

The Telecommunications Act of 1996 opened the telcos to local competition. At roughly the same time the Internet took off. There were already millions of PCs in US homes, and, for most households, the only way to connect a PC to the Internet was through a POTS line. Subscribers soon grew tired of having their primary lines tied up and began ordering additional POTS lines for Internet access. Millions of additional POTS lines!

pected demand, with two distribution pairs dedicated to each home. Nobody could imagine any subscriber wanting more than two POTS lines.

From the 1970s onward, most new residential neighborhoods were built this way: CTTH, two pairs per home, with distribution cables buried under several feet of dirt, streets, sidewalks and landscaping. This is the layout for the copper distribution in a development I'll call "Ross Highlands" – an actual residential neighborhood of 748 single-family homes built about 15 years ago.

FIBER TO THE "X"

Digital transmission and fiber optic technologies came into use in the 1980s. Telcos quickly deployed both technologies in their interoffice networks between COs. By 2000, most COs had been connected by high-speed digital trunks running on fiber optic cables.

Things went a bit slower for subscriber loops.

In the 1970s, the most urgent job was building more copper loops to accommodate new POTS lines and to get rid of party lines. Bell Labs stepped up to the challenge by inventing the "digital loop carrier" (DLC) system. A DLC extends POTS line circuits to distant subscribers by digitizing and multiplexing the signals from local loops onto a single data stream from the DLC to the CO. Many POTS lines can be multiplexed onto a handful of digital T1 signals for transport to the CO. DLCs were quickly adopted to reduce the amount

of new copper needed to cope with the pressing demand for more POTS lines.

By the early 1990s, a new breed of fiber-fed DLCs appeared: the "next-generation digital loop carrier" (NGDLC). Fiber-fed NGDLCs can handle up to 2,000 POTS lines in high-density suburban applications. Some NGDLCs even extend fiber almost all the way to subscribers' homes. This is called "fiber-to-the-curb" (FTTC) or "fiber-in-the-loop" (FITL).

DLCs, NGDLCs and FTTC have three things in common:

They all substitute electronics for copper in order to deliver POTS more efficiently. Of course there were requirements for "special services," and DLC suppliers were continually challenged to come up with the right combination of line cards to please the telcos' network planners. But these systems were designed, built and bought primarily for POTS. And POTS is, primarily, what they do.

They are designed to serve 100 percent of the homes and whatever businesses are within about two miles of the remote sites – that's a 100 percent market share.

They all rely on copper to reach the last few hundred or few thousand feet to subscribers' homes – still CTTH!

THE RULES CHANGED IN 1996

The Telecommunications Act of 1996 (TA96) opened the telcos to local competition. Telcos didn't immediately realize TA96's implications because of another event that happened at roughly the same time: the first commercial Web browsers were introduced and the Internet took off like a shot. There were already millions of PCs in US homes, and, for most households, the only way to connect a PC to the Internet was through a POTS line. Subscribers soon grew tired of having their primary lines tied up and began ordering additional POTS lines for Internet access. Millions of additional POTS lines!

Telcos were taken by surprise by the increased demand. They scrambled to catch up. They added capacity to COs. They added thousands of new NGDLCs. And they added thousands of miles of fiber to connect the new NGDLCs to COs.

Thanks to the two-pairs-per-home design rule adopted in the 1970s, telcos usually didn't need to add more copper cables in existing neighborhoods. For the last few hundred or few thousand feet to the subscribers, CTTH was still the rule.

THE MARKET CHANGED IN 2000

POTS growth stopped. In fact, telcos began to lose POTS lines. Since 2000, US telcos have lost more than 40 million POTS lines. They are currently losing POTS lines at an annual rate of 7 percent. Many subscribers who rushed to telcos to order additional POTS lines in the 1990s rushed away to order cable modems for faster Internet access. Some consumers discovered that cell phones met their

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needs for voice service and cancelled their POTS subscriptions altogether.

Telcos began scrambling for strategies to replace their lost POTS lines and the revenues and profits lost with them. It soon became apparent that telcos would need to rebuild the CTTH networks that they had spent the last century building. They would need to change their technology from electrical circuits to digital packets, and to create new, compelling multimedia services to be carried by these packets. And they would need networks capable of delivering billions of packets to millions of homes every hour of every day.

PACKETS TO THE PEOPLE

The telcos' engineers have risen to these new challenges with two technology solutions: the "digital subscriber line" (DSL) and fiber. A DSL has an encoder and a transceiver at each end of a pair of copper wires. It encodes information as digital data, organizes the data into packets, and transmits the packets to the distant transceiver. A DSL uses frequencies that are well above those used by a POTS circuit, so it can operate on the same copper pair as a POTS line.

The latest DSLs can deliver about 30 Mbps worth of packets over a cop-

per loop up to 3,000 feet long. If a subscriber loop is longer than 3,000 feet, the DSL delivers fewer packets because of attenuation and interference from other signals.

For long distances, a telco needs a medium with low attenuation and immunity to electrical interference. A telco needs fiber! Fiber is ideal for transmitting large quantities of packets from one point to another – for example, from a telco's CO to a subscriber. A telco can organize its packets into multimedia services, such as the voice/Internet/TV "triple play," and it can combine the packets in ingenious ways to create new services. Telcos desperately need the revenues and profits from these new services to replace those they lost along with their POTS lines.

So, all they need to do is to replace their copper with fiber...right?

FIBER TO THE HOME

Almost everyone agrees that FTTH is the way to go for new residential neighborhoods. Methods and materials are now available to enable all-fiber distribution in new neighborhoods. In fact, a new neighborhood can be built with fiber at a lower cost than with copper. And the superior capabilities of fiber should enable the telco to capture and

keep a higher market share in the face of whatever competition it encounters.

Major telcos and their suppliers have collaborated on new international standards for FTTH, and hardware built to these standards is coming onto the market in volume. The latest standard is the ITU G-984 specification for "gigabit passive optical network," or GPON, which allows up to 64 homes to be connected through a passive optical splitter to just one strand in a fiber feeder cable. (The party line stages a comeback!) The splitters are housed in a new form of FDI, now called a "feeder distribution hub" (FDH), located about where the FDI would normally be.

But what about existing neighborhoods like Ross Highlands?

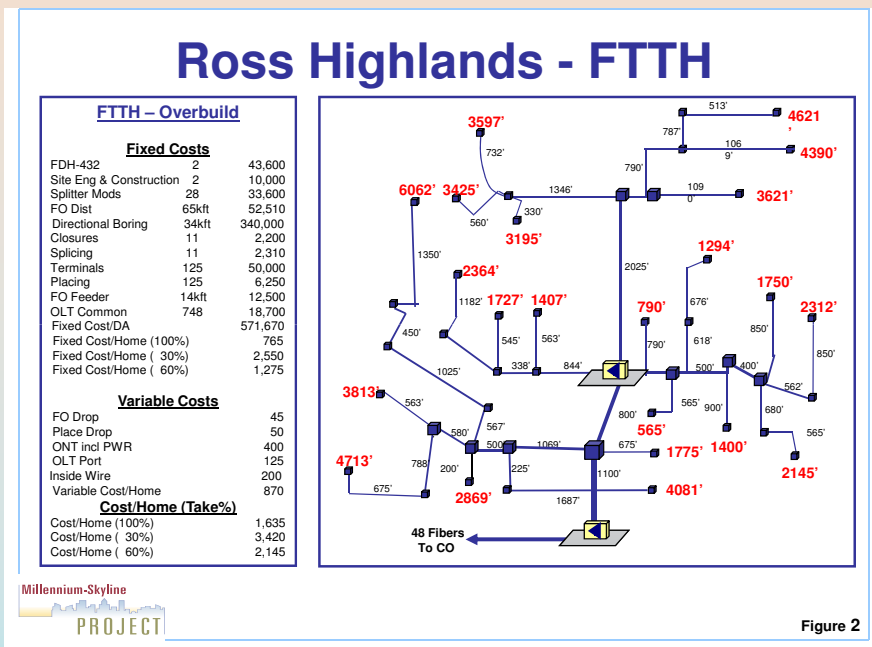
If we were building the distribution network in Ross Highlands today, we would do it with FTTH, probably GPON. We could build FTTH for about what it would cost to build CTTH, or maybe a little less. We would build our network to serve all 748 homes, and we would probably get most of them to "subscribe" to our services because our network would be installed along with the other utilities before the first homes were constructed.

It's a different story if we want to replace the existing CTTH with new FTTH. To the left is our plan for overbuilding Ross Highlands.

We'll need to install over 34,000 feet of new fiber cable, and most of it will require directional boring at about \$10 per foot. We'll need to install two FDH boxes with splitters. We'll need to place and splice 125 fiber terminals. We'll spend almost \$600,000 before we can connect the first subscriber. Then, we'll spend another \$870 per subscriber for a new service drop, an ONT, and inside wiring. We'll need to hook up as many subscribers as quickly as possible so we can spread the high fixed costs, and so we generate the revenues to recover our large front-end investment as quickly as possible.

FIBER TO THE NODE

Some telcos have decided that they can't afford the large front-end investments



Here's what the FTTH distribution system would look like in Ross Highlands, using GPON technology.

There have also been recent, well-publicized problems with the backup batteries in some FTTN cabinets. Solving these problems and taking steps to avoid a recurrence of them could well raise both the short- and long-term costs of FTTN.

When the dust has settled after all the construction, the costs of FTTN will be substantially more than claimed by some of its proponents. And the final connections to subscribers will still be copper...CTTH!

SOLVING FOR "X"

FTTH and FTTN each have their proponents and advocates. The pros and cons of the two strategies have been argued with passion and, sometimes, religious fervor by some of the most knowledgeable and experienced technologists and leaders in the industry. Statistics, data and analyses are presented and debated in public forums and private conference rooms.

When we compare just the fixed costs of the two strategies, it looks as though FTTN would be the way to go in Ross Highlands. However, FTTH might be the better strategy for the long term, when we consider its potential for lower operating costs and higher rev-

The costs of operating the FTTN network will be higher than for FTTH, if only because of the additional AC power connections and consumption. The higher operating costs will continue over the life of the network, and they'll slow our ability to cover our fixed costs. If we don't capture a large fraction of the subscribers in Ross Highlands, we'll be forced to spread the fixed costs and the recurring costs over fewer subscribers.

enues from the rich array of services delivered by an all-fiber network. And, if we have the slightest suspicion that we might need to upgrade or rebuild our FTTN network in a few years, FTTH looks like the course to follow now.

In the end, none of the arguments that telcos are having about the "X" in FTTx matter very much. Both solutions for "X" appear to work. The costs of both are enormous. And both will transform the telcos' businesses from POTS to broadband multimedia services. What matters is that each telco selects

a strategy for transforming its network to packet technology and to broadband operation, and that it is relentless in pushing its chosen strategy to completion in the shortest possible time.

In the 1980s, the guiding principle was "We'll build it and they must come." In the 1990's, it was "If we don't build it, they will go away." In the new 21st century, it's "If we don't rebuild it in time, they will have gone!"

We need to get busy! **BBP**

About the Author

Kermit L. Ross is founder and principal of Millennium Marketing, a consulting firm in Frisco, Texas. He has more than 43 years of experience in the telecommunications industry, beginning at Indiana Bell Telephone Company in 1965 and including sales, marketing, and executive positions at Raychem, Raytheon, GN Netcom, Teltone, Optilink, DSC, Teledata, and Taqua Systems. He can be reached at klross@grandecom.net.

Solving For "X"

Cost (Take Rate)	FTTH-New	FTTH-OB	FTTN-OB
Fixed Cost/DA	265,670	571,670	273,070
Fixed Cost/Home (100%)	355	765	365
Fixed Cost/Home (30%)	1,180	2,550	1,220
Fixed Cost/Home (60%)	590	1,275	610
Variable Cost/Home	620	870	550
Total Cost/Home (100%)	975	1,635	915
Total Cost/Home (30%)	1,800	3,420	1,770
Total Cost/Home (60%)	1,210	2,145	1,160

Millennium-Skyline
PROJECT

Figure 5

FTTN is cheaper in overbuild situations. But what if you need more bandwidth in the next few years? Or even in the next 15?

BROADBAND PROPERTIES
Summit08
Don't miss Kermit Ross's
presentation at the
Broadband Summit,
"FTTH: Pivotal Advances in the
State-of-the-Art: Technology
Developments That Will
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