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

WHAT FIBER BROADBAND CAN DO FOR YOUR COMMUNITY

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

FTTH
FIBER TO THE HOME
COUNCIL
AMERICAS

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This primer was originally written by Steven S. Ross and has been 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, Oregon, is based on a* ***Broadband Communities*** *article authored by Christopher Mitchell and Hannah Trostle.*

Why Fiber?

WELCOME TO THE BROADBAND 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 has for decades formed 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.

The final step is to build fiber optic cables all the way to homes and businesses and replace the old copper networks entirely. Worldwide, network operators agree that only fiber to the home, or FTTH, can meet the exploding demand for bandwidth and deliver next-generation services. 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

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

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

reliable broadband technology. They appreciate that fiber networks can deliver broadband services for medicine, education, home-based businesses, home automation, video and games. For economic efficiency and for redundancy, critical business systems now operate at huge data centers – in the "cloud" – rather than on local computers. The speed, reliability and security of fiber connections make cloud services viable for consumers and small businesses as well. Any business that accepts credit and debit cards is probably using cloud services.

In the United States, more than one in four households have fiber connections available. That's less than the average for the rest of the developed world. U.S. broadband providers have finally begun to catch up. The target is moving, however. China alone has more than 100 million FTTH subscribers and more than 700 million homes, many in rural areas, passed by fiber.

WHO IS BUILDING FTTH NETWORKS IN THE UNITED STATES?

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 a third 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 inherited more than 1 million FTTH customers from Verizon.

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

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

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

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, technology companies and partnerships between municipalities and such private entities. 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 provide broadband to their business and residential customers as well.

Local governments are attracted to FTTH because it positions their communities for tomorrow's jobs and economic growth. In 2010, when Google announced that it planned to build fiber networks, more than 1,100 local governments proposed their communities as suitable locations. More than 200 communities are served by municipally owned or public-private fiber networks. 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.

FTTH IS THE ONLY UNLIMITED BROADBAND TECHNOLOGY

Cable providers have historically used fiber to get close to homes and then used 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. Fast cellular connections require fiber connections at cell sites. Today, copper and millimeter-wave, point-to-point wireless networks can help bring broadband to especially difficult-to-serve neighborhoods, making fiber-rich networks even easier to justify economically. They are designed so that the non-fiber sections can be replaced with fiber over time.

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.

30 BILLION
The number of networked devices worldwide, by 2020.

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 or cable subscribers – not because basic services are more expensive (they aren't) but because more and better premium services are available.

For example, high-definition video communications are challenging to implement well over any medium but fiber. 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, home education 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 homes easier to sell and 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. Fiber-passed homes also sell and rent faster, on average.

Renters and buyers both know that with fiber, 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. In fact, entrepreneurs are a third more likely to start a home-based business if they have FTTH than if they have cable or DSL. That's an extra $40 billion a year added to the U.S. economy.

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.

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

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 have been deployed. In a 1 Gbps network, a two-hour video can be downloaded in as little as 16 seconds, and the images will be perfect.

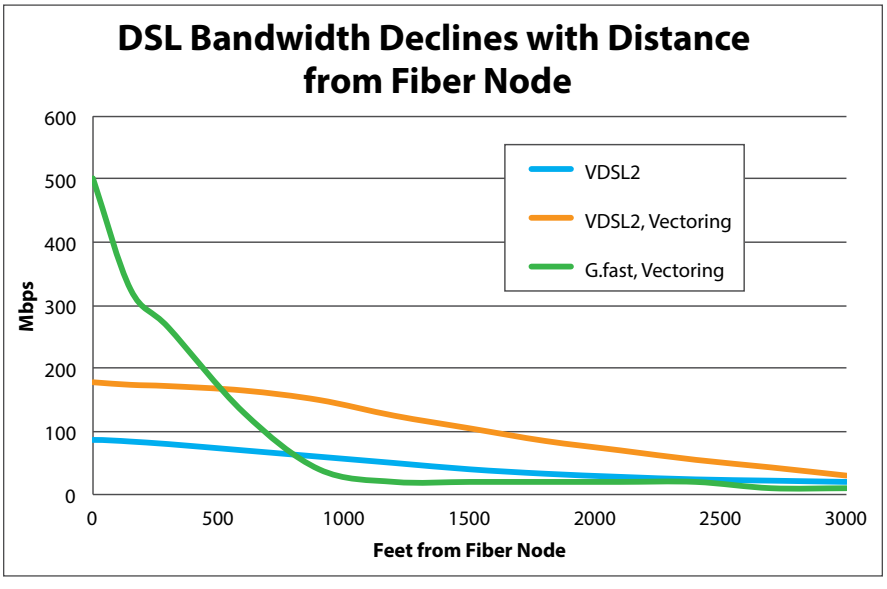
Q: How much bandwidth – or information delivered by bandwidth – do we need?

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. Traffic has continued to increase since then.

Video requires not only extra bandwidth but also extra reliability. The smallest delay in data transmission can result in distorted views. 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 the best 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 readily available for movies, games and even news reports. VR adds visual information to each frame, making possible multiple alternative views, and thus can vastly increase file sizes and bandwidth requirements. Consumers can easily create VR clips with "360-degree" cameras that cost $300 or less and view them on phone screens attached to simple headpieces – one style, from Google, is made of cardboard.

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 create larger and larger images; 30 megabytes is not



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.

uncommon. Amateur HD video cameras create 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). As voice search becomes the norm, upstream bandwidth is being saturated quickly.

In health care, the medical images produced by equipment such as CT scanners are easily a hundred times larger than camera images. A 2D mammogram image is about 20 megabytes; the newer 3D mammograms top 500 MB. Business and science 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 single 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. G.fast has an important role: Inside multiple-dwelling-unit buildings that have existing good copper wiring, G.fast can meet today's bandwidth needs.

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

Fiber: The Light Fantastic

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. 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!

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

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

degrading enough to keep it from being received. The international minimum standard is 20 kilometers (12 miles). Fiber also is far better able to support upstream bandwidth – that is, from a user to the network.

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, often need upstream bandwidth as well – consider a wedding photographer sending proofs by email to clients. Businesses now often copy all their working data files upstream to a remote computer center for safekeeping.

Q: What about cellular 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 4,000-fold from 2005 to 2015 and will grow another eightfold by 2020.

2X
Growth in global business broadband traffic by 2020.

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 of peak usage on an FTTH connection.

On the other hand, point-to-point wireless links, typically using millimeter-wave antennas, can be very useful to extend a fiber network to serve a specific neighborhood or building. (There's a slight penalty in reliability, however.) That kind of wireless is not cellular. Each user gets much of the total bandwidth potential of the transmission link, as long as the wireless link can be connected easily to fiber. Increasing the user density in a point-to-point wireless system makes the links shorter and thus more reliable. This is exactly the opposite of cellular, where higher densities mean that more people must share each cell site. 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 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 almost 40 years to carry communications traffic from city to city and from country to country. Almost every country

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.

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 new copper-based DSL technology, may be 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 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.

HYBRID FIBER-WIRELESS (HFW) Extending millimeter-wave wireless from a fiber node to a building is an emerging technology, similar to but in some cases less expensive than hybrid fiber-coax.

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, Florida) was 30 years ago.

Q: All providers seem to claim they have fiber or "fiber-rich" 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

54%
of U.S. carriers are likely to offer gigabit service by 2019.

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 use 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, it limits upstream bandwidth and it requires expensive electronics. However, it is touted as an interim solution. A new technology, G.fast, under ideal conditions and with vectoring (crosstalk cancellation between individual copper strands) and bonding (simultaneous use of more than one pair of copper wires), can provide 750 Mbps symmetrical bandwidth up to 300 feet from a fiber node – at least in the lab. G.fast is 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 wireless networks are often 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 subject to speed degradation when the condition of the wiring is poor. 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.

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, which can work well with fiber. However, DOCSIS (whether 3.1 or earlier versions) limits upstream bandwidth – and in some cases, downstream bandwidth, too – even if there is fiber all the way to the home. At the same time, some cable companies are beginning to install true fiber to the home, replacing DOCSIS with standards, such as GPON, EPON or active Ethernet, that allow symmetrical gigabit services. It's confusing – and that's why consumers need to find out exactly what a cable company is offering.

Q: Is FTTH technology expensive?

A: In new construction, fiber costs about the same as copper to build. (At the time of writing, copper is more expensive to buy, as copper prices rose sharply in fall 2016; copper is also too valuable as scrap to leave unguarded on a construction site). Fiber costs much *less* than copper to operate and maintain. 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. However, these less-expensive solutions won't meet users' needs in the near future, even if they work now.

Some providers that do not upgrade to FTTH 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. It's not clear that providers save money by failing to meet users' needs because limiting bandwidth means limiting revenue potential as well. ❖

90%
of seniors who own condos demand fast internet.

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, 32 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 is available in 48 states plus the District of Columbia.

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 Express Care 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 Centerstone Research Institute, a nationwide 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 operated its LIFE telehealth program, modeled on the Medicare/Medicaid Program of All-Inclusive Care for the Elderly (PACE) initiative, since 2007. 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.
- 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.

Fiber providers, whose networks rarely suffer outages, have a huge advantage in supporting programs like these.

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 IBM with its Watson supercomputer technology, are rolling out services to monitor and interpret such data automatically for physicians who care for those with chronic medical problems. Apple and other marketers of "fitness" watches aim to do the same. ❖

1 IN 9

U.S. households subscribe to FTTH.

Why We'll Always Need More Bandwidth

In a century of telephone communications, the bandwidth on voice channels changed very little. But for the past 25 years. internet bandwidth needs have grown exponentially. Cisco Systems estimates that global internet traffic in 2020 will be equivalent to 95 times the volume of the entire global internet in 2005. In 1992, global internet networks carried approximately 100 gigabytes of traffic per day. Ten years later, in 2002, global Internet traffic amounted to 100 gigabytes per second. In 2015, global Internet traffic reached more than 20,000 gigabytes per second! Globally, annual internet traffic will reach 21 gigabytes per capita by 2020, up from 6 gigabytes per capita in 2014. By 2020, the gigabyte equivalent of all movies ever made will cross the global internet every 2 minutes. Monthly worldwide IP traffic will reach 25 gigabytes per capita by 2020, up from 10 gigabytes per capita in 2015.

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 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 even heard of the "cloud" a few years ago? Today, consumers and businesses store data, run programs and 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.

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.

Virtual reality will create massive new bandwidth demand.

Today, people visit doctors from home or work, saving trips to the doctor's office or emergency room if they don't need to be seen in person. (Home 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 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 about 20 million users enrolled in almost 2,000 courses from 29 countries and 149 institutions – and Coursera accounts for less than half of such online activity.

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.

On the internet, bandwidth drives innovation, and innovation drives bandwidth demand.

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 new applications emerging today:

- Virtual reality and 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. ❖

196 FIBER STRANDS

each thinner than a human hair, in a bundle not much thicker than a pencil, can carry all the world's internet traffic.

NO. 1

The amenity most desired in multifamily buildings is fast internet.

1 IN 4

U.S. households have access to FTTH.

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, Tennessee) was the first to offer 1 Gbps access throughout a large service area. Other network operators, both public and private, quickly followed suit. By the end of 2016, large companies such as AT&T, CenturyLink and Cox had begun offering gigabit FTTH service in selected locations, and Comcast offers 2 Gbps FTTH service in some locations. So at least some residents in 500 communities or more have gigabit access today.

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, North Carolina) and Rocket Fiber, a new ISP in Detroit. Residential 10 Gbps service is still well beyond the "affordable" range, but some customers 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. 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. 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.

Chattanooga STEM students access USC researchers, 4K microscopic images and knowledge from 1,800 miles away.

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 – such as applications for managing smart cities and smart electric grids – 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. ❖

Aha! CUSTOMIZED Courses at Your Site

On Fiber-to-the-Home Financing and Operations

Education is our mission at Broadband Communities, and now we are offering a new way to carry it out – a service focused on fiber-to-the-home. Our editors and experts will visit your community or organization to help you learn about …

INNOVATIVE PATHWAYS toward paying for the network you need.

NEW OPPORTUNITIES for public-private partnerships.

NEW WAYS to phase and bootstrap a project with current cash flow … sweat equity … and savings on a municipality's existing communications costs.

VENDOR FINANCING that is often available in the form of delayed payments … just-in-time inventories … and equipment leasing.

Courses can include use of any or all of our unique tools:

- MSO, ILEC or Muni Financial Calculator
- MDU/PCO Calculator
- Rural Calculator
- Monthly Revenue Calculator
- 18-Month Operations Cash Flow Calculator

Our sessions will give you such important information as:

- How FTTH has MUCH higher revenue potential than copper
- How you can get to positive cash flow as fast as possible

Let us come to your site for daylong or two-day intensive lessons.

We'll start with whatever tools you need, and teach you how to use them. We'll also talk about what has worked, what hasn't, and where projects similar to yours have succeeded or gone bad. Our classes include custom exercises drawn from your situation, to give you hands-on experience in both the spreadsheet math and the thought processes involved. You'll get beyond some old misleading rules of thumb and gain a solid understanding of how FTTH is different.

HOW IT WORKS.

We customize our on-site courses to suit your needs.

WHO CAN BENEFIT?

Everyone interested in or already building a broadband network.

THE NEED.

Our custom courses are a convenient, low-cost way to bring people up to speed on the latest technologies, what they cost, and what they can provide.

Take the first step toward your community's fiber future … BBC experts can customize a program that will meet your needs. And it's surprisingly affordable – as little as $2000 plus expenses.

Barbara DeGarmo, CEO
Broadband Communities Magazine
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www.bbcmag.com

Vital For Education

Can communities afford *not* to assure high-capacity broadband for their students? U.S. communities and private schools spend $700 billion a year educating 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 taxpayer investment.

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.

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.

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.

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, Georgia, 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, KENTUCKY

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 home computers.

Students take courses online that are not available locally, and sophomores, juniors and seniors are offered dual-credit courses at several

Photo courtesy of the San Mateo Daily Journal.

Middle-schoolers in San Carlos, California, take a virtual field trip to a museum in Denver.

100 GB
Global internet traffic per day in 1992.

20,000 GB
Global Internet traffic per second in 2015.

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.

Owsley's teachers don't get snow days off, either. "I send [students] 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, GEORGIA

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 and creating new learning environments.) In Forsyth schools, 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," says 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." ❖

2 MILLION
Robotic surgeries could be performed each year in the U.S. with reliable broadband.

SMART CITIES, SMART FARMS

Fiber networks benefit all types of communities. In particular, the emerging "Internet of Things" offers applications that are transforming both cities and rural areas. Internet of Things applications collect vast quantities of real-time data from sensors or other devices and transmit it to centralized computers for analysis, and sometimes take action based on the results. Sensors are often connected wirelessly, especially if they are attached to movable objects – but real-time collection and upload of large data sets depends on dense, reliable fiber networks.

In cities, fiber connections are revolutionizing the delivery of services. One common application is IP cameras for protection of lives and property. Security cameras are used both by local governments and property owners. For example, the Newark (New Jersey) Housing Authority greatly increased the safety of its public housing when it installed a high-performance, fiber-based physical security solution. The high quality of the camera images, which enabled the housing authority to aid in prosecutions of crimes, was made possible by having enough bandwidth to transport and store the camera footage.

Using a fiber network, the Housing Authority also linked its emergency operations center to the Police Department and the Office of Emergency Management, allowing all three entities to share camera footage and databases.

In the Belgian city of Antwerp – one of the first cities in Europe to invest in fiber infrastructure – the Antwerp City of Things includes tens of thousands of sensors and connected devices built on the city's underlying broadband infrastructure. In one project, cars from the Belgian postal office, bpost, were equipped with sensors to measure the city's air quality in real time. In another experiment, sensors were installed to measure traffic on two routes. "We can start to tap into the Internet of Things' full potential – opening up a world in which everything is connected," says Bart De Wever, mayor of Antwerp. "When the bpost vehicles cross those traffic routes, we can examine the relationship between traffic and air quality. And that's just the beginning. We want to connect a lot of sensors so we can efficiently gather loads of intelligent information about what is going on in Antwerp. That is information we can then use to make living in Antwerp an even more enjoyable experience."

Newark's fiber-enabled emergency operations center keeps the city functioning in an emergency.

RURAL APPLICATIONS

The Internet of Things is just as important in the most remote areas. Energy companies monitor wind turbines, check the status of oil wells and tanks and monitor power-generation equipment.

Farmers use fiber-enabled solutions to prevent expensive equipment and livestock from leaving the perimeters of their properties. By placing sensors on grain bins, they can receive alerts if any grain is missing. Sensors in barns or chicken coops monitor temperature and humidity and close curtains or turn on fans and water pumps if animals are likely to be in distress.

Most important, broadband allows farmers to practice "precision agriculture." Sensors in the field or on tractors can measure soil conditions, enabling farmers to apply exactly the right amount of fertilizer, water and other inputs to each square foot of farmland. This reduces costs and avoids harmful pollution and runoff. ❖

Broadband, Property Values And Economic Growth

Recent studies continue to show that access to high-quality broadband boosts property values and contributes to economic vitality.

2014

Fiber to the Home Council Americas releases a study finding higher per capita GDP in U.S. metropolitan areas in which gigabit internet is widely available. Infrastructure investment, job creation, entrepreneurship, productivity gains and companies relocating to or expanding in gigabit cities are all elements of this growth.

Broadband Communities' examination of all 3,144 U.S. counties shows a clear relationship between access to robust broadband and population gain or loss.

2015

FTTH Council Americas finds that access to fiber to the home increases a home's value by up to 3.1 percent. Using the National Broadband Map and a nationwide sample of real estate prices from 2011 to 2013, the study's authors investigated the relationship between fiber-delivered internet services and housing prices. The boost to the value of a typical home – $5,437 – is roughly equivalent to that added by a fireplace, half a bathroom or a quarter of a swimming pool. For homes where gigabit-per-second broadband was available, transaction prices were more than 7 percent higher than comparable homes where the highest speed available is 25 Mbps or lower.

Broadband Communities shows that the 20 states that restrict municipal broadband have lost rural population at a faster rate than other states even though overall population growth in those states is higher.

2016

Michael Render of RVA LLC surveyed MDU residents in the U.S. and Canada to find out what they would pay for access to ultra-high-speed, reliable broadband. Respondents were asked to consider what discount would have to be given on an otherwise equal $300,000 condominium purchase or on $1,000 monthly rent for them to live where they would not have access to fiber. Render showed owners would need an average discount of $8,628 and renters would require an $80 discount per month.

Fiber access increases residents' satisfaction with their homes and appears to reduce churn, helping building owners and operators maintain high levels of occupancy and provide a quality living environment. There is evidence that residents in MDUs with better broadband also spread the word, reducing customer acquisition costs for these MDU properties. Using base financial data from the National Apartment Association, the study estimates fiber can add 11 percent to net income for MDU owners and operators per average apartment unit. ❖

FTTH for Communities

By the end of 2016, 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. However, the bulk of communities that have FTTH are served by private carriers, and municipal efforts often focus on attracting private investment rather than on building municipally owned networks.

Questions Municipal Officials Ask About FTTH

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

A: 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 high-quality 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 the 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. In states that have such restrictions, rural counties are losing population faster even though the states as a whole are growing faster. **Overall, lack of broadband is responsible for almost exactly half the rural population loss in the United States.**

Municipal officials are 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 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.

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. Consider using tax increment financing or helping providers apply for grants.

If you own an institutional fiber ring that connects municipal buildings, schools and libraries, or if your traffic lights are connected by fiber, you might 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

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.

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 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 (goo.gl/RYX3hu) 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 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

1000+
U.S. companies and others are deploying FTTH.

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, 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?

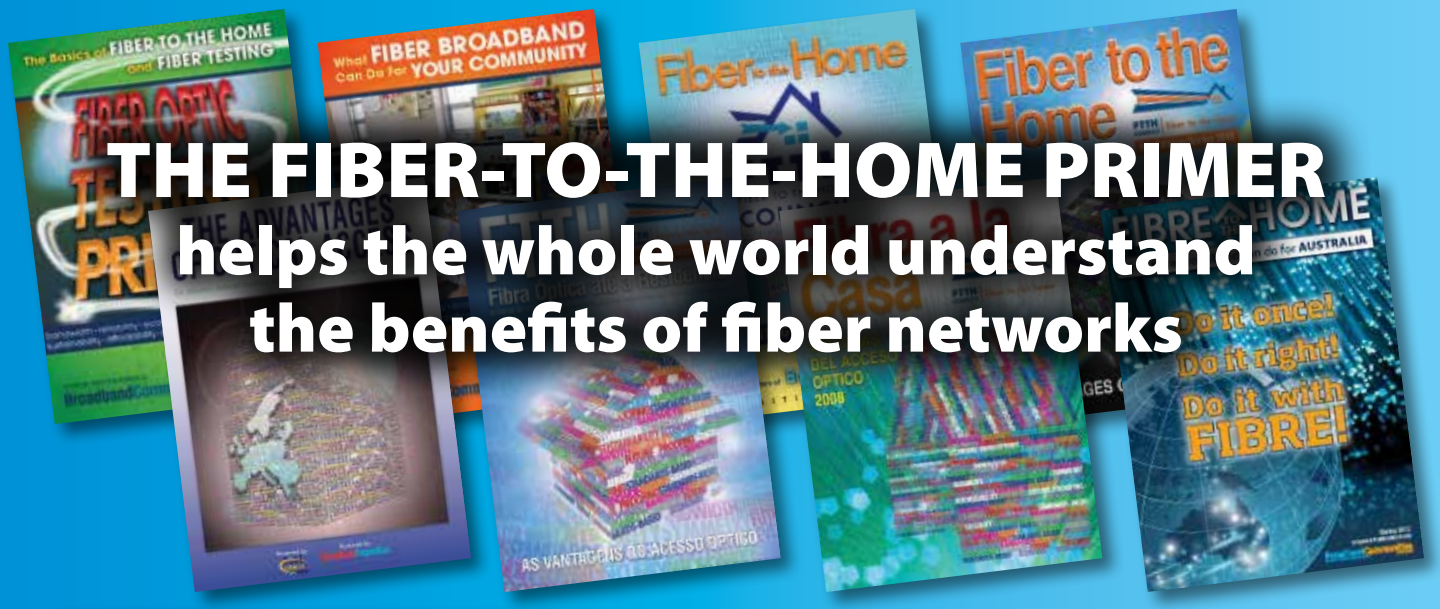
A: Both methods have been successful. Open-access networks, in which public or private network builders "rent" bandwidth to a potentially unlimited number of service and content providers, are more common in Europe and Asia than in the United States. However, they have succeeded here as well and offer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

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 federal broadband stimulus funds are required to allow open access.

Because both direct service delivery and open access have advantages, some communities are experimenting with different ways of combining the two models. ❖

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



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

Community 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 **Broadband Communities** has reported on.

CHARLES CITY COUNTY, VIRGINIA

Charles City County is a rural area between Richmond, Virginia, 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, which at press time had just gone live – including 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.

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

SANDY, OREGON

Sandy, a town of 10,000 in the forests 25 miles east of Portland, 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 Fiber who noted that Google is watching Sandy. Pietzold was surprised enough to clarify, "Sandy, *Oregon?"* Sure enough, Sandy's success is attracting attention.

TULLAHOMA, TENNESSEE

Tullahoma, with a population of about 19,000, has one of the older, established municipal fiber systems, already in its eighth year of delivering FTTH services. But the city isn't resting on its laurels; in 2012, it became the smallest U.S. gigabit city (since that time, even smaller cities have gone gigabit), and it continues to earn high marks for service quality, reliability and customer support.

LightTUBe Installer Robert Overman assists in a residential installation.

Of the roughly 9,000 premises now eligible to receive LightTUBe services, more than 3,500 are subscribers, including an estimated 50 percent of local businesses. Customers can subscribe to internet, telephone and video services. Residential internet offerings range from 30 Mbps/5 Mbps to 1 Gbps symmetrical, and Tullahoma Utilities Board (TUB) general manager Brian Skelton says the video service is "super high quality, with no compression off the satellite." To differentiate its service even further, TUB created two local TV channels, which broadcast local news, high school sports, school plays and community events.

In addition to selling triple-play services to residents and businesses, TUB is its own best customer: It uses the fiber network for several smart-grid applications. Its automated metering infrastructure (AMI) system reads electric and water meters and uses the fiber backbone to backhaul information from the wireless collectors. TUB now bills all its electric customers on a time-of-use rate, which it "couldn't do without AMI," according to Skelton. Other smart-grid applications include automatic reconfiguration of circuits to minimize the effects of outages and supervisory control and data acquisition (SCADA) to monitor and control the water and wastewater infrastructure.

Like many municipal broadband networks, LightTUBe contributes to the city's economic vitality. Tullahoma is trying to attract technology, health and retail businesses, and Skelton notes that the fiber network helped attract a new call center and enabled existing businesses to expand. It also attracted new residents who need to be able to work from home. "From an infrastructure perspective, we can be a one-stop shop for companies looking to move here," Skelton notes. "We can customize speeds based on their needs. They won't get 100 Mbps symmetrical service from twisted-pair or coax. Businesses need to send information out, not just receive information."

About 100 residential customers have now subscribed to the gigabit service tier. Even if the market for gigabit service is small, the fact that TUB can offer the service is a matter of civic pride, and TUB has generated excitement about it through ads, billboards and community sponsorships. "Most people think of LightTUBe as their utility," Skelton says. "The fact that we're owned by the community means that we think about customer service differently from our competitors." ❖

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.

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 median-price single-family home sales by the FTTH Council Americas showed that a fiber connection increases housing value by about 3 percent. A follow-on survey of higher-priced homes by the council in 2016 showed the same effect. Fiber equals higher prices.

Fiber adds value because FTTH subscribers (as shown in many surveys) 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.

7X

Growth in global video game traffic by 2020.

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 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, as well as managed Wi-Fi. 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: 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 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

2 MINUTES
The time for all the movies ever made to cross the global internet in 2020.

25
Gigabytes of IP traffic per month per capita worldwide by 2020 (up from 10 GB in 2015).

may govern where fiber optical network terminals (ONTs – the boxes that convert pulses of light from 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 (802.11ac and 802.11ad) can handle close to 4 Gbps wireless throughput, and some FTTH deployers now use wireless connections for all devices except whole-home DVRs. Creating a wireless home network requires careful placement and tuning of equipment, but it is generally much simpler and less expensive than rewiring homes, which was standard practice until very recently.

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 40 percent 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 many 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 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 40 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, California, 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 cellphone 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.

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 halving network power consumption and reducing the space needed for telecom closets and from the longer usable life of fiber.

FIBER TO THE UNIT IN DEER RIDGE APARTMENTS

Jamestown (aka "The Buffalo City") is a thriving city in North Dakota with a diverse economic base – the kind of place people want to move to. IRET Properties, a midwestern real estate investment trust, had already built rental properties there, but rental vacancy rates were still below 2 percent. As Steven Paul, IRET's regional manager, says, "This showed the need for quality housing in that market," so IRET decided to build another multifamily property.

Deer Ridge Apartments, which opened in fall 2015 with 163 units in three buildings, is now the largest apartment community in Jamestown. It's targeted to a broad range of middle- to upper-income residents – anyone from University of Jamestown students to empty nesters – and offers such amenities as a heated underground

"In the future, apartment properties might be branded or labeled in terms of their internet access as much as their curb appeal. If owners don't plan for that, they'll miss an opportunity."

garage, a game room and a fitness center. "The entire project is the amenities," Paul says. "That's what has differentiated us."

Once the plans for Deer Ridge Apartments got underway, the opportunity for a new type of amenity presented itself. Jamestown is a CLEC community for Dakota Central Telecom (DCT), a telephone cooperative based in Carrington, North Dakota, about 40 miles from Jamestown. Over the last few years, DCT has upgraded all its facilities, both in its home territory and its CLEC territory, and it is now 100 percent fiber-based.

Because DCT's service area is mostly rural, MDU buildings are relatively rare. DCT does serve another Jamestown MDU with fiber, but that building has copper cabling from the comm room to the individual apartments. As Deer Ridge was new construction, DCT saw it as a great opportunity to try out some new fiber-to-the-home technology that it hadn't had a chance to use before, such as indoor riser-rated microduct and 3mm pushable/pullable fiber, as well as managed Wi-Fi. IRET saw a great new amenity for its residents – an amenity that no other service provider in Jamestown was offering.

And the residents? After some initial puzzlement about where to plug in their computers, "they're excited about it," Paul says.

SAN TRAVESIA: POSITIONING FOR LONG-TERM COMPETITIVENESS

Things are percolating in the McDowell corridor, a formerly rundown, 8-square-mile portion of southern Scottsdale, Arizona. Ever since the mall that anchored the area closed, the city has promoted revitalization there; today, private capital is pouring in, and new jobs are opening up. The McDowell corridor has great potential because it's close to everything – the Phoenix beltways, the Sky Harbor Airport, Arizona State University, the quaint Old Town (Scottsdale's downtown area) with its financial and health care institutions, and the cities of Phoenix and Tempe.


San Travesia

"It's a phenomenal location," says John Carlson, vice president of the residential division of Mark-Taylor, one of Arizona's largest apartment developers. So phenomenal, in fact, that Mark-Taylor chose it as the site of a Next Generation community – the designation it gives its newer assets, whose living units, Carlson says, are "more like modern, custom homes" than like apartments.

Assembling the 29-acre site was a complex undertaking – Mark-Taylor had to redevelop several parcels, including the dilapidated mall – and took several years. It was worth the effort, Carlson says: "We felt this was the ideal product for an urban environment like south Scottsdale. An opportunity with this much space is quite rare. We leveraged the expansiveness by building the Valley's largest rental units. … We believe residents appreciate that apartments don't have to be compact just because they're in urban locations."

San Travesia (named after the Spanish word for "crossroads," not for an actual saint) opened in January 2015, complete with "everything a discerning apartment resident expects, and more." The property is already nearly half leased; the average resident age is 32, and the average household income is above $100,000. Residents include both empty nesters moving out of their houses and young professionals who aren't ready to buy their first houses.

One thing Mark-Taylor expected discerning residents to want was good internet access. Fortunately, the property was being planned at about the same time as Cox Communications' 1 Gbps service, branded as Gigablast. When Cox approached the developer about installing the new technology at San Travesia – based on fiber to the unit and wireless 802.11ac gateways – Carlson jumped at the chance. "Our strategy is long-term hold," he explains. "We're not looking to exit. We wanted to be armed with the right technology to take care of our residents on a going-forward basis."

The choice appears to have been a good one. When the property first opened, leasing agents had to explain to prospective residents what a gigabit was; today, residents tell their friends about the gigabit service, and the friends call the leasing office to ask when they can move in. The property is 9 percent ahead of its rent projection – which, given that Mark-Taylor prides itself on accurate projections, is "very significant," Carlson says.

The company's next three developments will all be Gigablast communities. "There's no going backward at this point," Carlson says. "The take-home is that, as you move into the future, apartment properties might be branded or labeled in terms of their internet access as much as their curb appeal. If owners don't plan for that, they'll miss an opportunity." ❖

For More Information – Digging Deeper

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'** database at www.fiberville.com shows all FTTH deployments in the United States.

Broadband Communities' investor feasibility models and monthly cash flow models for FTTH are 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 of 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 of getting started, organizing your community, creating a business case and building a network.

LEGAL AND FEDERAL

The law firm of **Baller 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 Commerce Department's **National Telecommunications and Information Administration** (NTIA, www.ntia.doc.gov/category/broadband) 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** regulates broadband providers and oversees the Universal Service Fund, which supports broadband in high-cost 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-utilitiesservice) 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)

61X
Growth in global virtual reality traffic by 2020.

64X
Growth of global internet traffic from 2005 to 2019

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

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 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.

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 154 member cities at the end of 2016. 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.

NTCA – The Rural Broadband Association (www.ntca.org) represents small and rural telecommunications carriers, of which a substantial portion have deployed some fiber to the home. It sponsors a Smart Rural Community program and a Certified Gig-Capable Provider program.

The **Multifamily Broadband Council** (www.mfbroadband.org) advocates for independent broadband operators and service providers that serve multifamily housing communities, fostering knowledge and networking among its members.

2X
Growth in peak-hour internet traffic is twice as fast as growth in daylong traffic.

66%
Percent of data traffic worldwide from mobile and Wi-Fi in 2020, up from 48% now.

The FTTH Council is here to serve you.

Grow your Business

Become a Fiber Community

Know the Latest Technology

Network and Access Customers

Join our 300+ membership of network operators, manufacturers, consultants, municipalities and others interested in promoting the benefits of all-fiber networks.

FTTH
FIBER TO THE HOME
COUNCIL
AMERICAS

For more information and to join, visit www.ftthcouncil.org