a home – sometimes right outside, or even in the basement of an apartment building – and the fiber termination unit (a GPON ONT) is integrated with a DSL modem in a small enclosure (the distribution point). Signals are carried using one of the newer variants of DSL – VDSL2 or G.fast – to anywhere from one to 16 subscribers. Distribution points generally take their electric power from the customer premises.

HYBRID FIBER-COAX (HFC) This architecture is used mainly by cable TV companies and is also common in community broadband networks built before 2004. In a typical HFC system, fiber runs to a node in each neighborhood, and coaxial cable running from the node serves between 100 and 500 users. However, just because a cable company is still called a cable company doesn't mean it can't use fiber to the home! Cable companies are increasingly deploying all-fiber networks for new construction, using any of several methods to integrate their FTTH and HFC networks. A new version of DOCSIS (Data Over Cable Service Interface Specification), the technology that cable companies use to manage their broadband networks, both enables higher speeds over HFC networks and makes it easier to integrate FTTH with HFC networks.

original cost of laying the fiber. At the customer end, the system can be designed so that customers themselves can simply pull an old unit out and plug a new one in. Therefore, once fiber has been deployed, network operators can keep increasing bandwidth as needed at very little cost.

Q: How long has fiber optic technology been in use?

A: Fiber optic cable is the foundation of the world's telecommunications system. It has been used for more than 30 years to carry communications traffic from city to city and from country to country. Almost every country has some fiber optic cable, delivering services reliably and inexpensively. The first time fiber delivered a signal directly to a home (in Hunter's Creek, Fla.) was nearly 30 years ago.

Fiber and Bandwidth

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 FTTN (DSL) networks use fiber. In these networks, the fiber carries the signal close enough to homes so that copper can carry it the rest of the way. However, this approach requires expensive, difficult-to-maintain electronics at the point where fiber meets copper. These electronic devices use a great deal of power and are quite sensitive to lightning strikes. Even the cost of bringing electric power to them can be huge, depending on where they are located. The available bandwidth is far less than in an all-fiber network. And most of these halfway approaches do not allow symmetrical bandwidth – cable and DSL systems generally can't upload information as fast as they can download it.

Q: Isn't a network with some fiber good enough?

A: It may be fine to send emails, download songs or share family photos. If you want to log on to the corporate LAN from home and work effectively, or run a home-based business, you'll need more. If multiple people in your household are using the Internet at the same time, you'll need more. And what about uploading a high-def video of your child's football game, or sitting down to dinner virtually with family members a thousand miles away?

Q: Why does it matter how close to the home fiber comes?

A: With copper cable, bandwidth drops precipitously with distance. Vectored DSL allows 50 Mbps downstream for as far as 1,800 feet under ideal conditions, though it won't work on very old copper wiring, its upstream bandwidth is limited and it requires expensive electronics. However, it is touted as an interim solution for network builders that cannot afford FTTH. A new technology, G.fast, under ideal conditions and with vectoring (crosstalk cancellation) and bonding (simultaneous use of more than one pair of copper wires), can provide 500 Mbps symmetrical bandwidth up to 300 feet from a fiber node. G.fast may prove to be an excellent solution for retrofitting apartment buildings with fiber to the basement (as long as those buildings already have good internal copper wiring), but it requires bringing fiber very close to customer premises and is still limited in comparison with true fiber to the home.

Q: With cable and DSL, there's often a gap between advertised and actual bandwidth. Is that true for fiber?

A: No. Cable, DSL and even wireless networks are usually heavily oversubscribed – that is, providers promise users more than the total amount of available bandwidth because they know not all users are going full throttle most of the time. As a result, networks slow down during periods of heavy use, such as when teenagers come home from school. Copper networks are also more subject to speed degradation due to the condition of the wiring. Fiber has enough bandwidth and reliability that providers can guarantee high speeds with little or no oversubscription. If a fiber network is designed properly, users will always get the speeds that are advertised – or better. Data published by the FCC in June 2014 showed that, on average, fiber-to-the-home services delivered 113 percent of their advertised speeds.

44%
of students get all their video over the Internet.

Q: My cable company says it can deliver fiber all the way to my home. Is this possible?

A: Yes, using any of several methods, including a new technology called DOCSIS 3.1. That technology can indeed handle FTTH, although FTTB systems are more common. In addition, cable companies have seen fiber's light. They are installing new electronics to bring more bandwidth to existing DOCSIS nodes – the spots where the fiber signal is normally converted to travel over "coax," short for copper (or aluminum) coaxial cable. In addition, the DOCSIS nodes can be split, so that each node handles as few as 20 or 30 homes, instead of the old industry standard of 500. Cable companies are beginning to offer reliable 2 Gbps download speeds in some locations. But customers have to know exactly what flavor of DOCSIS 3.1 they are getting, to be sure it is FTTH or FTTB.

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 a new network – that is, with making minor tweaks to an existing copper network. The problem is that these less-expensive solutions don't meet users' needs. In the last few years, the flood of video content has outrun the ability of older copper technologies to handle bandwidth demands. In many parts of the world, providers shut off or slow down service or impose prohibitive fees for customers who exceed monthly data caps. Customers don't like these restrictions, and they don't appreciate being called "bandwidth hogs" for using services they have paid for.

In addition, it's not clear that providers save money by failing to meet users' needs because limiting bandwidth means limiting revenue potential as well. ❖

Telehealth and FTTH

Fiber has long been the technology of choice for in-hospital networks and for the consultations between local clinics and off-site specialists that improve the standard of health care outside major metropolitan areas. Today, telehealth is even making its way into homes and offices. Reliable, high-speed Internet connections, combined with secure videoconferencing systems and networked health-monitoring devices, allow patients to receive health care services from home or from the workplace.

Until recently, regulatory and insurance restrictions limited the opportunities for such home-based telehealth. But use is now expanding, in part because reliable fiber broadband is more available and in part because of new products aimed at the young and the well-off. Currently, 29 states and the District of Columbia require that private insurers cover telehealth the same way they cover in-person services. Medicare covers some costs in areas (especially rural) that don't have easy access to caregivers, and Medicaid coverage varies by state, even where private insurers must offer coverage.

HOME-BASED CARE

Following are some examples of how telehealth is being used:

The Cleveland Clinic, one of the leading U.S. health care providers, now operates a nationwide virtual urgent-care clinic called MyCare Online. A patient can call in from any smartphone, tablet or computer and have a secure video call with a clinician, with or without an appointment. In most patients' states, the clinician can provide a prescription if appropriate.

Thomas Jefferson University and Health System in Philadelphia has invested more than $20 million in telehealth. Its virtual emergency room, JeffConnect, connects patients with doctors 24 hours a day to deliver care and consultation by videoconferencing through phone, tablet or computer. The technology comes from American Well, a Boston telemedicine company the hospital invested in. In addition to emergency care, JeffConnect offers remote second-opinion consultations from specialists. Another use of JeffConnect is for family members of a hospitalized patient to attend hospital rounds remotely and confer with the patient's doctor.

The Centerstone Research Institute, a behavioral health provider headquartered in Nashville, runs a telehealth program, Coaction Health, for health care "superutilizers." Coaction Health provides broadband connections and intensive broadband-based monitoring for clients whose multiple physical and mental health problems make them very expensive to treat. Clinicians conduct daily assessments of each client, and sensors in clients' homes alert clinicians to the need for additional interventions (for example, if a client has not gotten out of bed). By reducing unnecessary hospital visits and by getting clients to the hospital in a timely fashion when they are in need of care, the program greatly reduces the costs of their care.

NewCourtland, a senior services provider in Philadelphia, has been operating its LIFE telehealth program, modeled on the Medicare/Medicaid Program of All-Inclusive Care for the Elderly (PACE) initiative, since 2007. The company has about 2,000 beds available. PACE serves individuals age 55 or older who are certified to need nursing home care, are able to live safely in the community with supportive services and reside in a PACE service area.

In the LIFE program, remote monitoring helps substitute a $125 per month technology cost per person for $225-plus per day (usually more) in nursing home costs. By employing remote monitoring over broadband, NewCourtland's pilot project enabled 33 residents to move safely from traditional nursing home care to less restrictive environments, realizing an annual savings of more than $1.8 million.

2M

Robotic surgeries could be performed each year with reliable broadband

Fiber providers, whose networks rarely suffer outages, have a huge advantage over DSL or cable providers in supporting programs like this one. By mid-2015, 32 states had received Medicare and Medicaid waivers to operate PACE programs.

Remote monitoring also promises to reduce the cost of treating patients who have chronic diseases. A U.S. Department of Veterans Affairs review of its home telehealth program found a 25 percent reduction in the average number of days hospitalized and a 19 percent reduction in hospitalizations for patients using home telehealth.

For some patients, the cost of telehealth services in their homes averaged $1,600 a year – much lower than in-home clinician care costs.

Several innovative telehealth applications are being developed and tested in gigabit communities today under the aegis of the US Ignite program. Some of these include video-based support for caregivers of dementia patients, a solution for home-based psychological counseling and 3D video interaction for physical therapy.

The future of telehealth looks even better as even active young adults get used to monitoring their waking and sleeping hours with sensors on smart watches tethered to home Wi-Fi. Large computing firms, most notably Apple and IBM with its Watson supercomputer technology, are on the verge of rolling out services to monitor and interpret such data automatically for physicians who care for those with chronic medical problems. ❖

Why We'll Always Need More Bandwidth

In a century of telephone communications, the bandwidth on voice channels changed very little. Today, however, Internet bandwidth needs are growing exponentially. Cisco Systems estimates that global Internet traffic in 2019 will be equivalent to 64 times the volume of the entire global Internet in 2005. Globally, annual Internet traffic will reach 18 gigabytes per capita by 2019, up from 6 gigabytes per capita in 2014.

To put that another way, global Internet traffic increased more than fivefold in the past five years and will increase at least threefold over the next five years, Cisco predicts. On the Internet, bandwidth drives innovation, and innovation drives bandwidth demand.

Sure, increased bandwidth lets us send email faster, but bandwidth's real value is that it lets us do entirely new things. In the past decade, Internet video evolved from a novelty to the standard way of accessing news, information and entertainment. New Internet-connected devices have emerged – always-on smartphones and tablets that keep us connected with the world full time, smart TVs (and TV-connected devices such as Roku boxes and Chromecasts), home security devices and thermostats that broadcast alerts and video images to our phones, smart watches, and fitness trackers that save our workout information in the cloud. Phones and computers magically respond to voice commands, aided by Internet connections to supercomputers.

Who had heard of the "cloud" a few years ago? Today, consumers and businesses store data, run programs and even access computing power "in the cloud." Most new computers, tablets and smartphones come with a free cloud service, above and beyond what Apple (iCloud) and Microsoft (OneDrive) provide free. It is little wonder that about 1 billion people have access to the cloud now. The default storage location setting in the most recent version of Microsoft Office is OneDrive, not your own PC. Most users no longer know or care exactly where their files are located or their programs are running – that's what makes it a cloud. All they need is fast, reliable Internet access.

> Hundreds of millions of consumers store their data files in the "cloud," using services such as Apple iCloud, Microsoft OneDrive, Google Drive and Dropbox.

Families stay in touch via social media and video calls – Facebook, Skype and Twitter have become household words. Businesses use 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 participate via their home TVs.

Today, people visit doctors from home or work, saving a trip to the doctor's office or emergency room if they don't need to be seen in person. (Home

Photo courtesy of UC2B

Fiber ambassadors sign up their neighbors for a new FTTH network.

18 GIGABYTES

Traffic globally, per capita, by 2019, up from 6 GB per capita in 2014

3X

The number of devices connected to IP networks per person, globally, in 2019

1.0 PETABITS PER SECOND

Busy-hour traffic forecast for 2018, the equivalent of 335 million people streaming HD video continuously

telehealth is a great way to reduce hospital readmissions.) A **Broadband Communities** editor recently participated in a video conference between a relative, her in-home physical therapist, and cardiologists at two different hospitals. The physical therapist used a mobile app to live stream the physical therapy session.

Taking classes from home or dormitory has become routine for many. MOOCs, or massive open online courses, give anyone and everyone a taste of what the country's leading universities have to offer. The most popular MOOC platform, Coursera, boasts 16 million users and more than 20 million course enrollments. Among the special programs available at Coursera are outreach to veterans and translation of course materials and interactions for students around the globe.

Telecommuting and home-based businesses are on the rise, too. A quarter of all owners of home-based businesses say they could not operate without fiber to the home, and telecommuters say their employers would be less likely to let them work from home without fast, reliable fiber broadband. There appears to be a pent-up demand for working from home at least part-time – in a recent survey of federal employees, 93 percent said they valued the option to telecommute.

There is 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 vastly superior upstream capacity, will be able to keep delivering the goods.

Here are a few of the new applications emerging today:

- Ultra high-definition video with four times the pixels of conventional HD, creating massive bandwidth requirements. (With the new home video cameras that can shoot in 4K HD format, the demand will be as great for upstream bandwidth as for downstream.)
- Seamless audio control and voice recognition capability for all digital devices – the devices get their smarts from remote computing centers.
- E-jamming and rehearsal applications for musicians and music teachers, requiring perfect synching of multiple remote audio streams.
- Remote operation of complex equipment, such as medical robots, electron microscopes, radio telescopes and even nuclear power plants.
- Interactive classes in which students not only watch their professors but also participate in real-time, video-based discussions.
- Videos and games created in virtual-reality formats, including 3D virtual reality. ❖

FTTH for Communities

By the end of 2015, the number of public and public-private fiber networks in the U.S. reached about 175 – and many of these serve multiple communities. Many communities are expanding the networks they started building in earlier years, and are upgrading them to offer gigabit-speed service.

In 2012, Google Fiber launched gigabit Internet service in Kansas City, Kan., and Kansas City, Mo. – locations it chose in large part because the city governments were willing to collaborate with it. In 2013 it expanded to Austin, Texas, and acquired the municipal FTTH network in Provo, Utah; now it is building out networks in six more cities and negotiating with several others.

All this activity has made municipal officials keenly aware of the potential for using ultra-broadband to promote economic development and enhance the quality of life in their communities – and more aware that they need to take proactive roles in getting better broadband for their communities.

More municipalities than ever before are exploring the possibility of building their own networks. In addition, they are looking for new ways to encourage private providers to build FTTH networks, new partnership arrangements with telecom providers and new ways to leverage such municipal assets as conduit, utility poles and existing fiber.

Questions Municipal Officials Ask About FTTH

Q: How will a fiber network help our local economy?

A: There's growing evidence that fiber connectivity encourages businesses to stay, helps businesses grow and become more productive, and attracts new businesses, particularly in high-tech industries. FTTH supports home-based startup businesses and helps workers telecommute. It makes a community a more attractive place to live – especially for young people – which can stem the population loss that many small communities experience. If inadequate health care resources hamper economic growth, fiber connections permit local health care providers to call upon specialists in regional health centers. And if an unprepared workforce is a hindrance to business expansion, fiber connectivity can enable cost-effective distance learning.

FTTH is only one component of an overall economic development strategy – but it's a vitally important one.

Q: Will *not* having a broadband network hurt my community?

A: Yes. Award-winning research conducted by **Broadband Communities** found that, on average, counties with little or no broadband access had almost no population growth in 2014 and 2015. In fact, most such counties have lost population since 2010. These years are first extended period in U.S. history during which a majority of rural counties lost population.

Restricting municipalities from building their own broadband networks appears to harm local economies. Broadband-starved counties in the 20 states that restrict municipally owned broadband were even more likely to lose population than similar counties in the 30 states that have no such restrictions, despite the fact that the "restriction" states grew faster than average overall.

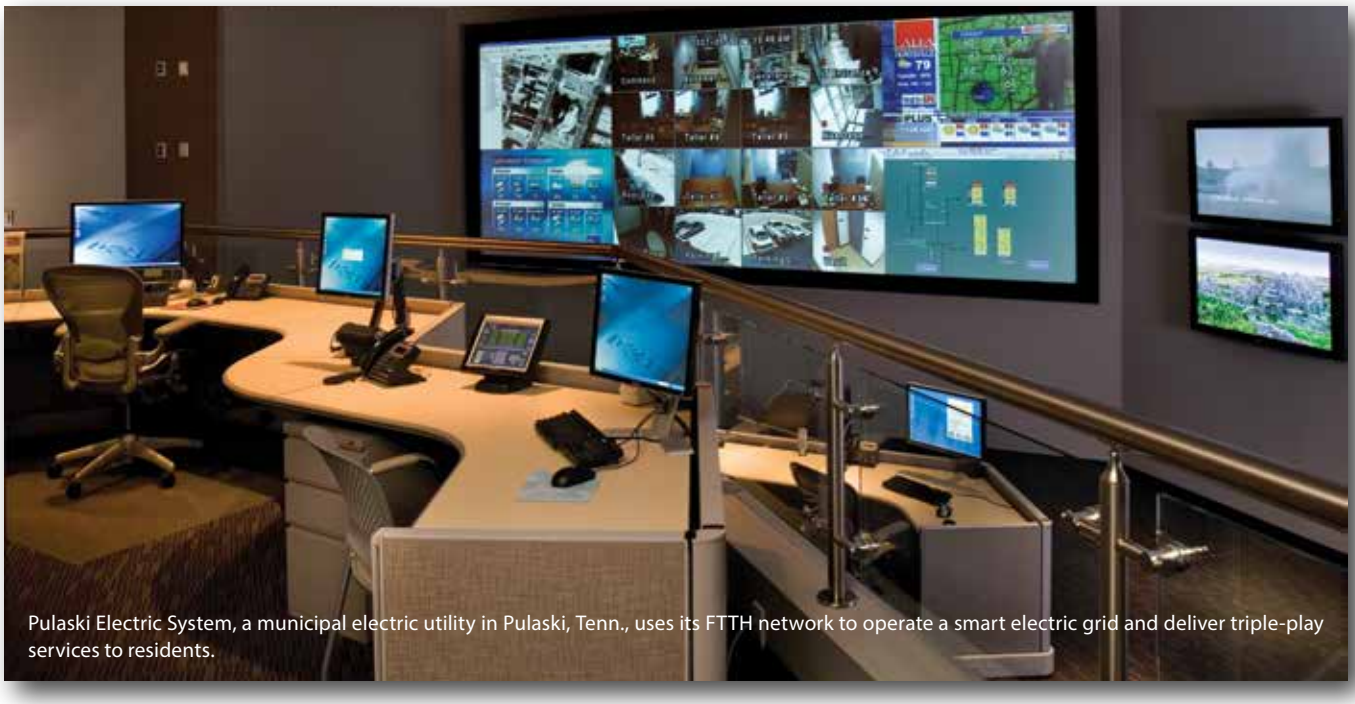
Q: How can I get fiber to my residents without building my own network? My town has too much debt now to borrow more, and we have no experience operating a municipal utility.

A: Lobby the incumbents – the cable and telephone companies that serve your town now. Lobby competitive providers or even local businesses that need more bandwidth and have the capability to undertake such a project. Offer such incentives as reduced franchise fees, access to public property or an accelerated permitting process.

If you own an institutional fiber ring, perhaps one that connects municipal buildings, schools and libraries, or if your traffic lights are connected by fiber, you might be able to propose fiber swaps to a potential provider. Take a fiber inventory to find out whether there is abandoned or unused fiber in your town that might either revert to the locality or be donated in exchange for a tax exemption.

Educate residents about the value of FTTH, and encourage them to commit to taking fiber services if and when a provider offers them. Start a community fiber campaign online so you can document the extent of subscriber interest in fiber broadband.

Alternatively, enter into a partnership to build a fiber network jointly with a private partner. In Europe, such



Pulaski Electric System, a municipal electric utility in Pulaski, Tenn., uses its FTTH network to operate a smart electric grid and deliver triple-play services to residents.

partnerships are common, and this approach is gaining traction in the United States. A variety of arrangements between the public and private parties are used, depending on legal requirements and on each party's assets and capabilities.

Complete the Google Fiber city checklist to provide information about existing infrastructure, help ensure access to existing infrastructure and help make construction speedy and predictable. Then use that information to issue a request for information, a request for proposals or another formal document that outlines your community's goals for expanding broadband access and invites service providers to propose how they might meet those goals.

Q: Would it be better – and cheaper – to put in a community wireless network?

A: Wireless services are important public amenities, but they are not substitutes or replacements for FTTH. Rather, they complement and extend existing fixed fiber networks. Many wireless access points and cell sites are already fiber-connected, and most of them will be soon. Wireless service can thus be considered an application on a fiber network rather than a separate type of network.

Wireless access alone cannot attract new businesses to a community or enable businesses to grow. Wireless networks that cover wide areas are not reliable enough to deliver video and other emerging broadband services with high quality of service. Wi-Fi is highly desirable in targeted areas such as commercial shopping streets and common areas, but no one has developed a compelling business case for a municipalitywide Wi-Fi network.

Q: Don't all wired broadband networks use fiber?

A: They use fiber, but not all the way to the home. Generally, the last 1,000 to 5,000 feet from the fiber's endpoint to the home is copper – coaxial cable in cable networks, plain copper wire in telephone networks. That limits bandwidth, reliability and versatility.

Q: How do I know whether my community is underserved?

A: If you can't get corporate site selection committees to look at vacant commercial properties, or if your residents have trouble selling homes due to their poor Internet connections, your community is underserved.

Without a fiber network, your community is underserved – or it will be very soon. Even with upgrades, your non-fiber network won't be able to handle the ever-increasing bandwidth demands placed on it. Be sure to consider the needs of the business community in addition to those of residents – many economic development officials believe that affordable, symmetrical 1 Gbps access is needed to lure new businesses to a town and eventually to keep existing ones from leaving.

Q: The telephone company that operates here is installing FTTH in the new development just 10 miles up the road. Why not here?

A: Installing fiber in new developments is usually easier than installing it in existing neighborhoods. The fiber can go into the same trenches that have to be dug anyway for water, electricity and sewer service. In fact, copper wiring usually can't be run that way, so fiber is usually cheaper. Also, the new residents have not yet subscribed to cable or phone service, so whoever installs an FTTH network in a new community has an easier time signing up customers. That's why most new, large housing developments are being equipped with fiber.

Q: Would installing fiber require that my streets be dug up?

A: It depends. Many network builders in North America use aerial fiber installed on poles along with existing telephone, electric and cable wiring. Where trenching is impractical, contractors can often use horizontal drilling or pull fiber through existing ducts, water pipes, sewers and gas lines rather than dig up streets and sidewalks.

When there is no good, cost-effective alternative to trenching, new microtrenching techniques allow fiber to be laid with less disruption to traffic. In microtrenching, a deep groove is cut quickly into the pavement or road with a large circular saw on wheels, and fiber is laid into the groove. Finally, many cities already have usable fiber under their streets – fiber that is not being used to its limit or that has been abandoned altogether.

Q: What can I do to make installing FTTH less expensive?

A: Start preparing for fiber now by adding underground ducts whenever you or a utility repair a street or open it to excavation. You can also adopt an "open trench" policy that gives telecom providers the opportunity to install ducts any time a street is opened. When it comes time for the city or a private provider to install fiber, the cost will be much lower if the fiber can simply be blown or pulled through ducts.

Q: Is it better for the same company to run the network and provide services, or should we consider an open-access network with multiple providers?

A: Both methods have been successful. Open-access networks, in which the public or private network builder "rents" bandwidth to a potentially unlimited number of service and content providers, are more common in Europe and Asia than in the United States. However, they have succeeded here as well and offer an alternative for municipalities that either are legally restricted from selling retail services or simply do not want to be in that business.

Eventually, as broadband services multiply, there may be too many services for any single provider to be able to handle. At that point, just as mobile platforms have been opened to app developers, both public and private network operators may find they need to allow multiple service providers on their networks.

Today, however, municipal utilities sometimes prefer to provide services directly, at least at the outset, for two reasons: First, being the service provider gives them more control over the quality of user experience; second, they may have difficulty attracting third-party providers to new networks.

The downside of a closed network is less variety in content and services. Many public broadband advocates believe that opening networks to innovative service providers is the best way to maximize the networks' value for their communities. Networks built with broadband stimulus funds are required to allow open access.

Q: Both direct service delivery and open access seem to have advantages. Why not do both?

A: Some network operators, especially smaller ones, are doing just that. Networks built with funds from the 2009 stimulus program must offer access to third-party providers. In some cases, network owners have developed infrastructure-sharing arrangements. Others use local data centers as "managed service providers" that package outside content for local carriers. Another possibility is for a network operator to provide voice, video and data and allow third parties to add services such as backup or home security. This is the same arrangement that cellular phone providers use. The cell phone company provides voice, video and data. Users then customize their smartphones with third-party apps. ❖

Danville, Va .'s use of its own utility poles for the nDanville network saved the city time and money.

Gigabit (And More) To the Home

A gigabit (1 Gbps, or 1,000 Mbps) is about 100 times higher than the average downstream Internet speed in the United States and many times higher than the average upstream Internet speed. However, it will soon be the standard for both downstream and upstream bandwidth. Only fiber to the home (or fiber to the building, with excellent inside wiring) can support symmetrical gigabit speeds consistently to multiple users.

Google Fiber made "gigabit" a household word, but it was hardly the first to offer these speeds. Many providers now offer gigabit – or even 10 gig – speeds to businesses. Among residential providers, EPB Fiber Optics (the municipally owned network in Chattanooga, Tenn.) was the first to offer 1 Gbps access throughout a large service area. Other network operators, both public and private, quickly followed suit. By mid-2015, residential gigabit speeds were available from local providers in parts of about 150 communities, a number that is expected to double and redouble by the end of 2016. Large companies such as AT&T, CenturyLink and Cox have begun offering gigabit FTTH service in selected locations, and Comcast is offering 2 Gbps FTTH service in some locations.

The first residential 10 Gbps deployment was announced in late 2014 by US Internet, an ISP in Minnesota. Several others followed during 2015, including EPB Fiber Optics, Fibrant (the municipal utility in Salisbury, N.C.) and Rocket Fiber, a new ISP in Detroit. Residential 10 Gbps service is still well beyond the "affordable" range, but some users have already adopted it for home-based business use.

WHAT WILL YOU DO WITH A GIG (OR 10 GIG)?

A survey by Telecom Thinktank and RVA LLC found (not surprisingly) that 1 Gbps subscribers are heavy Internet users – or even members of households with several heavy Internet users. They are online an average of eight hours per day, compared with the overall average of 2.5 hours, and they have many networked devices. Some may be streaming movies and chatting on Facebook while participating in multiple online games through multiple consoles.

In addition, many are content creators. Traffic measurements by Hong Kong Broadband, which provides 1 Gbps service in Hong Kong, show its gigabit subscribers use three times more upload bandwidth than download bandwidth. Upload speed is critical for distributing HD photos and videos, backing up files, cloud computing and virtual-presence videoconferencing.

Finally, superfast connectivity also appeals to work-at-home professionals who need low latency and rapid file transfers.

Broadband Communities' interviews with gigabit users suggest that these speeds are especially useful for telecommuters who need to work without interruption while other household members watch videos or engage in other recreational uses.

And a reporter for Macworld recently wrote that, with gigabit access, he no longer had to consider Internet throughput as a factor, and his "local network has just been extended to be the whole world."

NEW APPLICATIONS

Soon, gigabit speeds will enable entirely new applications. US Ignite, a nonprofit coalition of industry, academic and government partners, is promoting the development of new applications in health care, education, workforce development, energy, advanced manufacturing and public safety, and many of these are now reaching the stage of commercialization.

Cities across the United States are holding "hackathons" – events in which software developers collaborate intensively over a weekend or other short period – to encourage the development of high-bandwidth applications.

In just a few years, gigabit applications may revolutionize the delivery of government services, health services, education and more. ❖

Broadband for Education

When Google Fiber announced it was coming to Kansas City to build its first citywide gigabit network, the reaction was frequently: Who could possibly need that much bandwidth? Today, parents and educators would probably agree with Joe Fives, director of technology for the Kansas City, Kan., public schools: "It almost seems like you can't have enough."

Connected schools offer students the opportunity to take interactive field trips to museums and historical sites, study specialized subjects with teachers at other schools, and watch activities ranging from neurosurgery to Himalayan expeditions in real time.

School districts with superior broadband capabilities use "flipped classrooms," in which teachers record lessons as videos on YouTube or similar sites and students study the lessons at home. In school, students solve problems based on the previous night's lesson and get individual help from teachers.

Can communities afford *not* to assure high-capacity broadband for their students? U.S. communities spend $634 billion a year educating the 55 million K–12 students. Yet these students rank 35th in math, 23rd in reading, 27th in science and 16th in technological readiness compared with students in other developed nations. High-speed broadband is one key to closing the gap – and getting a better return on taxpayers' investment.

> Students need good broadband at home as well as in the classroom so they can use Internet-based resources for homework.

Today's fiber-connected schools demonstrate how broadband enhances students' educational opportunities. Though most schools now have Internet access, adequate school broadband is still a work in progress. But over the next few years, fiber-connected schools should become more common, thanks to the federal government's ConnectED initiative. One big issue that is taking longer to solve: ensuring that all students have access to broadband after they leave the school building for home. Fortunately, marketing surveys show that families with K–12 children at home are more likely than any other demographic to buy broadband services. Still, not all homes have broadband available, and not all parents can afford broadband connections.

Here are a few of the many districts that have solved the problem.

Photo courtesy of Belen Jesuit Preparatory School

Students at Belen Jesuit Preparatory School in Miami began using iPads in the classroom during the 2011-12 school year. In this picture, sixth-grade students use iPads during a Spanish class taught by Alicia Fariñas.

NORTH GEORGIA NETWORK

North Georgia Network Cooperative (NGN), a regional fiber provider, supplies dedicated gigabit Internet connectivity to area schools. High schoolers connect to labs, teachers and courses that are available in other districts but not in theirs. Preschoolers at the Little School in Clarkesville, Ga., recently watched a puppet show staged 80 miles away – too far for a "field trip" – as it was streamed into their classroom. When it was over, they participated in a live Q&A with the puppeteer.

"This is just one example of how our technology is giving children amazing learning opportunities," said Michael Foor, VP of marketing at NGN. "We are constantly on the lookout for new and exciting ways for students to benefit, and we're very excited for the future of this technology."

OWSLEY COUNTY SCHOOL DISTRICT

For the Owsley County School District in eastern Kentucky, the mission is "to create an innovative learning environment that breaks down all barriers to student learning and prepares *all* students for college, career and the 21st-century world."

It's a big goal for one of the poorest counties in the nation: Median family income is less than $20,000 in the small rural school district, 41 percent of adults lack high school diplomas and nearly 90 percent of the 740 students qualify for free or reduced-price meals.

But Owsley *is* rich in broadband. Almost all students have gigabit-certified fiber Internet access, both at school and at home, thanks to People's Rural Telephone Cooperative (PRTC), the district's local telephone company. Superintendent Dr. Tim Bobrowski said that PRTC has donated service in some cases and that the district tries to help students with surplus equipment if they don't have their own home computers.

Academically, the results have been startling. Three years ago, 8 percent of Owsley County graduates were recognized as being college- or career-ready. For the class of 2015, it was 83.3 percent.

Students take courses online that are not available locally, and sophomores, juniors and seniors are offered dual-credit courses at several local colleges. In May 2014, Owsley High graduated its first student receiving both a high school diploma and an associate of arts degree.

One of Owsley's most innovative ideas is virtual snow days. Each winter, students missed nearly a month of school when snow and ice made traveling to school too dangerous. Now kids log in to Blackboard Learn, the district's learning management system, and tackle the day's work from home. Blackboard allows teachers to upload lessons and supplemental materials for students to access anywhere, electronically.

"Instead of just learning from the book, it gives you a lot of additional material," said one Owsley High student, who says she accesses the site frequently to supplement her Spanish classwork.

Thanks to programs such as MasteryConnect, which monitors student performance and spots remediation needs, teachers can deliver individualized lessons. Both teachers and administrators monitor the coursework to ensure that the virtual day parallels the learning that would have taken place on a regular instruction day.

> "Every time you increase the speed of the network, you are enabling incredible educational opportunities."
>
> – Bailey Mitchell, CTO and CIO, Forsyth County (Ga.) Schools

Owsley's teachers don't get snow days off, either. "I send them Facebook messages, email them, text and call," reports one math teacher. Notices and requirements for each snow day also go out on Twitter and Infinite Campus Messenger. With students messaging back, it's a two-way street. The district keeps finding new ways to take advantage of the community's robust fiber infrastructure. Two of its school buses are now equipped with Wi-Fi.

The latest new program? Telemedicine. Equipment provided by a county health department grant connects the school nurse with a local health care provider, who can virtually examine a patient and then call in a prescription or refer the child to a specialist. Staff members have access to the service as well.

FORSYTH COUNTY

Since 2012, the Forsyth County school district just outside Atlanta has used a business Ethernet connection from Comcast to support streaming video, interactive whiteboards, mobile devices and digital content for its 40,000 K–12 students in 35 schools. The system provides learning plans based on individual students' needs, preferences and performance. It takes into account learning interests and learning style to increase student engagement and boost academic performance. Students can learn at home on their own or at school, using high-speed Internet connections, and be rewarded by their teachers in collaborative settings.

Forsyth lets students use their individual Internet-capable tablets, laptops, netbooks and cellphones to work in classrooms. Other schools around the country have substituted standard equipment – iPads, Chromebooks and so forth – vastly cutting their maintenance costs while creating new learning environments. In Forsyth schools, for instance, students participating in the NOBLE Virtual World project interact in a digitally created world where they can create anything they imagine. Students develop creativity, data analysis and problem-solving skills by working in teams and creating plans and solutions.

Forsyth County Schools reduced its textbook costs by about 85 percent using interactive online content, including streaming video, simulations and other digital resources that, unlike physical textbooks, are kept always up to date. Administrative offices also benefit from fast, efficient data transmission as well as from file sharing and document storage via the district's central server.

"Bandwidth is the key. The only way to have access to all that digital content is to connect the technology and infrastructure in support of it," said Bailey Mitchell, chief technology and information officer for Forsyth County Schools. "My view is that every time you increase the speed of the network, you are enabling incredible educational opportunities." ❖

FTTH Success Stories

Almost every new FTTH community offers a success story – young people who didn't leave town or new businesses that arrived. However, economic development doesn't inevitably occur as a result of investment in fiber infrastructure. Bankers have to be sold on investing in local businesses. Existing business operators have to learn how broadband can help them. Government agencies, local health care providers, educational institutions and builders all have to be brought up to "speed" on what fiber broadband can do.

The good news: Broadband offers more "bang for the buck" than any other major infrastructure category – and it can be built faster. The bad news: Most planners have never studied bandwidth issues, and few know how important broadband is to fulfilling a master plan.

Following are a few of the many FTTH success stories that **Broadband Communities** has reported on.

CHARLES CITY COUNTY

Charles City County is a rural area between Richmond, Va., and historic Williamsburg. Despite its name, the county has no cities, and its population of 7,256 is only 1,668 more than it was in 1790. Residents and businesses have struggled with poor telephone and Internet service for years; in 2013, officials resolved to do something about it.

The businesses in the county's one office park employed more than 500 residents. As these businesses increasingly competed in regional and global marketplaces, the need for reliable, affordable telecommunications became more apparent. Company representatives and the county's director of economic development documented regular Internet outages linked to degraded, obsolete infrastructure.

Several businesses revealed that they were considering relocating because of it. The economic development department decided to prioritize upgrades based upon economic impact, number of residents and businesses served, and costs. The county applied for and received a planning grant administered by the Virginia Department of Housing and Community Development. Local officials created an online survey and solicited more than 130 letters of support from government representatives, businesses and regional chambers of commerce, civic groups, churches, and schools. Residents completed another 200 survey submissions.

One of the county's largest existing employers, along with a new business planning to relocate there, approached the county's economic development director to say they were questioning their future in the county. With close to 175 total jobs at stake, there was new urgency. The new network – several fiber rings, much improved broadband connectivity for administrative offices and county schools, and new wireless towers for improved residential, work-from-home and small-business connectivity – kept the jobs and attracted a private economic development project with an anticipated investment of more than $300 million, the largest single private investment in the county's history. Deployment is underway.

1.1%
is the increase in per capita GDP for U.S. cities with widely available gigabit services.

Charles City County saved jobs for county residents by deploying a fiber network.

SANDY, ORE.

Sandy is a town of 10,000 in the forests 25 miles east of Portland. It built its own gigabit fiber network. In 2001, when the local telephone company couldn't provide a DSL connection to city hall, city officials began to worry about broadband availability for local businesses and residents. Sandy formed its own utility to provide DSL over the phone company's infrastructure before investing in a wireless system that would ultimately stretch across and beyond city limits. After concluding in 2008 that the wireless network was unreliable and could not provide the high-capacity connections that were already becoming necessary, city leaders decided to provide broadband to businesses via municipal fiber. By 2012, most of the larger

companies in the downtown area had connected to the network, which sold 100 Mbps service for an eighth the cost of 10 Mbps from the previous provider. One company, AEC, uses Internet access to communicate better with its facilities and offices around the world. It serves global companies such as Lufthansa, Technik, LifePon and Biz.Jet International.

In 2010, city officials held a "Why Wait for Google?" contest that invited residents to demonstrate demand for fiber to their homes. The city intended to build an FTTH pilot project in the neighborhood that had the highest response rate. But the contest demonstrated strong demand everywhere. After comparing the cost of the pilot project with the level of demand, the city decided to build fiber everywhere.

SandyNet calculated that the network would need a 35 percent take rate to pay off the bond. Even before finishing the network, SandyNet achieved a take rate of 60 percent.

The network enabled the city to replace its aging phone systems with VoIP. Other savings, however, were less obvious. Police use high-speed connections to deliver grand jury testimony. Having reliable, affordable, high-speed Internet gives people greater opportunities to work from home. That improved the real estate market.

Sandy is using an urban renewal district (often called a tax increment financing, or TIF district) to add a business fiber loop to the almost-completed network. Businesses that take advantage of the expansion will have no connection fee.

City Council President Jeremy Pietzold, an elected official with a technical background, has long been a strong supporter. While attending the 2015 **Broadband Communities** Summit, he bumped into an engineer from Google who noted that Google is watching Sandy. Pietzold was surprised enough to clarify, "Sandy, *Oregon?*" Sure enough, Sandy's success is attracting attention.

91%
of students demand fast Internet or broadband in their housing.

The Taos Pueblo is the oldest inhabited structure in the U.S. – and there's fiber next door.

NORTHERN NEW MEXICO

For Kit Carson Electric Cooperative (KCEC), which serves nearly 30,000 members in Taos, Colfax and Rio Arriba counties, FTTH was just one more step along a nearly 80-year path of service. Though electricity distribution was – and still is – its primary business, it considered diversifying as early as 1999, when deregulation of the energy markets got underway. Feedback from members indicated that the region's top needs were for economic development, propane and Internet service, so KCEC set to work on all of them.

In 2000, KCEC launched a fixed wireless Internet business, but because of the mountainous terrain, it became clear that wireless couldn't serve members adequately. Soon afterward, KCEC built a call center, recruited three tenants for it, created 200 new jobs – and discovered fiber optics. The call center needed good connectivity, so KCEC ran fiber to it and also began using fiber to build a smart grid.

Over time, the fiber network expanded. School districts hung fiber cable on KCEC's poles and traded individual fibers for pole access. More businesses connected to the network. All that stretched KCEC's comfort level, just in time to take advantage of $64 million in Rural Utilities Service grants and loans through the 2009 stimulus program.

As of late 2015, nearly 800 customers have been connected. The first was a graphic designer who had moved from California and telecommutes from his cabin with reliable 20 Mbps symmetrical Internet. More than 10,000 members have signed up for services, for an expected final take rate between 60 and 70 percent. KCEC sees an uptick in corporate interest and cites proposals to locate small data centers, software companies and other broadband-dependent businesses in its service area. ❖

Builders, Real Estate Developers and FTTH

Most large developers of single-family homes and many developers of multiple-dwelling-unit (MDU) communities add FTTH to new properties. Many MDU owners are retrofitting older properties as well. As early as 2006, FTTH was economically viable in new developments with as few as 80 MDU living units or 100 single-family homes. That number has continued to fall based on improvements in deployment technology. Today, deploying FTTH in new MDUs and single-family subdivisions costs about the same as deploying copper. Retrofitting is almost always practical in older multistory MDUs that have 10 or more units.

FTTH ADDS VALUE

Since the mid-2000s, the market research firm RVA LLC has surveyed home buyers and developers. Through boom, recession and recovery, surveys found that FTTH adds more than $5,000 to the price of a single-family home. The most recent survey indicates that fiber access adds between $5,000 and $6,000 to the value of a $300,000 home. RVA's 2014 survey of MDU residents found condo buyers were willing to pay a 3 percent premium for an FTTH connection, and renters would pay an 8 to 15 percent premium for FTTH. A spring 2015 analysis of single-family home sales by the FTTH Council Americas showed that a fiber connection increases housing value by about 3 percent.

Fiber adds value because subscribers are more likely to be very satisfied with their broadband and video services and much less likely to consider moving from their current homes. According to RVA's most recent survey of MDU residents, good broadband is now the No. 1 amenity, beating out even in-unit washers and dryers. Similarly, a 2015 survey by the National Multifamily Housing Council found that high-speed Internet was the No. 1 home amenity for apartment renters.

Q: How can I justify increasing my construction cost by adding fiber?

A: First, don't assume that fiber is more expensive to install than copper – that's not necessarily the case. Equipment rooms and ducts can be smaller with fiber, and electricity has to be supplied only to the point at which fiber enters the building or an individual unit. Fiber does not conduct electricity, so it does not have to be grounded. Labor costs in most markets tend to be a bit higher for fiber than for deploying copper, but even that gap is eroding.

Second, as noted, homes sell for higher prices when they are wired for high bandwidth and provide access to fiber. And because FTTH homes sell faster than non-FTTH homes in the same market, this may translate into a greater profit. This is equally true for rental properties. Developers of MDU communities say their new buildings lease up faster if they can advertise them as fiber-connected, especially when many of the new tenants are students or recent college graduates.

Q: Do buyers and renters really care about fiber to the home? How many of them have heard of it?

A: They really care about fast, reliable broadband. Survey after survey shows that FTTH customers are more satisfied with their broadband and TV service than cable, DSL and wireless customers.

Q: Do I need to hire an engineering firm to design the installation?

A: Fiber does need to be engineered in large apartment complexes – but that's true for coax, too. A key engineering need now is for managing Wi-Fi systems in large MDUs so that cellular providers can use the Wi-Fi to connect telephone calls. But smaller installations do not need that kind of sophistication to work well. Greater standardization, clever new systems from equipment vendors, fiber that can be stapled and bent tightly around corners, distributors' growing design expertise and an expanding corps of qualified technicians have made less formal design regimes feasible and common.

Q: Will other labor on my construction site damage the fiber cable?

A: Optical fiber is very, very thin – thinner than a human hair. But vendors have developed many techniques to protect fibers from harm. Cable can be armored to ward off cuts. Contractors can route inexpensive microduct – hollow plastic tubes typically 1/8 inch in diameter – through walls before the walls are closed in with drywall or other materials. The microducts are easily repairable. After everything else is completed, thin fiber can be "blown" through the microduct for hundreds of feet. New fiber can be bent almost like copper. Some vendors offer fiber on thin adhesive tape that can be easily rolled onto walls.

Q: Do any building codes pertain to fiber?

A: Yes, all the usual fire and life-safety issues apply. For instance, just as copper with PVC sheathing would be considered a life-safety hazard because of the combustion products released when it burns, so would various plastics used in fiber that is meant for outside installation. Indoors, look for Low Smoke Zero Halogen (LSZH) cables. If you are using thin plastic microduct, it should be labeled Halogen-Free Flame Retardant. You usually

$5,000-$6,000
Value that FTTH adds to a typical house or condo.

$81
Monthly rental premium that FTTH adds to a $1,000 apartment

use a simple junction box to change from "outside" to "inside" wiring, just as you might with electrical cables. Unlike electrical cables, some fiber can be stripped of its outer sheath with a simple hand tool and used inside or out without a splice.

Of course, you should check with your local building code inspector. Aside from fire issues, codes may govern where fiber optical network terminals (ONTs – the boxes that convert pulses of light from the fiber into electrical signals for the computer or TV) may be placed on the outside walls or in common areas. A few municipalities specify where network connections should be placed in homes.

Q: Where should we put users' network connections, assuming no specific building code or guidance document covers that subject?

A: Expect users to desire broadband connections in virtually any room in the house – bedrooms, office-dens, the kitchen. That's because Internet connections these days accommodate telephones, televisions, set-top boxes, thermostats, security sensors, fire and smoke monitors and, of course, computers. As the "Internet of things" develops in the next few years, more appliances will be Internet-enabled. Many manufacturers already provide such connectivity.

The newest generation of FTTH gateways can handle close to 1 Gbps wireless throughput, and in single-family homes, some FTTH deployers now use wireless connections for all devices except whole-home DVRs. Creating a wireless home network requires careful placement of equipment, but it is generally much simpler and less expensive than rewiring homes, which was standard practice until very recently.

To minimize wireless interference inside multifamily buildings, experts advise using either managed wireless connections or wired Ethernet connections for all stationary IP-connected devices rather than permitting residents to use their own Wi-Fi routers.

Q: In single-family homes, I often see ONT boxes – the fiber terminals – hung on the outside walls. Can they also be placed indoors?

A: Yes. In harsh climates, where heat or heavy snow could affect the outside installation, you will probably want to put ONTs indoors. Outdoor ONT models are sometimes placed in unheated garages or utility rooms; you can also buy small, portable indoor models that look more like cable or DSL modems and connect them with tough, flexible fiber that can be laid anywhere. Indoor ONTs, which are popular with apartment dwellers, are sometimes designed to be user-installed. Most are not much bigger than a cellphone.

Q: Why do ONTs sometimes require backup batteries?

A: Optical fiber cannot conduct electricity. Thus, to keep a network connection running during a power outage, you need a battery at the user premises or a fiber cable that includes a thin copper conductor connected to an off-site battery. This requirement is changing as cellular phones replace landlines – a change that has already taken place in most of Europe. In North America, where about half of all households still have landlines, many standard designs are available for in-wall, between-stud boxes that hold the battery, ONT and fiber connections.

Q: Does every dwelling unit or office need its own ONT located at the unit?

A: No. Separate ONTs for each unit in an MDU building can be located centrally, often in a basement or an equipment cabinet. There are also ONTs designed to serve multiple units, typically four or eight. This flexibility is made possible by small, low-power circuitry and by the fact that some ONTs can deliver 1 Gbps or more – often enough bandwidth to share among multiple customers.

Q: Is lightning a problem with fiber?

A: No. Because fiber does not conduct electricity, lightning strikes do not directly affect fiber at all. Fiber does not have to be grounded.

Q: Is FTTH a sustainable technology?

A: Glass is made from sand – an inexhaustible resource that uses far less energy and creates far less pollution to manufacture than does extraction of copper from its ore. FTTH generally consumes less power than other broadband technologies. Passive optical networks (GPON and EPON) are especially energy-efficient because they require little or no active electronics in the field. FTTH enables more sustainable lifestyles, too. A 2008 study by PricewaterhouseCoopers showed that the greenhouse gas emissions associated with deploying an FTTH network are outweighed within five years by the savings from increased telecommuting. Other fiber-enabled applications, such as telehealth, telepresence, distance learning and cloud computing – and, of course, smart-grid applications and home energy management – reduce travel, minimize heating and cooling loads or help shift energy consumption to renewable sources. ❖

Property Developers Win With Fiber

For a collection of more detailed articles on these and other properties that have deployed fiber to the building or fiber to the unit, see www.bbpmag.com/property/Property_Land.php. There you will find details of the technologies used at more than three dozen properties in all property sectors and in all regions of the U.S. Here are three recent examples.

$25 GIGABIT WOWS RESIDENTS

Park Square at Seven Oaks in Bakersfield, Calif., is an upscale apartment community whose developer built its own fiber-to-the-unit network. Now every resident receives gigabit Internet service for an unbeatable $25 monthly price – an attractive amenity for high-tech professionals.

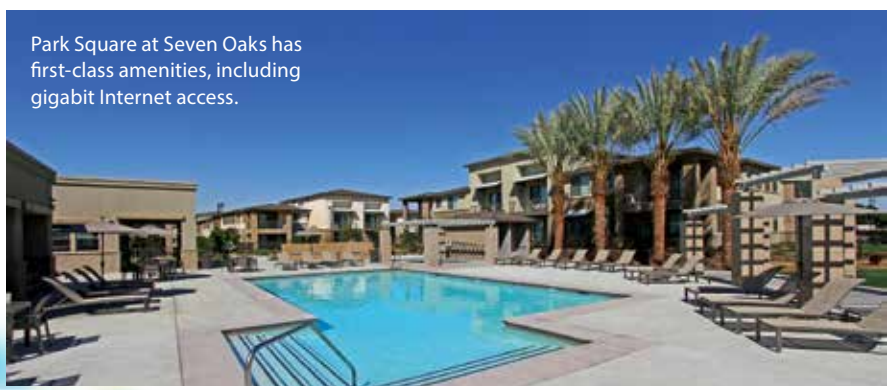
Bakersfield, halfway between Los Angeles and Fresno, is home to high-tech hipsters and oil executives. Telecommuting is popular there, in part because it reduces employers' needs for high-priced office space. For telecommuters, the basic prerequisites are a strong cell phone signal and a broadband connection – preferably a gigabit. Andrew Fuller, president of Fuller Apartment Homes, knew he needed first-class broadband to appeal to his target audience.

Fuller had done many bulk service deals with cable companies, obtaining bandwidth at one-third the street price and using cheap and plentiful Internet access as a marketing tool. By the time Park Square was being designed, bulk wasn't such a good deal. It would have cost 80 percent of market price.

Instead, Fuller decided to bring fiber to the 224-unit mid-rise property, build a traditional copper Ethernet LAN and provide Internet services directly – an approach he had used once before. But the 14-acre Park Square site needed cable lengths that far exceeded the limits of Ethernet over copper. The solution: a full FTTH network. Installing the GPON fiber LAN cost considerably less than Fuller would have paid a service provider, and the costs of operation, maintenance and future expansion are also lower. Consultants helped raise the contractors' comfort with the technology.

Network operations and technical support are outsourced to a local service provider. Fuller Apartment Homes has a commercial contract with a national carrier for bandwidth to the property.

The carrier's fiber terminates in the Park Square clubhouse. Fiber is run directly to each of the 16 buildings, and a fiber patch panel on the side of each building distributes the fiber to an ONT in each unit.



Park Square at Seven Oaks has first-class amenities, including gigabit Internet access.

Said Andrew Fuller: The field subcontractors … knew mostly electrical and standard copper communications cabling, but installing an optical fiber network was something many had never been involved with before. Surprisingly, with the help of a local network cabling expert, they discovered that it was really pretty straightforward."

The total cost was about $100,000, or a bit more than $400 per unit. Fuller Apartment Homes saved up to $150,000 by building the network itself. But the true ROI, says Fuller, came from multiple sources:

- Network power consumption was halved.
- Multiple buildings are served by one main telecom closet. The space normally allocated for a telecom closet on each floor is now usable, revenue-producing space.
- Future expansion costs are lower. The life cycle of a fiber network is 10 years, compared with five years in a traditional copper structured cabling environment.

UP AT METROPLEX: NEW BENCHMARK FOR STUDENT HOUSING

As part of an overall renovation for a 186-unit, 710-bed student-housing complex in Vestal, N.Y., Newman Development Group, the property owner, installed state-of-the-art wired and 802.11ac wireless broadband infrastructure that will meet student needs well into the future.

NDG had partnered in 2004 with the property manager, Ambling Management Group, and the owner, Binghamton University Foundation, to build the four-building complex, then called University Plaza. The property was advanced for its time and was popular with students. A decade later, however, it no longer looked so advanced. The clubhouse was small,

the amenities were unimpressive, the furniture and appliances showed signs of wear and, most important, the broadband was not up to par.

A cable company provided Internet, video and phone services, and there was no propertywide Wi-Fi service. Cable modems hung from the walls of the units. There were continual problems with connectivity.

Students are avid movie watchers and gamers, and they increasingly rely on broadband for coursework. Binghamton keeps class time dedicated to lectures and hands-on research. After hours, the students complete their coursework through Blackboard, a learning management system, and do their quizzes online. To take a quiz online, a student needs reliable Internet service.

Eventually, the foundation decided to exit the housing business, and in August 2014, NDG, which by then had developed many other student housing projects, purchased the property and decided to bring it up to date.

NDG brought 10 Gbps fiber onto the site (a mix of four-story townhouses and garden apartments) and is using 1 Gbps of it now, distributed through existing Cat 6 Ethernet cabling to in-apartment managed Wi-Fi. The inside work was done in less than three weeks during the students' winter break. Students get 50 Mbps Ethernet, and the technology supports more – the service to the complex can be upped to 10 Gbps without changing any wiring or Wi-Fi hotspots.

Although students had numerous complaints about the existing provider's customer service and reliability, the old ISP was the devil they knew; they worried that the new service could be even worse. So the leasing team mobilized a successful marketing campaign to educate residents, highlighting how the new service would elevate their digital lifestyles.

A fiber-to-the-building deployment at the St Laurent apartments helped increase property value.

A STRATEGIC FIBER UPGRADE

Continental Realty Advisors used fiber for a major overhaul at the St. Laurent Apartments, an upscale apartment complex in Grand Prairie, in the Dallas–Fort Worth area. Covering 25 acres, the property has 16 apartment buildings totaling 372 garden apartment units, numerous attached and detached garages, and one primary amenity structure. Since the 1980s, CRA-sponsored investment funds have acquired more than $2 billion in multifamily real estate, targeting properties that can benefit from upgrades whose costs can be recouped quickly through rent increases.

Residents leaving the community cited the cable and Internet services as their second most common source of dissatisfaction. The property had a 10-year contract with the cable provider, but CRA was able to terminate the contract early because the provider was unable to deliver the top advertised speed.

Because the home-run and in-unit wiring were sound, CRA didn't have to invest capital in the upgrade. Instead, it contracted with a company to construct a fiber ring throughout the property – there's a connection on each building – and connect it to the building wiring. This propertywide fiber plant is a first step in eventually running fiber to each unit, should the owner decide to do that.

Today, the fiber optic network provides broadband service for residents, management offices, the clubroom, the pool area, the business center and the laundry center. In addition, there's dedicated fiber for two satellite dishes that bring video to the entire property to be used by a national satellite TV provider. The video system improved the aesthetics of the complex.

CRA can easily match or beat local competitors' speeds and pricing. The top download speed offered, more than 50 Mbps, is slightly higher than the area norm. But CRA's top upstream speed was set at 16 Mbps, far beyond what any local competitors offer. Service greater than 200 Mbps symmetrical can be made available almost instantaneously.

Although residents care about speed, what matters to them most is a pleasant online experience without disruptions or slowdowns. The take rate is well over 50 percent. CRA profits from the network itself, but residents are also staying in their apartments longer even though rents are rising faster than the area average.

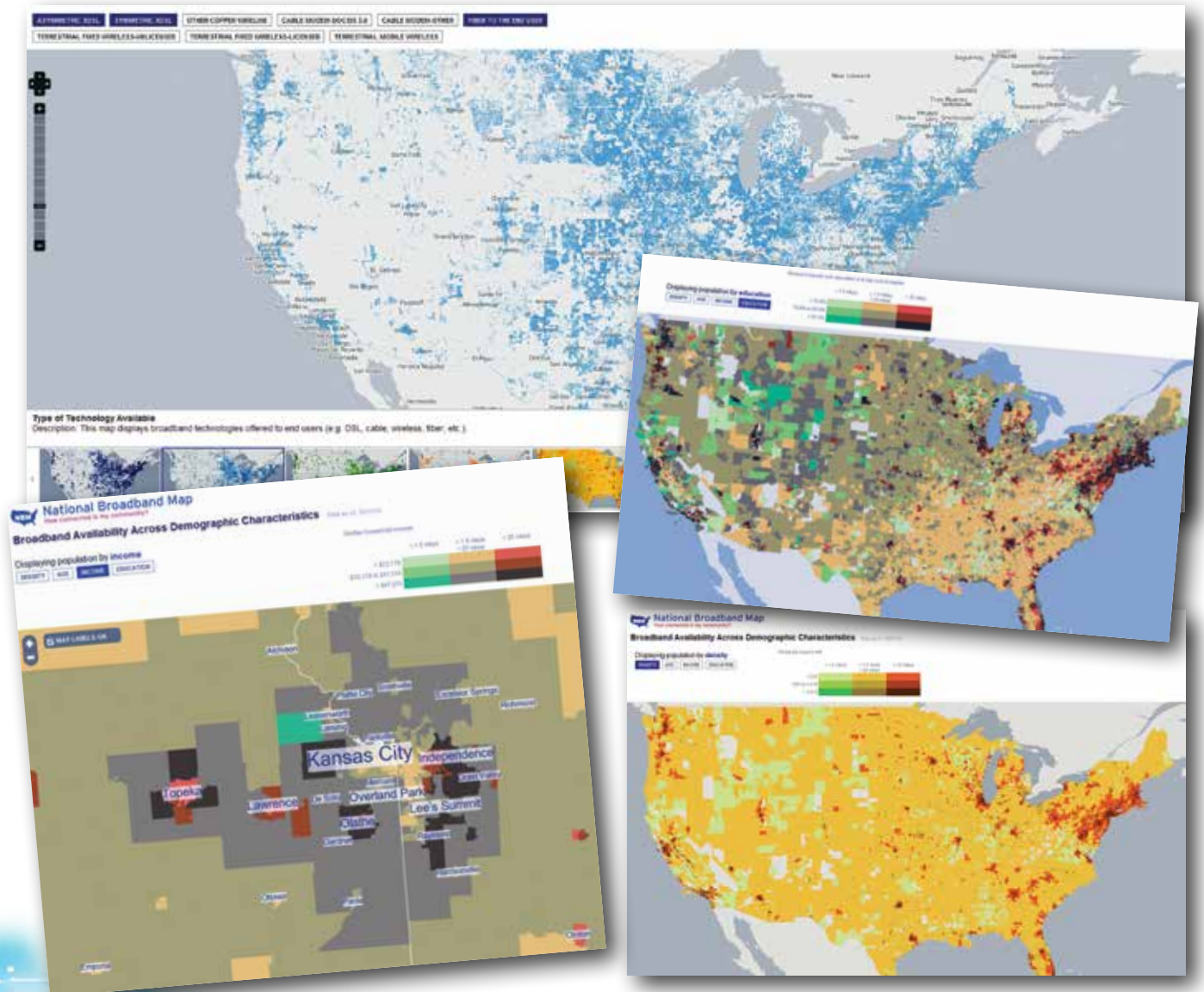
The network is designed to accommodate IP-based access control, in-unit home automation, and building management services in the future. One bonus: IP cameras attached to the fiber network have virtually eliminated costs and downtime associated with repair to the gates because all entries and exits are recorded.

Outside-plant work was completed in approximately three weeks. Cross-connects and unit activation took another 10 days. ❖

More Information For Community Leaders And Network Operators

Interested in fiber to the home? Start with a visit to www.bbcmag.com. **Broadband Communities** publishes a print and online magazine seven times per year, publishes breaking news online every day, and holds two conferences per year. Its mission is building a fiber-connected world. **Broadband Communities'** municipal portal, www.bbpmag.com/MuniPortal/FTTHLand.php, can direct you to additional resources, and its database at www. fiberville.com shows all FTTH deployments in the United States.

Broadband Communities has also created investor feasibility models and monthly cash flow models for FTTH, available free at www.bbcmag.com/FTTHAnalyzer. The models are designed to be adapted to your specific situation – whether you are in an urban or a rural district, whether you are a community leader, a service provider or a property owner.



Hundreds of network providers use these models, but they are a special boon to municipalities and small telephone, cable and electric companies as they start to investigate the feasibility of fiber in their localities. With the models, you can do preliminary studies for little or no cost and then decide whether to take the next step, hiring a consultant.

Most users of these models get rough cost data from nearby communities or companies that have already deployed fiber. Find them on the magazine's Fiberville.com database. Planning a network in two or more very different sections? Run the model on separate spreadsheets for each section's expected costs, revenues, and completion schedule. Then combine the results on a summary sheet.

The **FTTH Council Americas** (www.ftthcouncil.org) is a nonprofit association whose mission is to accelerate deployment of all-fiber access networks by demonstrating how fiber-enabled applications and solutions create value for network operators and their customers, promote economic development and enhance quality of life. It holds quarterly meetings and monthly webinars and offers other information for fiber deployers. See especially its Community Toolkit (toolkit.ftthcouncil.org) for resources for municipalities. The toolkit guides you through the process:

- Why Fiber? Read about the value of FTTH and about broadband success stories.
- Organizing Your Community: Identify champions, find partnerships and build consensus.
- Creating the Business Case: Identify your assets, estimate demand, build the financial model and find the money to build.
- Building the Network: Develop an RFP, find or create a provider and manage the deployment.

LEGAL AND FEDERAL

The law firm of **Baller Herbst Stokes & Lide** (www.baller.com) offers links to many groups working on broadband issues and to discussions of laws and regulations covering FTTH. Its open resource library is at www.baller.com/category/community-broadband.

The **National Broadband Map** (www.broadbandmap.gov) – a continuing, nationwide collection of broadband availability and usage– can help communities deploy FTTH networks where they are most needed and use them to best advantage. Though the data are imperfect, the map has been used by:

- **Industry** to site new facilities.
- **Service providers** to target new opportunities.
- **Municipalities** to monitor broadband adoption.
- **Policymakers** to target broadband grants.
- **Native American tribal authorities** to reveal broadband training needs.

The Commerce Department's **National Telecommunications and Information Administration** (NTIA, www.ntia.doc.gov/category/broadband) originally built the map and helped fund more than $3 billion worth of middle-mile fiber networks (the networks that link national interstate communications trunks with local broadband providers). It is now helping to coordinate multiple federal agencies as they rewrite regulations to encourage broadband network construction.

The **Federal Communications Commission** is committed to increasing broadband competition and deployment, especially in underserved areas. View proposed regulations and submit comments on them at www.fcc.gov.

The Agriculture Department's **Rural Utilities Service** (www.rd.usda.gov/about-rd/agencies/rural-utilities-service) helps fund infrastructure, including telecommunications infrastructure, in rural communities and on Native American reservations. The application process is now online. To apply for Telecom Infrastructure and Telecom Farm Bill grant and loan funding, visit www.rd.usda.gov/programs-services/rd-apply.

ORGANIZATIONS AND ACTIVISTS

The **National Association of Telecommunications Officers and Advisors** (NATOA, www.natoa.org) supports the communications interests of local governments. It helps clarify local, state, and federal communications laws, administrative rulings, judicial decisions and technology issues. It analyzes and addresses emerging issues in areas such as local government communications and Internet policy; broadband planning best practices; cable franchising; wireless zoning; new technology initiatives and advancements; and operation of public, education and government (PEG) access channels.

Members include consultants for and employees of state or local governments and agencies. Industry representatives, students, government

More Information for Community Leaders and Network Operators

or access center employees can join as nonvoting associates.

The **Rural Telecommunications Congress** (www.ruraltelecon.org) is a national nonprofit organization for government, university, industry and private citizens committed to addressing crucial broadband issues in rural areas.

The **Blandin Foundation** (www.blandinfoundation.org) aims to help rural Minnesota communities thrive, but its information on FTTH, including case studies, is relevant to any would-be deployer. The foundation has partnered with nearly 70 Minnesota communities and 110 organizations across the state. In 2016, it expects to award up to $1.5 million in grants and technical support to rural Minnesota communities.

What makes a smart community? The **Intelligent Community Forum** (www.intelligentcommunity.org) has an annual "smart community" competition and publishes numerous reports and studies showing what communities worldwide can do with broadband. In 2015, it expanded its brief to help communities evaluate the broadband networks that make these services possible.

The **Institute for Local Self-Reliance** is a nonprofit research and educational organization that provides technical assistance and information on environmentally sound economic development strategies. It is a great source of information about community broadband networks, and its broadband advice, blog and podcasts (www.ilsr.org/initiatives/broadband, www.muninetworks.org) have helped many communities.

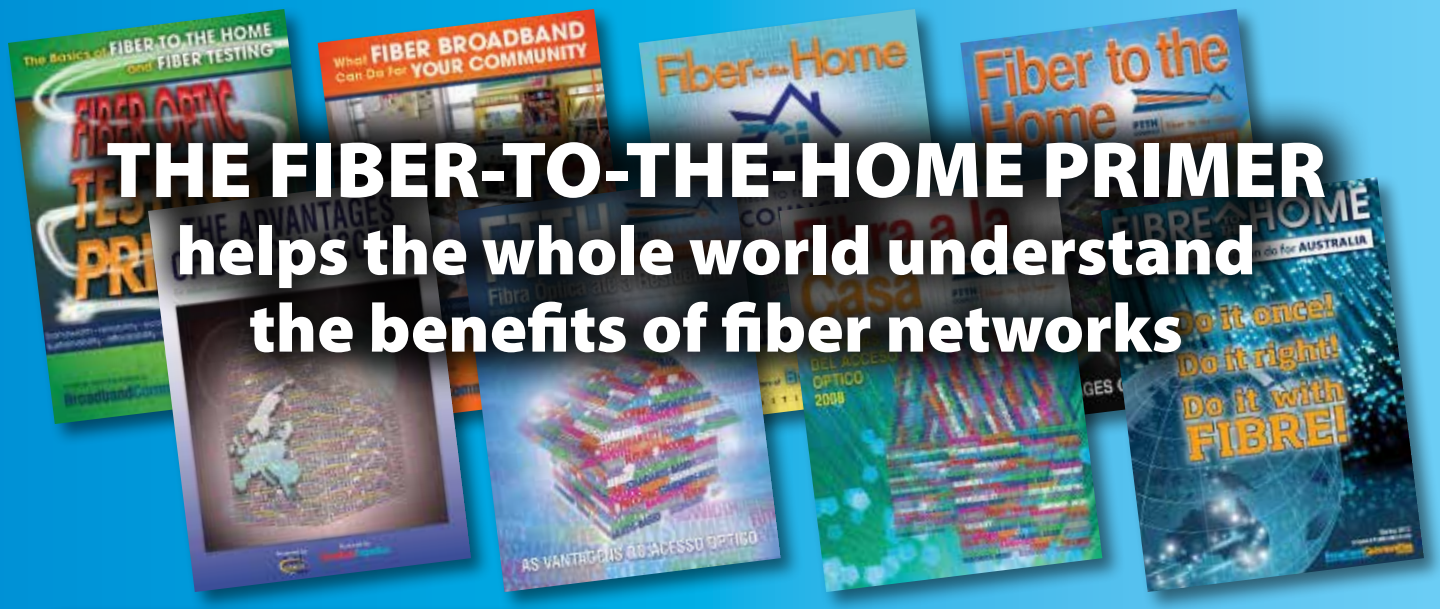
The **Coalition for Local Internet Choice** (CLIC, www.localnetchoice.org) represents private and public interests that support the authority of local communities to make their own broadband choices – including construction of their own networks.

Next Century Cities (www.nextcenturycities.org) had 124 member cities at the end of 2015. Its members are committed to helping other cities realize the full power of high-speed, affordable, accessible broadband. It is politically neutral and does not advocate exclusively for municipal-run networks. Member communities have pursued a variety of paths to better broadband, including private and public-private networks.

The **Schools, Health & Libraries Broadband Coalition**, popularly known as "Shelby" or SHLB (www.shlb.org), promotes broadband for anchor institutions and their communities.

The **University Community Next Generation Innovation Project** (Gig.U, www.gig-u.org) is a coalition of 30-plus leading research universities across the United States that seeks to accelerate the deployment of ultra-high-speed networks to universities and their surrounding communities. Its website offers many resources for aspiring gigabit communities.

KC Digital Drive (www.kcdigitaldrive.org) is the organization formed to ensure that Kansas City–area communities would take full advantage of the gigabit network deployed there by Google Fiber. It shares its findings with other communities around the United States. ❖



THE FIBER-TO-THE-HOME PRIMER helps the whole world understand the benefits of fiber networks

"The Primer is an excellent way to not only educate people about the basics of FTTH but also inform them of its many benefits."

—Mark Erickson
City Administrator and Economic Development Director - Winthrop, Minn.

BUILD COMMUNITY SUPPORT

Printed FTTH primers are helping thousands in communities get on the same page about the benefits of fiber networks.

Community leaders and fiber champions are launching mailing campaigns to send FTTH primers to every household and business.

Besides the primer, mailing packets include brochures, questionnaires and schedules of public meetings about fiber networks.

FTTH marketing campaigns use volunteers, both adults and children, to reach every household and business in a project area.

Get more information or place your request for a bulk shipment of printed primers for your community at:

www.FTTHPrimer.com
877-588-1649