FTTH Primer for Developers

We explain how FTTH works – and why property owners should care

Steven S. Ross ■ *Editor-in-Chief*

DSLAMs. DSL. ONTs. OLTs. Pedestals. Microduct. 802.3ah. RF. IPTV. To the typical developer who has been living with coax and satellite dishes, the new brew of acronyms is daunting. It shouldn't be. Behind the alien terms are some rather simple concepts.

The key concept is this: Fiber optic cable carries information by carrying pulses of light. The pulses are turned on and off very, very fast. Multiple streams of information get carried on the same fiber at the same time by multiple wavelengths of light. The pulses of light are created by light-emitting diodes that are built right on to the circuitry of the chips that control them. These specialized circuits keep getting faster, so the same old fiber can be used to carry ever more information. New equipment is just slipped in.

The ability to carry information is called **bandwidth**. Lots of bandwidth allows lots of information to be carried.

Fiber has a lot of advantages over copper wire or coaxial cable, as it is easier to maintain and delivers far more bandwidth. Three of the biggest advantages for property owners are:

1. Signals travel a long distance inside fiber cable without degradation – 20 miles or more under some circumstances. In contrast, as the distance traveled by a signal in copper wire or coax increases, the bandwidth decreases. Short lengths of coax, for instance – the lengths typically found in a small building – can carry 1 Gbps. That's a thousand times more bandwidth than typical broadband service using DSL over copper wire, and 200 times more than typical broadband over cable TV coax. But those speeds are impossible over longer distances. The closer fiber gets to your building, the faster the service that is available to your tenants. Service providers have been bringing fiber closer and closer for years, even if they haven't brought it inside your property. The process "shortens the copper loop" to your building, by replacing part of it with fiber.

2. Fiber cable is thin. It can, in fact, be made thinner than a human hair. It can be carried by a thin ribbon, or inside a "microduct" of hollow plastic less than an eighth of an inch wide. One typical fiber cable configuration with about 200 super-thin strands is about the thickness of a standard coax cable. That fiber cable could theoretically carry enough bandwidth to handle all the information being sent on Earth at any one time today. The bottom line: Fiber can be "hidden" easily on the surfaces of walls in old construction.

3. Once installed, fiber is upgraded by changing the electronics that creates the light pulses, and not by replacing the cable itself. The fiber is amazingly reliable. Nothing hurts it except a physical cut, or the destruction of the building it is in. Passive optical networks, or **PON**s, use a minimum of electronics. In fact, there may be no electronics at all between the provider's central office and your building. **Active** networks are more flexible, but use more electronics.

Bandwidth providers are increasingly bringing fiber optics all the way to customer premises. That technology, **FTTH** or fiber to the home (also called FTTP, for fiber to the premises or FTTx for fiber to everyplace) is the "gold standard." But in cases where population density is too low, or where high-quality coaxial cable or copper networks exist, it may make sense to bring fiber only part-way to the customer. The fiber is then connected to the existing networks. As time goes on, fiber is moved closer and closer to the customer, to provide more bandwidth. That approach is called **FTTN** for fiber to the neighborhood or (for greater bandwidth) fiber to the curb (**FTTC**).

In the US, single-family suburban homes have been the easiest to equip with FTTH. MDUs and urban residents are starting to be served with FTTH in really large numbers just this year. MDU fiber service is common in Europe and Asia, however.

Associated Hardware

Much of the alphabet soup of acronyms has to do with devices that convert electrical signals that travel in wires, to pulses of light and back again.

OLT stands for Optical Line Terminal. OLTs put the pulses on the fiber in the first place. As a property owner, you will rarely see them.

ONTs are Optical Network Terminals. They are the devices at the consumer end that turn the light pulses back into electrical signals. Usually, customers will have equipment such as computers that expect an Ethernet connection. This is a standard way of networking that's used around the world. Your computers, and perhaps your little home Wi-Fi system, all use Ethernet. Ethernet connectors are built into virtually all computers that have been sold in the past three or four years. So a typical ONT turns the light pulses into Ethernet signals. In the United States the ONTs are typically inside cigar-box sized enclosures on the outside walls of houses or apartments.

Companies that may wish to gain access to your property, or to joint venture with you, are often nervous about the technology themselves. Thus, they often deal with fiber optic network vendors that offer "end-to-end" technology. That is, they guarantee that everything will work together, reducing risk. This magazine has enumerated almost 700 large fiber-to-the-home systems. There are thousands more that are fiber to the curb or to the neighborhood. So the technology risk is low as well. More important is the business sense and commitment to service of the people you will be dealing with. Those qualities are easier for most property owners to judge.

But they can be made smaller than a deck of cards, and could be used inside customer premises as well.

You'll sometimes hear about **DSLAMs**. The term stands for Digital Subscriber Line Access Multiplexers (DSL Access Multiplexers for short). DSLAMs used to be only in telephone company central offices, where they connected customers' DSL loops to the high-speed lines that carry the signal away to the rest of the network.

Increasingly, DSLAMs and a DSLAM substitute, the **MSAP** (Multi-Service Access Point) are being located closer to your building, so that the copper lines that carry DSL can be shorter. That increases bandwidth. MSAPs typically add Ethernet management capabilities that make service easier to provide and monitor. MSAPs and DSLAMs can be in nearby plastic or metal enclosures, inside manholes, and sometimes even in your building's basement. You'll also hear about the **point of presence**. That's the point at which the signal from multiple customers joins the rest of the extended network.

Hybrid fiber coax, or **HFC**, is the cable company's coax, with fiber bringing the signal fairly close to the building, or even into the basement or a central area on your property.

Pedestals are enclosures that hold DSLAMs, MSAPs, ONTs, and **beam splitters** that take the signal from one fiber that extends back to the central office, and divides it (typically 8:1 up to 32:1) among fibers that go to individual dwelling units. Pedestals can be below ground, above ground (they often look like short posts or squat air-conditioner-size boxes), or attached to buildings. Connections and splits can also be made in boxes hung under eaves, in attics or basements, on telephone poles, or on what look like power lines or phone lines. For best reliability, many contractors bring two fibers into each dwelling unit from the pedestal, not one.

Managing the Network

There are many standards-setting bodies that serve the networking industry. Foremost among them is the Institute of Electrical and Electronics Engineers, or IEEE. This group, international in reach but American-based, worries about the ways signals are sent, managed, interpreted and kept secure from intruders. The common Wi-Fi standards (802.11b or 802.11g, for example) are from IEEE. So are most of the standards for Ethernet. The standards do not cover everything. So many vendors have to add their own "extensions" to make everything work smoothly. That's a necessary evil. But avoid vendors who ignore the standards entirely, and use their own proprietary methods and software *in place of* IEEE standards.

Physical standards – the ones that ensure that plugs will mate property – are mainly the realm of the TIA, which stands for the Telecommunications Industry Association. This is a trade association. But what about durability, or ability to withstand high temperatures or moisture? The technology has been moving so fast that standards-setting bodies can't entirely keep up. Many independent groups, such as Telcordia (a private company) have developed their own testing standards to assure reliability. You will see them show up as references in contracts.

There's nothing entirely unusual about any of this. Your property is subject to standards from the National Electrical Code, building and fire codes, Underwriters Laboratories, and so forth. But the organizations that are responsible for fiber may be strange to you. Get acquainted with them on their Web sites.

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Delivering Services

All pulses of light look the same to fiber, and to consumers' equipment. The pulses get converted to Ethernet signals that move over Ethernet wiring (typically **Category 5** or **Category 6** wiring, **Cat5** or **Cat6** for short). Many companies make special equipment that converts the cable company's coax, or your buildings electrical wiring, so that it can carry an Ethernet signal. Such setups may require that the same company's equipment be used at both ends of the wire – that is, one "box" turns the signal into "Ethernet" over coax and the other turns the signal back to something customers' TV sets understand. These devices tend to offer an interim solution, but some companies' technology is so robust that it can be depended upon for many years.

If all pulses look the same, what's the difference between video, voice, and data?

Zeros and Ones

Theoretically, there is no difference. But each requires special skills on the part of providers. Voice, for instance, does not require much bandwidth; 100 kilobits per second will carry a high-quality phone conversation over Ethernet. A regular "analog" phone line uses as little as 8 kbps. But the voice signal must be very clean, with no noticeable delay and no static. That's difficult to do on a network such as the Internet, which is used for many purposes at the same time.

Technical people thus describe voice as requiring a high **QoS** (quality of service and the low bandwidth. Telephone service over digital data networks is called **VoIP** for Voice over Internet Protocol. Cable companies until last year were offering both VoIP and switched telephone services (similar technically to regular telephone company services). But they are now transitioning quickly to VoIP.

Video also requires good QoS, but not as good as voice. Small delays and a bit of static will often go unnoticed by viewers. But video requires a lot of bandwidth – 3 Mbps for standard-definition TV, and as much as 20 Mbps for the new high-definition TV, or **HDTV**. Even 3 Mbps is the equivalent of 30 simultaneous phone calls.

But the video world is changing. Part of that change is already obvious: Cable companies are offering video on demand, or **VOD**. To deliver, they have to send extra signals down the coax, to individual customers.

This increases the need for high quality service. Today, almost all of those signals arrive as **RF** (radio frequency or analog) signals. Even when the signals move over fiber, they are treated as if they are RF.

This is changing. The new technology is **IPTV**. In IPTV, the video moves as data, using the same Internet Protocol (hence IP) as any other data. As IPTV develops over the next few years, expect thousands, even tens of thousands, of channels, mainly sending video on demand to consumers, who will be able to view the video on computers or portable devices (think iPODs) as well as on conventional TV sets. Verizon's FiOS video service is mainly RF (for the time being), with IPTV for program guides and VOD.

Satellite TV vendors, who now count almost a fourth of American households as subscribers, cannot directly compete with VOD, because they can only send signals one way – from satellite down to subscribers. But some video providers are supplementing the satellite feed with VOD through a terrestrial network, fiber or coax or both. They can also package personal video recorders with their services.

Data is requiring more and more bandwidth to meet consumer needs, although 1 to 5 Mbps is typical. QoS needs are not as great as for voice or video, because the Internet Protocol automatically splits up data streams into "packets" of zeros and ones, and reassembles them when they arrive at their destination.

They do not have to arrive at the same time, as long as they arrive within a short period – typically a few fractions of seconds but sometimes much more.

Providers of all of these services have been used to thinking about consumers' bandwidth needs as **asymmetrical**. That is, the bandwidth has to be higher on one direction (the inbound direction to consumers) than the other. Few consumers create video now, for instance, but almost all view it from elsewhere.

Likewise, most users download more data than they upload. But those patterns have been changing. In much of Europe, where providers have offered symmetrical bandwidth, users have tended to upload more data, and even to create their own video.

In the US, service providers have started to talk to Congress about being allowed to charge different users of the network different fees, depending on QoS as well as on bandwidth.

Phone and cable companies, for instance, are incensed that third-party VoIP companies such as Vonage "ride free" over their networks, as long as customers pay for the bandwidth in the first place. (They could block these third-party services, but worry now about annoying customers and attracting regulatory scrutiny.)

A "quality-priority" based pricing scheme would be radically different from the approach elsewhere in the world, where governments are simply pushing for universally high bandwidth and QoS.

The key rule, when contracting with bandwidth providers, therefore, is to think ahead. Today, Verizon is offering more bandwidth in more places than anyone else in the US – its FiOS service can be purchased with up to 30 Mbps download bandwidth and 5 Mbps upload. A few local US providers are offering even more. But 100 Mbps and even 1 Gbps is available at the same price in Hong Kong and through some large providers in Japan and Korea. **BBP**

About the Author

Steve Ross can be reached via email at steve@broadbandproperties.com.