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Broadband Deployment & Connectivity

IN THIS ISSUE

Deployment • Fiber & WiFi • Litigation • Legislation • Reconfiguration

fiber to the premises and the node:

Key Technical Issues for Local Government

America's communities are experiencing the largest communications infrastructure construction projects in a generation, as Verizon, AT&T, and other Regional Bell Operating Companies (RBOCs) construct Fiber-to-the-Premises (FTTP) and Fiber-to-the-Node (FTTN) systems. The RBOCs promise that these systems will deliver state-of-the-art voice, video, and data services.

This article offers a technical analysis of these systems. The article summarizes the architecture of these systems, compares them with cable systems, and contemplates future technical developments—and additional future construction in the public rights-of-way (ROW).[1]

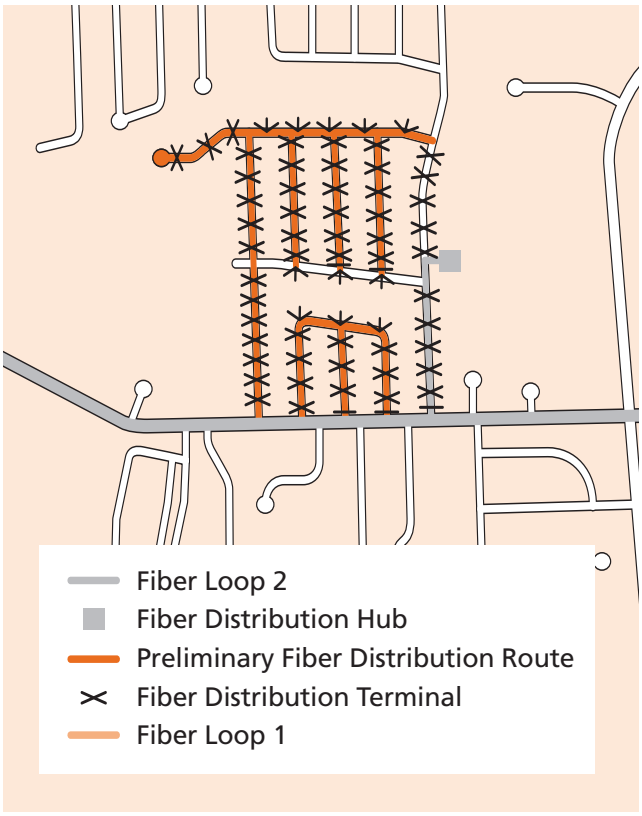
Broadband Deployment & Connectivity

FTTP

FTTP is the architecture Verizon is deploying in limited parts of the US – in other areas, it has chosen to rely on its current copper plant and DSL technology. FTTP is planned for deployment by AT&T only in new build areas, at least to date.

BY ANDREW AFFLERBACH, Ph.D., P.E.

Figure 1: FTTP architecture at the neighborhood level



FTTP is a flexible and capable technology. Compared to other forms of communications transmission, it boasts the highest theoretical capacity per user. It makes possible a wide range of potential applications and services, and enables the RBOC to constantly upgrade capability and capacity simply by upgrading end equipment and software, while using the same fiber cable.

It is an understatement to say that building an FTTP system is an enormous scale project. Localities that experienced recent Verizon builds underwent the largest communications builds in the ROW since cable systems were first deployed in the 1970s and 1980s. In these builds, fiber is constructed down every street, major or minor, where there exist potential customers – both business and residential. Simply put, these builds are touching nearly every ROW in affected areas.

Network designs call for expanding existing RBOC backbone fiber rings to deploy fiber throughout the system, replacing existing copper all the way to the curb (and into the homes of those customers who subscribe). This scope is significantly more burdensome to the ROW than were the cable upgrades of the late 1990s, which deployed fiber deeper into the systems but tended to touch only major arteries, not all rights-of-way. In Montgomery County, Maryland, for example, a community of just over 900,000 people, Verizon constructed more than 1,000 miles of fiber in a couple of years, in a densely-populated suburban area.

FTTP Architecture

At the neighborhood level (illustrated in Figure 1), the usual FTTP architecture calls for backbone fiber on the primary arterial streets, which meets the local distribution fiber at a cabinet placed in the ROW. The local distribution fiber then travels from the cabinets to pedestals or pole enclosures in front of the homes and businesses throughout the community. Depending in part on whether they are backbone or distribution plant, the cables typically contain 24 to 432 strands of fiber.

With respect to new electronics in the ROW and at customer premises (illustrated in Figure 2), this architecture generally calls for:

- Optical Network Terminal (ONT) boxes on the outside of subscribing premises
- Passive (non-powered) Fiber Distribution Terminals (FDT) in pole enclosures or pedestals
- Passive (non-powered) Fiber Distribution Hubs (FDH) in cabinets

FTTP Services

FTTP systems are capable of delivering a wide variety of high-bandwidth applications and services, including analog and digital **video** (viewable with or without a set-top converter, depending on whether IP or cable-based technologies are used). Standard cable-style signals are available from a port on the ONT.

These FTTP systems are theoretically capable of providing up to 1000 Mbps of **data** per customer, though current Verizon plans call for 5 to 30 Mbps downstream and 2 to 5 Mbps upstream. Hardware and software changes make possible increases in throughput without modification of outdoor fiber plant.

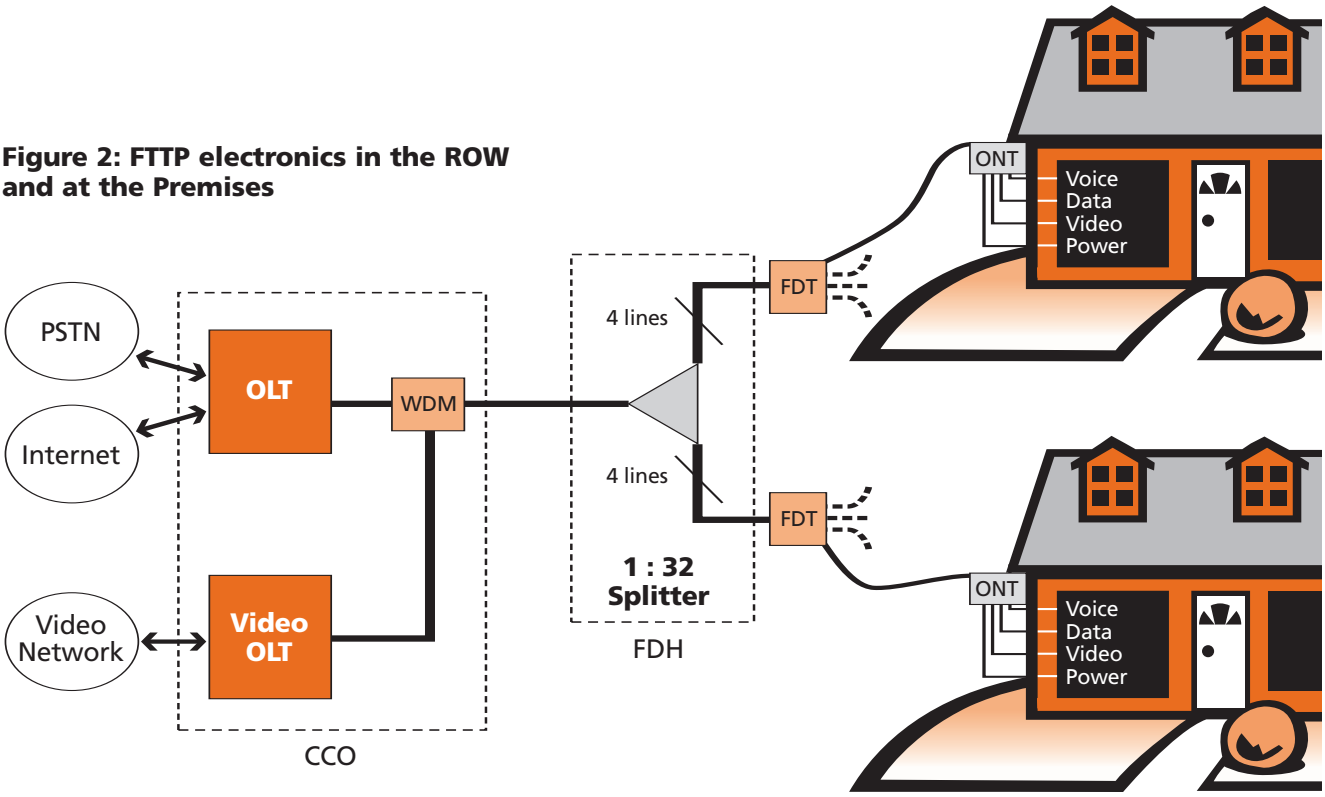
The systems are capable of both circuit-based and IP **voice** services of quality comparable to traditional phone services. The system is powered from both the Central Office (CO) and the home, but the customer is now ultimately responsible for powering – an important distinction from traditional phone networks, which powered the phone line from the CO down the copper phone line. Fiber does not carry electrical current, so backup powering is now required at the customer premises—if power goes out, the system's only backup is a battery located at the home that will typically last four to six hours.

FTTP Construction

Aerial construction entails overlash of fiber to the existing strand, spliced at new splice enclosures. For new subscribers, the technicians install new drop cable (and remove old copper lines) at the time of installation. They also install an ONT at the premises and

[1] This article is current as of this writing, but some of the technical parameters of these fiber builds are changing. For example, AT&T is reportedly considering deploying fiber deeper into some of systems than called for by its original designs. This possibility will be discussed further below.

Figure 2: FTTP electronics in the ROW and at the Premises



connect to existing power, home cable, and telephone wiring.

Underground construction entails construction of new conduit in public utility easement and to the home and installation of fiber cable in that conduit. In addition, there is installation of cabinets for FDH, new pedestals for FDTs, and an ONT on the customer premises.

FTTN

The FTTN architecture planned by AT&T Project Lightspeed (and potentially by Qwest and Bell South, which AT&T is attempting to purchase) is actually the next generation of Digital Subscriber Line (DSL) technology known as VDSL or enhanced DSL.

VDSL Architecture

In most areas (other than new developments, which may see FTTP construction), AT&T is planning to deploy this VDSL architecture. Fiber will be deployed to the node, but this architecture calls for retaining up to 3,000 feet of existing copper lines from the node to the home or business. The reason for implementing VDSL is clear—AT&T is avoiding the enormous expense (and time) to construct fiber down the majority of rights-of-way and to the premises. The actual fiber construction contemplated is a fraction of what Verizon is doing in its FTTP builds.

As is illustrated in Figure 3, AT&T plans to build backbone fiber on primary arterial streets. The fiber will terminate at a powered DSL Access Module

Figure 3: FTTN architecture at the neighborhood level

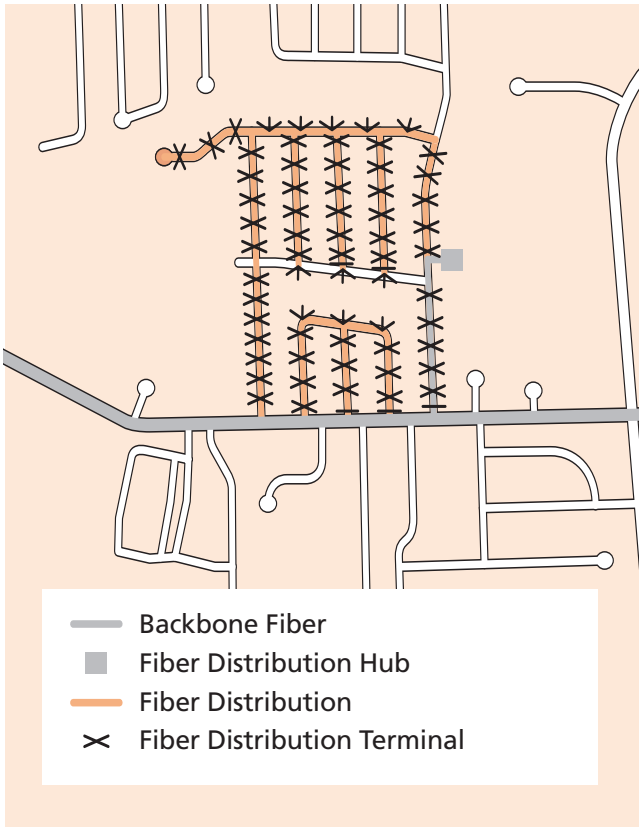
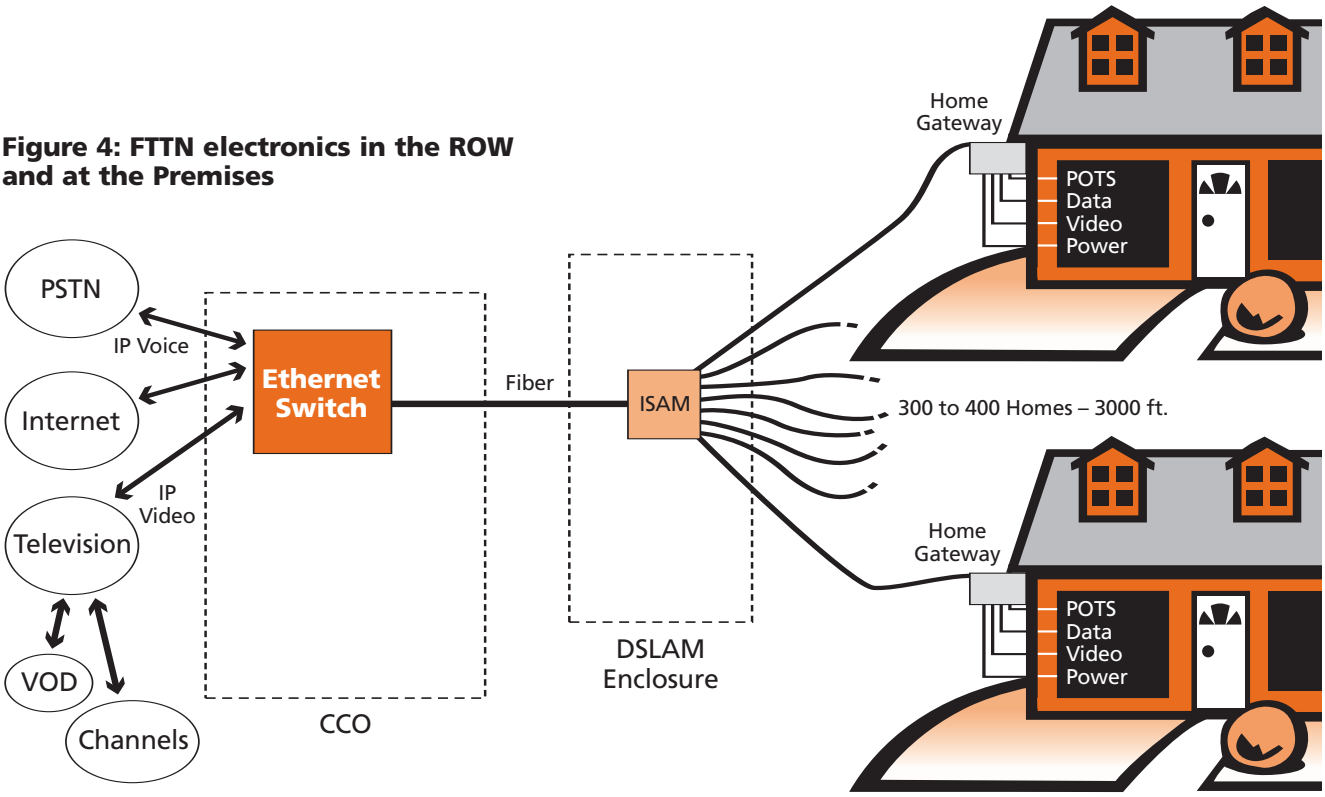


Figure 4: FTTN electronics in the ROW and at the Premises



(DSLAMs), which will be housed in a large cabinet comparable to the size of a refrigerator. The DSLAM provides the interface between the backbone fiber and the existing copper, which travels from the DSLAM to the home or business. A Home Gateway at the dwelling or business will connect with existing cabling in the premises (see Figure 4). The cabinets will house the DSLAM, batteries, and fiber/copper terminations.

The cabinets will be placed in the ROW approximately every 3,000 feet or so in order to make feasible an architecture that requires up to 3,000 feet of existing copper from DSLAM to Home Gateway. These cabinets are far larger than those necessary for the FTTP builds described previously.

VDSL Services

Voice, video, and data will be transmitted (actually, streamed) in Internet Protocol (IP) packets. IP represents the best mechanism for trying to stretch the limited capacity of AT&T's dated copper plant. Additionally, voice may be provided simultaneously over the line using analog telephone technology.

The planned systems will require an IP set-top converter for each television and will offer very limited bandwidth for video. The copper lines carry only a few channels at once—and perhaps no more than one HD channel at a time.

The theoretical data capacity of this architecture is up to 25 Mbps per customer. At the moment, however, AT&T plans to offer 1 to 6 Mbps downstream and up to 1 Mbps upstream. The remainder is required to offer video.

IP voice services will convert to standard telephone signals at the Home Gateway, which interfaces with existing phone, data, and video cabling. It also contains a built-in wireless interface. Power for IP voice will be inserted at the CO, the DSLAM, and at home, and—as with FTTP—the customer is responsible for powering in the event of an outage. Built-in battery backups at home will last only four to six hours. If voice is provided using analog telephone technology, however, the voice service will continue to operate in the event of an outage.

How Does Cable Compare?

A rapid evolution is expected for all these technologies, but it's safe to say that cable systems (which use a mix of fiber and coaxial cable) and FTTP systems (which use fiber) will not require the same future construction as will VDSL (which relies on that old copper).

With respect to current services, cable modem **data** speeds are currently faster than VDSL but slower than FTTP. This hierarchy is likely to remain true, because fiber has the highest theoretical speed limit. In the area of **video**, cable and FTTP operate similarly in that they simultaneously bring all channels to each premise, and the subscriber can choose among all available channels. VDSL is somewhat different—it uses IP video to stretch the transmission capacity of copper and therefore provides only up to a few channels at once—those selected by the subscriber at that moment.

With respect to **voice**, all these networks are capable of carrier-grade quality. All FTTP voice systems require power to be inserted at the home, as do some cable voice products. Generally, cable voice provided over IP will require home powering. In contrast, for the most part, circuit-based cable voice will draw

power from the cable system and not require home powering. Likewise, voice provided over VDSL using analog telephone technology will not require home powering.

And More to Come?

There has been some recent speculation in the media that AT&T is considering deploying fiber deeper into its systems in some highly-desirable neighborhoods where the limitations of VDSL are likely quickly to be reached. We do not know of any firm plans in this respect, but it is clear to us that VDSL is a short-term solution in a market where bandwidth needs are growing exponentially and high capacity is increasingly needed for popular emerging applications like gaming, video-gaming, video-downloads, and video-conferencing. The RBOCs' 100 year-old copper plant is not capable of meeting these needs in the long-run – no matter how sophisticated the electronics become – and future upgrades to more fiber are inevitable. In other words, this round of construction in the ROW is not the final round by any means. ■

REEL TIPS

Fresh Ideas for Programmers

Programmers - are you overwhelmed with the everyday challenges of managing and producing for your channel? A new feature has been added to the NATOA® Journal! Each issue look here for quick tips and fresh ideas.

When shooting a live event with multiple cameras, there may come a time during post-production when an editor needs to insert footage from a servo camera or re-cut entire sections from servo camera footage. Of course, the easiest way to do this would be to have time code from the master record deck inserted into all the servo cameras. This is often a technologically difficult task for most low budget productions where cameras do not allow for the insertion of time code.

An easy and low tech way of solving this problem is to fire a photographic flash from a camera when all servo cameras begin to roll tape. A camera flash fires at 1/1000th of a second. That means that only one frame of video at 1/30th of a second will contain that flash frame. If you match that frame of video on the master tape to those on the servo tapes, and there is no break in the recording, you will have sync for all of your servo tapes. This method works well indoors but can be used outside if your cameras are zoomed into a dark colored card and the flash is placed about a foot away from it.

Submitted by Howard Kleinstein, Cable Production Coordinator, Village of Mount Prospect, IL

Have a preventative maintenance system in place that involves routine inspections and cleanings. Have a back-up plan for all major pieces of equipment. Have tech support and vendor numbers easily accessible, along with serial numbers and invoices. Consider stocking a back-up supply of parts for those quick fixes, if it makes sense within your budget.

Submitted by Tom Sobel, Video Producer, MetroTV, Louisville, KY

The Pentagon Channel is the Department of Defense's cable television channel. We broadcast military news and information for and about members of the U.S. Armed Forces. Our programming is free to PEGs. You can get a feel for our offerings at http://pentagonchannel.mil. We stream live on this site 24/7 and archive our programming for video-on-demand viewing, as well.

Submitted by Maxine Teller, Director of Distribution, Pentagon Channel

Need talent? Look in your backyard. High school students needing to complete community services hours can be helpful serving as production assistants or continuity assistants. High school students also love the web. They use it to create their own web pages, logs and music.

Think about contacting the drama departments at the community colleges. They may be students but they are committed to honing their craft as actors, make-up artists, graphic artists, musicians and other production areas. The same can be said for your local theatre groups.

Many of them are quite talented and will add fresh ideas!

Submitted by Donna T. Keating, Program Manager, Montgomery County Government, MD

Is this an election year? When the new administration takes office, schedule meetings with all stakeholders including your legislative and executive branch representatives, department heads, division chief, program managers, etc. Show them now how your station can deliver their message effectively to their audience.

Submitted by Donna T. Keating, Program Manager, Montgomery County Government, MD