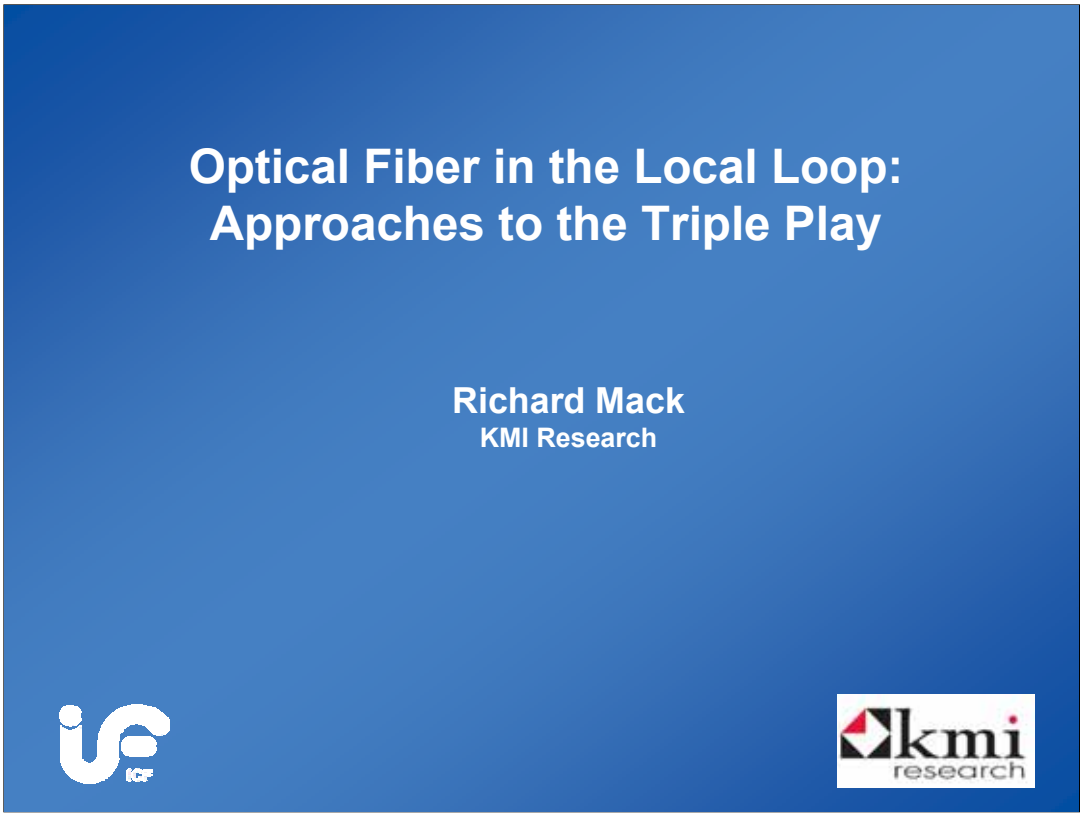


Mr. Larrie Rose, Session Chairman

Our next speaker has about 20 years experience in the fiberoptic field. Mr. Richard Mack is from the KMI Consulting Group in North America. He studied the fiber and cable industries around the world. He kind of stands on the balcony of the industry and is looking at all the players on the field, having a very good oversight of the world market.

Mr. Richard Mack:

The fiberoptic cable market has undergone several dramatic changes in a thirty year history. The big news in 2005 is that fiber-based broadband-access network deployments have started to make a meaningful contribution to fiberoptic cable demand.

The first installations of fiber-to-the-home in Japan go back about five years. Fiber-to-the-curb projects have been underway in Korea and in the U.S.-- in BellSouth's territory – for about the same period. But for several years, these installations did not drive growth in fiber or cable purchases. Now, deployments of fiber-to-the-home, fiber-to-the-curb, and other architectures are progressing at levels of millions of homes per year. And these deployments are driving growth in the fiberoptic cable market.

A small group of the world's major telecom operators have high-volume deployment of FTTX underway. These operators are using different architectures, depending on market, regulatory, and technical factors.

Agenda

- Introduction: Current status and trend of FTTx
- Fiberoptic cable market data
  - > Role of fiber in telecom applications – background
  - > By region, application, and growth trend
- Why use fiber for access -- factors in the shift to FTTx
  - > Changes in competition and regulations
  - > New services offered, especially IP (data)
- How fiber is used – choosing among architectures
  - > Examples from N. America: FTTP vs. FTTN
  - > Costs, risks, and "vision"
- Outlook and implications for industry participants
  (fiber, cable, and telecom companies)

Over the past 25 years, the application of optical fiber in telecom networks has progressed from long-distance (intercity) to metro (linking COs and major buildings within a city) to feeder (from CO to remote terminal), and most recently to the customer premises. The latter application began in the 1990s for business premises but has less than five years of history for linking to residential premises.

At present, fewer than 5 million of the world's 1.5 billion households have fiber-to-the-home. This talk will address questions such as: to what extent will fiber-to-the-home penetrate the wireline telecom market, and how fast will it progress.

Fiberoptics: New Transmission Capabilities plus New Acronyms (FTTx)

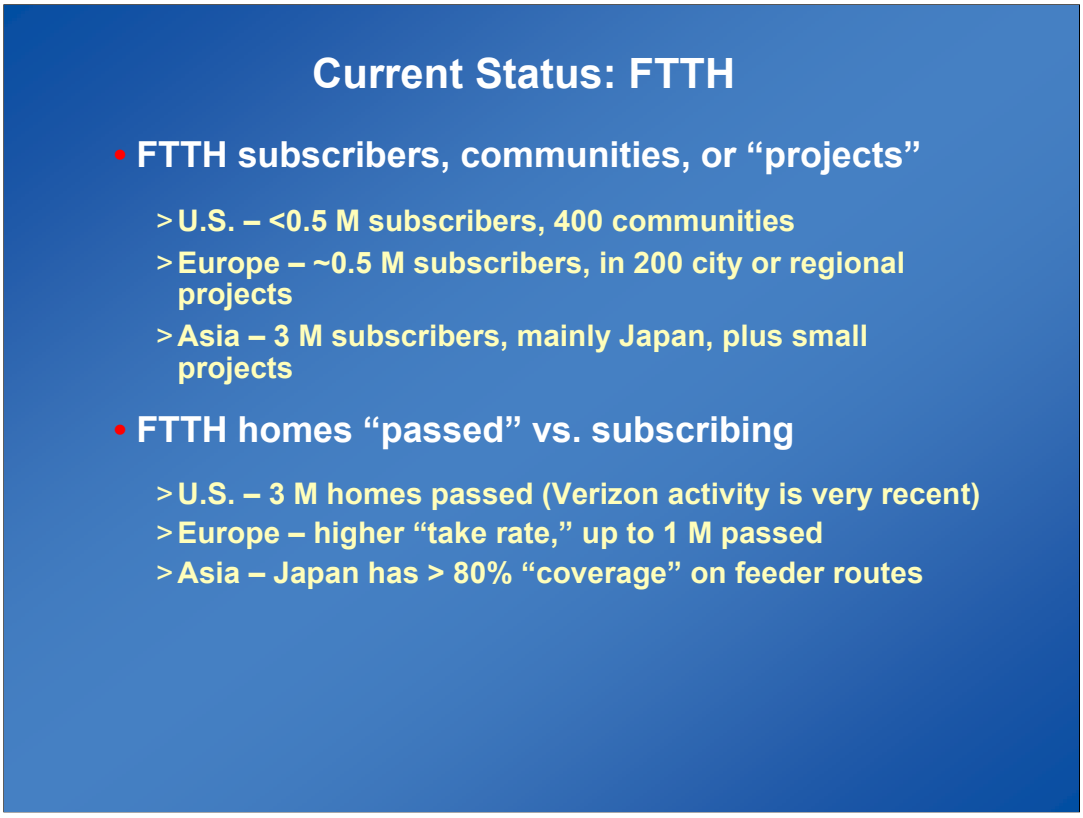
Fiber-to-the …	Ref.	Comment
H - Home	1978	Hi-OVIS, others in 1980s
C - Curb	1987	Bellcore papers on costs
N - Node	1992	AM DFBs enable HFC for CATV
B - Building	1990s	First for business, then residential
P - Premises	2003	RBOC, for home, small office, retail, school, other "cust. prem."
"x" (Variable)		All of the above, "FITL," access,

PLUS, Who operates the network

RBOCs, CATV MSOs, PTTs,
Local exchange carriers: ILEC, CLEC, BLEC, RLEC
Municipalities, Utilities, Real Estate Developers, others

A key factor in looking at the use of fiber-to-the-home in residential applications is a series of competing architectures that take fiber close to the home, but use copper for the actual drop. This group of access-network architectures is referred to as "FTTx" systems. These architectures are not new – they have been introduced over 20+ years. A key point is that all of these architectures are in deployment today by different carriers.

These diverse architectures in some cases may offer a "migration path" for carriers to pursue broadband access upgrades, and they may offer a menu of choices for carriers with different segments of access networks to address, depending on housing density, age of plant, new construction vs. upgrade, etc.



This slide and the next highlight recent developments with FTTH, FTTC, and FTTN worldwide, as of the second half of 2005.

Japan is dominant in FTTH systems with about 3 million subscribers. NTT East and West together are adding about 1 million new subscribers each year.

The U.S. has about 400,000 subscribers. Europe has 500,000 to 600,000 subscribers. U.S. and Europe have a diverse group of operators -- municipal, regional, CLEC, real-estate developer, and incumbent. The incumbents have entered more recently, and although they are fewer in number, they have large projects, especially Verizon in the U.S.

A key distinction is between homes subscribing and homes passed. This concept allows the operator to install some of the infrastructure – feeder and distribution cables – and to defer the cost of the drop cable and optical unit until the household is paying for services over the fiber.

Verizon is now in its second year of FTTP deployment, and is passing 2 million homes per year. But Verizon's marketing campaigns and subscriber sign-ups are still ramping up, so the penetration or "take rate" is less than 25%. For communities that have been upgraded, Verizon has said that the take rate of high-speed Internet is better than expected.

Current Status: FTTC and FTTN

- **FTTx deployments – more history, higher numbers**
  - > CATV FTTN -- ~90% of U.S. homes already passed with HFC and eligible for cable-modem service (~100 M homes)
  - > FTTC in U.S. –BellSouth has ~1 M homes passed
  - > FTTC in Korea – > 2M subscribers, high broadband usage
  - > Telco FTTN – SBC initiatives, Bell Canada, others, to achieve "rapid entry" with broadband and lower costs than FTTH.
- **FTTC and FTTN – various drop and CPE alternatives**
  - > BellSouth has used FTTC with 10-Mbps LAN, ADSL, and coax
  - > Bell Canada using ADSL2+ and VDSL
  - > SBC using VDSL, planning for IPTV

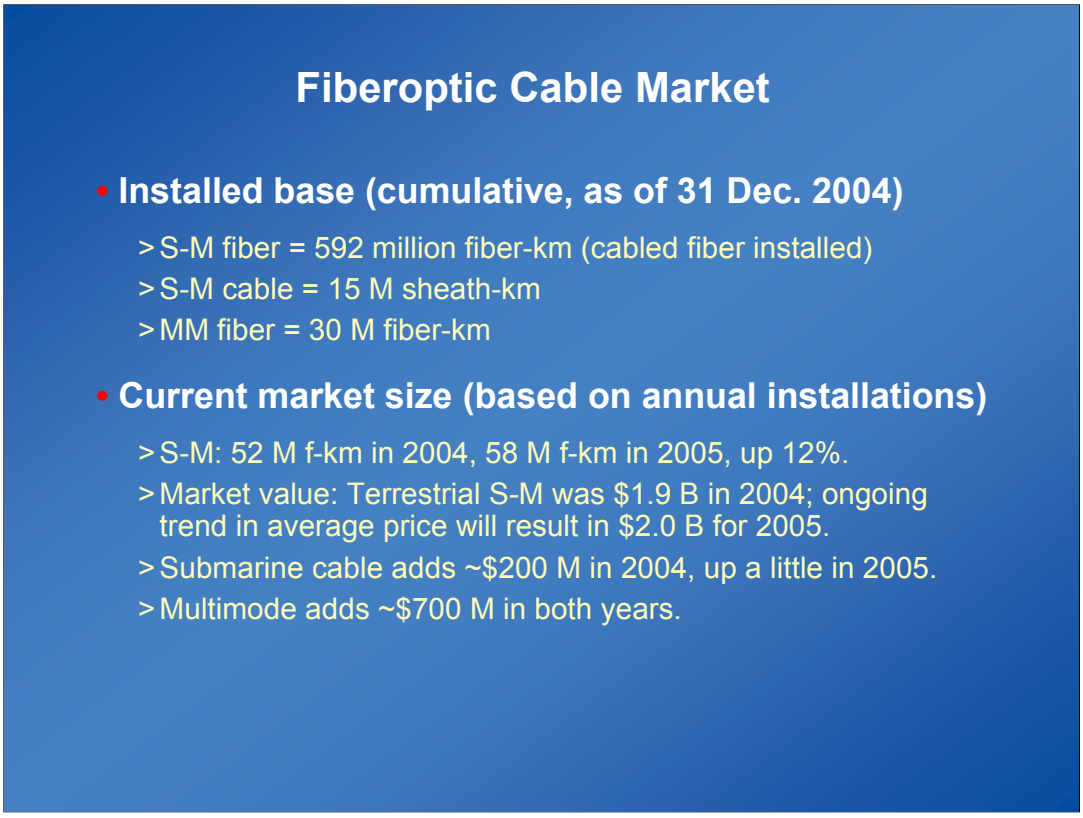
FTTN and FTTC architectures have been in high-volume deployments (not field trials) longer than FTTH.

FTTN began in the U.S in the mid-1990s, with CATV operators installing fiber to serve nodes that converted the optical AM signal to RF and launched it onto a coax distribution network serving 1,000 to 2,000 homes. Since then the number of homes served by a node has decreased to about 500, still using coax cables, but fewer RF amplifiers.

SBC and other telcos are pursuing FTTN but using digital technology (xDSL) and twisted pair for the drops. The number of homes per node in these cases will be 200 to 400.

The largest operators of FTTC networks are BellSouth and Korea Telecom, both having used this technology for about five years. BellSouth has more than 1 million subscribers, but many are not subscribing to broadband services. KT has more than 2 million FTTC subscribers, with very high penetration of broadband services. In the case of BellSouth, the curb-side optical unit serves four to 16 homes, with drop cables ranging up to 500 feet – less than 200 meters.

There are different technologies used for the "drop" with FTTC and FTTN. Alternatives include ADSL, VDSL, and Ethernet.



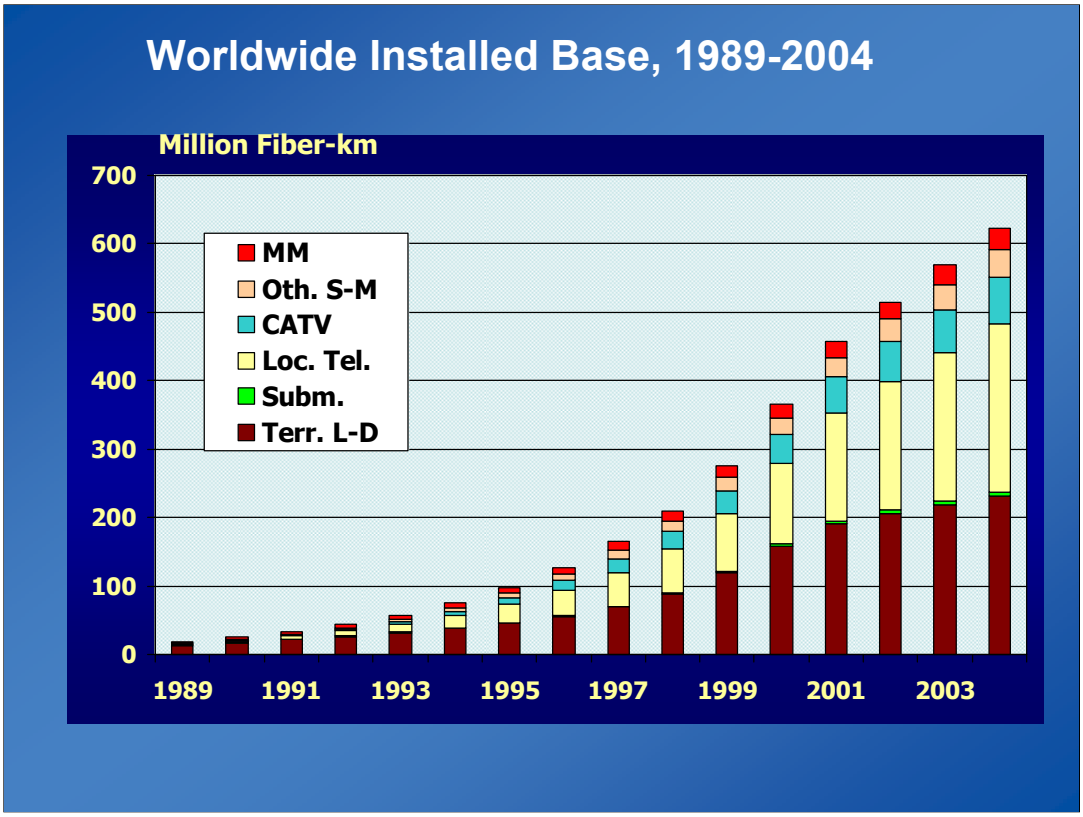
KMI tracks the amount of cable installed each year. Using analyses dating back to the 1980s for the major markets, we can add up an "installed base." Overlay of some older cables has begun, but the percent of previously installed fiberoptic cable that has been removed or retired from service is considered very small – less than 5%.

We track cable installations in terms of fiber-km, but we also collect data on fiber "counts" – the number of fibers in a cable. This enables us to derive data on cable in terms of sheath-km.

Multimode cable is less than 5% of the single-mode market in most countries. In some developed telecom markets, it may be 5% to 10%. Single-mode is used exclusively for telecom and remain so.

The current market in terms of fiber-km will grow 12% from 2004 to 2005. This is encouraging after negative or flat growth from 2001 through 2004. The mix of fibers in the market and price erosion will result in low growth in terms of market value.

The bare fiber market value is approximately half the cabled-fiber market.



The installed base in terms of major applications shows that fiberoptics has been used where it offers a bandwidth x distance performance: initially for intercity or long-distance routes, then as data services and traffic increased within metropolitan areas, it was used for metro rings. With the advent of CATV and telecom feeder applications in the 1990s, the bandwidth component, rather than distance, was more critical. Fiber also has proven to offer operational advantages in terms of reliability, maintenance, and supervision. The growth in the local telecom segment will drive the market in the future.

Penetration of Application Segments

Cumulative installed base as of 31 Dec. 2004			
Segment	M F-km	% of Total	Penetration
Long-distance	231	37%	High, some extension+overbuild, and emerging markets
Submarine	7	1%	High, cycles on major routes
Metro/local	245	39%	Low-Medium, FTTx is very low
CATV	66	11%	Low, US = 78% of WW CATV fiber
Other S-M	41	7%	Low-Medium
Multimode	30	5%	Medium
Total	622	100%	Medium, FTTx could add 500 M

This table provides data to accompany the previous column chart. The history now goes back more than 25 years:

• 1975-1980: first applications, “pioneering” installations

• 1980-1985: initial development of long-distance (intercity) market

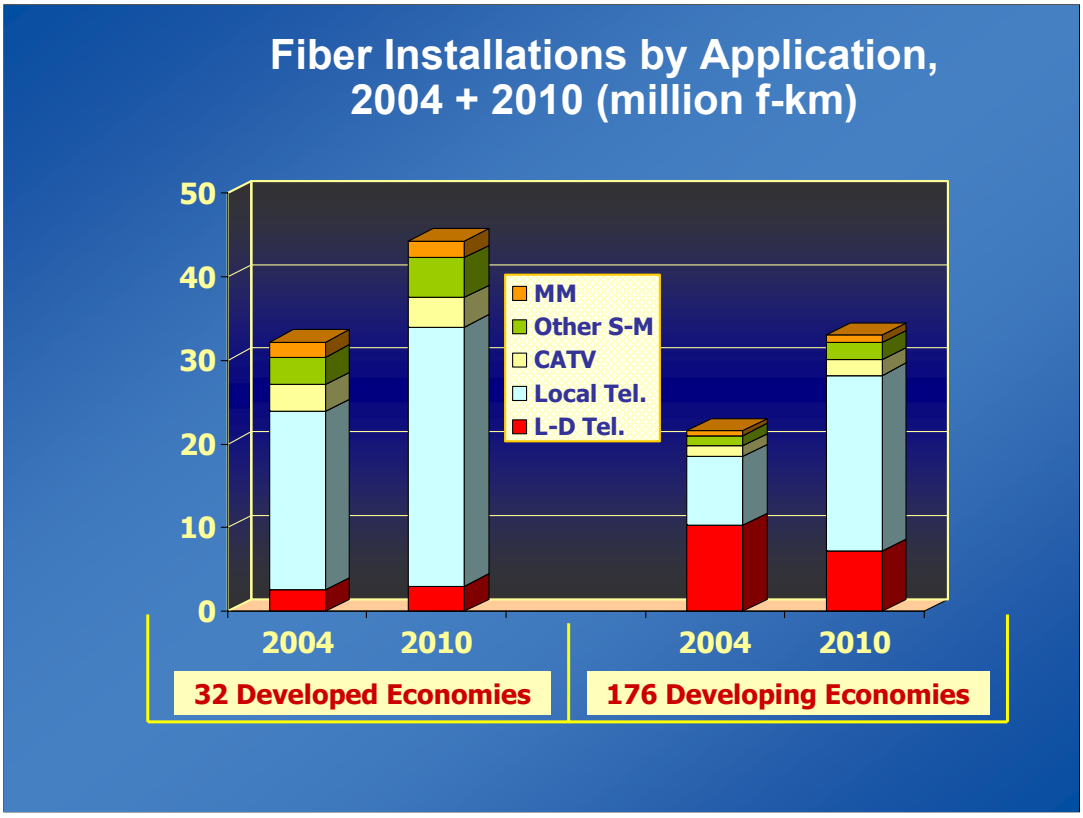
• 1985-1990: penetration of local-exchange carrier market with central-office trunking

• 1990-1995: expansion into local loop with digital “feeder” and AM CATV systems

• 1995-2000: massive wave of backbone deployment associated with Internet, plus WDM, plus high-volumes in metropolitan, business loop, and feeder segments

• 2000-2005: correction to the overinvestment in backbone, shift to penetration of last-mile (access network).

The right-hand column shows estimates as to the extent that the available market in that segment has been saturated. In long-distance, overlays of some routes installed in the 1980s is underway in the U.S. – in a limited fashion. The U.S. has fiber rings in more than 100 cities, but other markets are still pursuing such metro or regional installations. This is a large market in China, parts of Europe, and other key cities in Asia.



We have used several indicators – teledensity (telecom lines per 100 population, telecom investment per line, and GDP per capita) to divide the world into developed and developing markets. Developed markets include the U.S., Canada, W. Europe, Israel, Japan, Korea, Singapore, Australia, New Zealand, and several others. The data for this analysis has been downloaded from the International Telecommunications Union, World Resources Institute, and other resources.

The developed markets have been installing fiber for more years, and already have achieved a higher degree of penetration in the long-distance and metropolitan backbone segments. They also have stronger customer bases and greater revenues to support access-related capital expenditures. The developing markets are still installing intercity backbones. In Africa, parts of Asia, and some other areas, this backbone construction is partially driven by cellular traffic – a relatively recent development (since 2000) in worldwide fiberoptics markets.

Telecom Indicators for 32 Developed and 176 Developing Economies

	Developed	Developing
Population (M as of 2003)	1,021	5,202
Households (M as of 2001)	376	1,171
GDP ($ B as of 2002)	26,009	6,147
GDP Per Capita (2002)	25,619	1,189
Main lines (M as of 2002)	565	518
Main lines /100 pop.	56	10
Mobile subscr. (M as of 2003)	651	641
Mobil subscr./100 pop.	64	12
Wireline rev. ($B as of 2001)	400	85
Mobil rev. ($B as of 2001)	267	46
Wireline inv. ($B as of 2001)	137	70
PCs (M as of 2002)	445	140
Fiber-km (M, Inst. base at 2004)	459	164

Sources: International Telecommunications Union (ITU) and World Resources Institute (WRI)
Data shown for most recent year with countries reporting data representing 95% of peak values.

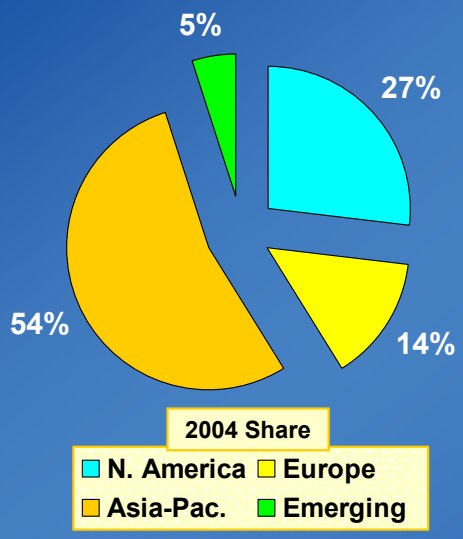
This shows some of the ITU and WRI data that can be useful to keep in mind when analyzing cable markets. First, note that cellular subscribers have overtaken wireline subscribers. Mobile (cellular) services have been available for 20 years, but almost all of this market has materialized in the past 10 years, especially in the developing markets.

Second, the average revenue per user is much lower in the developing markets – for both wireline and mobile.

Third, the number of households in developed markets is less than 400 million. This represents the bulk of the available market for FTTx, not all worldwide households.

A more detailed analysis might split China, India, and perhaps a few other Asian markets with large metropolitan and business populations – analyzing part of China, for example, as developed and part as developing.

Worldwide Market by Region, 2004-2010
(Based on S-M + MM F-km installed per year)



Region	04-'10 CAGR	2010 Share
North America	11%	35%
Europe	7%	14%
Asia-Pacific	3%	45%
Emerging	6%	5%

For most of the 1990s, the U.S was about a third of the fiberoptic cable market, Europe was about a third, and Asia-Pacific was about a third. After the market collapse in 2001, Asia-Pacific remained stronger– about two-thirds of the world fiberoptic cable market for several years

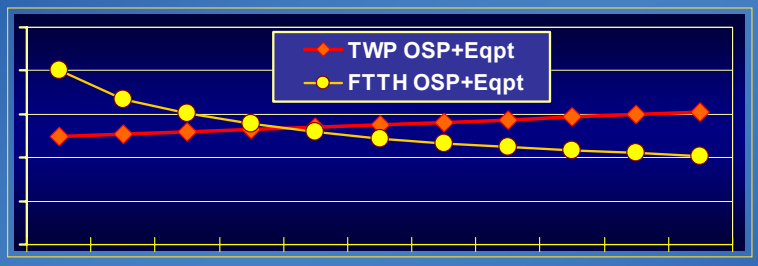
Japan and China were dominant within the Asia market, in some years controlling more than 75% of that region.

With the advent of FTTx in North America – mainly Verizon's FTTP, SBC's FTTN, and Bell Canada's FTTN, the North American region will have faster growth – increasing its share of worldwide installations from 27% to 35%.

The growth in Asia-Pacific and Europe will be slower. Although Japan has a robust FTTH market, it began cable installations for this application in 2001, and it already has passed a peak in cable demand for FTTH requirements.

Fiber in the Residential Loop: Why and when?

1990s view of installed first costs and "crossover"



Why the "crossover" vision didn't happen:

- Need to consider cost per bit transmitted
- Electronics (DSL chipsets) improved copper's performance
- Capitalized labor proved to be a dominant cost factor
- Market uncertainties: new services evolving, bandwidth requirements changing, new regulations, and new competitors.

In the 1990s, some proponents of FTTH said that fiberoptic equipment costs would decrease with increased production volumes (learning-curve phenomenon). As a result, FTTH systems would be cost competitive with copper loops, and the telephone companies would use fiber rather than copper thereafter.

Critics cited obstacles to FTTH, such as powering and operational software. But these were not the biggest problems. Field trials and "first office applications" showed construction costs were too high. Also, the use of Internet by residential customers caused rapid changes in the service and bandwidth requirements. The DSL manufacturers responded quickly to these opportunities.

As a result, copper remained competitive with fiber on a cost-per-bit transmitted for the near-term bandwidth requirements. This provided many large incumbent telephone companies with a near-term (some fiber proponents might argue a short-sighted) strategy for keeping up with bandwidth requirements using existing copper-based distribution and drop assets and less new fiber.

Note that a more complex view of any cost "crossover" will have to take into consideration three segments within a telecom operator's FTTx market: new construction, re-hab (due to trouble tickets/aging), and upgrades.

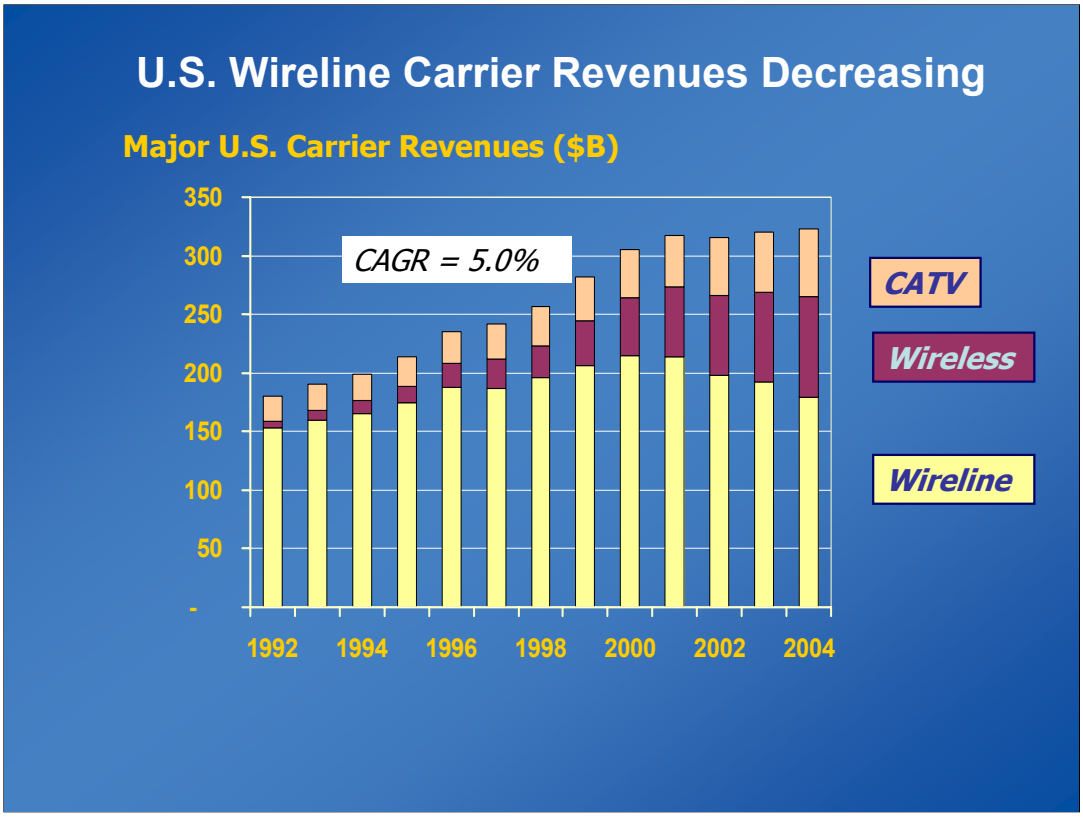
Changing Market Factors Have Improved the Case for FTTx since 2000

- **Service requirements -- challenging xDSL speeds**
  - > Demand for faster Internet access speeds (in Mbps)
  - > Marketing of bundled services, e.g. “triple-play”
  - > HDTV and new digital TV services
- **Government policies**
  - > National policies to promote broadband, e.g. Korea
  - > In the U.S., fiber exempt from “unbundling”
  - > U.S., Australia, others promoting broadband for rural
- **Increasing competition over new services**
  - > Telephone companies being challenged by new operators – municipalities, CATV, utilities, etc.
  - > In the U.S., CATV operators capturing phone lines
  - > Telephone companies – respond by offering video (TV)

The attractiveness of FTTx has changed due to a combination of changes in government regulation, advent of new competitors, and evolution of new services, especially IPTV and bundled packages (triple play).

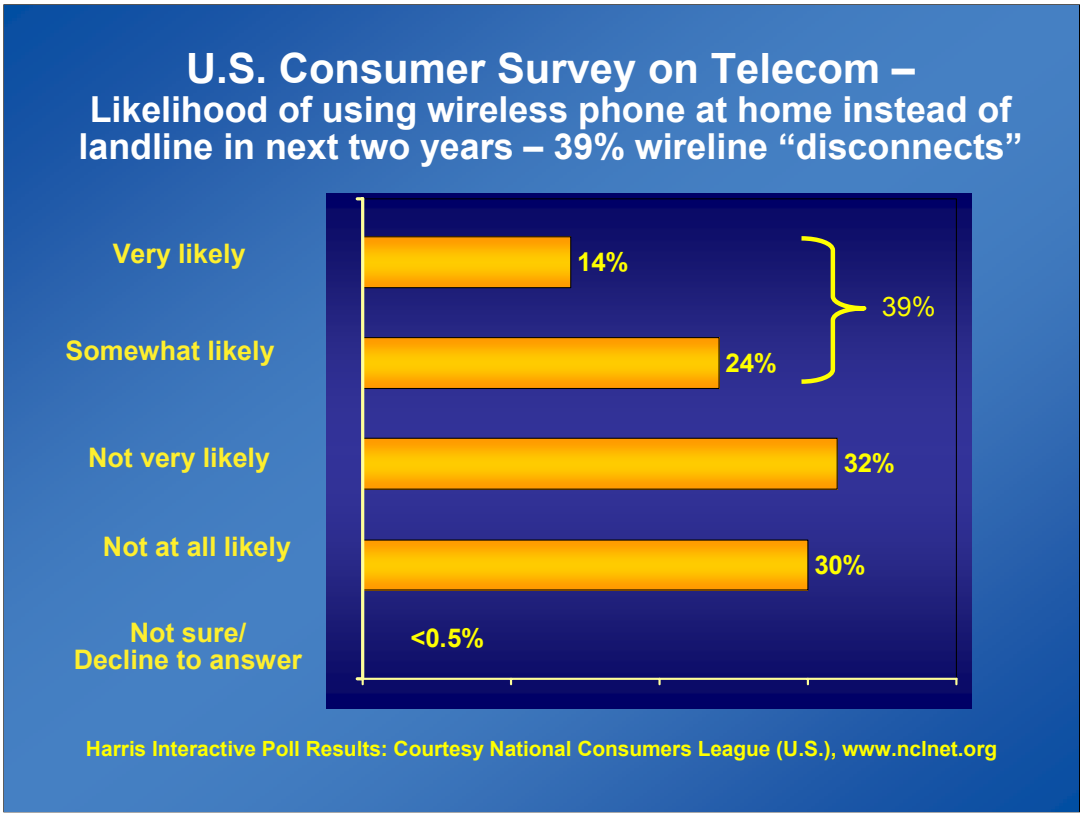
There are significant differences in these factors between countries. Further, the density of housing, availability of rights-of-way for new cabinets, age of the copper plant, and others also lead carriers to pursue different strategies in different countries.

In the U.S., Canada and other developed markets, the existing or potential loss of telecom revenues and market share to competitors is critically important. (See next two charts.)



This data is based on group of 12 dominant telecom operators in the U.S., plus the major MSOs. The wireline revenues include both long-distance and local. In fact, revenues are eroding in both of these wireline segments. The Bell Companies (RBOCs) have been able to offset some losses in local wireline services by adding and growing a new revenue stream in the long-distance market. But this strategy will not provide a long-term growth opportunity, because the U.S. long-distance market is mature, fully penetrated, and subject mainly to shifts in share but not rapid market growth.

The CATV MSOs have been capturing telephone access lines as well, and a key element in this shift has been their ability to offer packages of services – e.g. triple play.



The survey results are based on telephone interviews with 1,000 U.S. consumers. The previous question was "do you know someone that uses wireless telephone at home rather than a landline account," and this received a 46% response, with 5% saying they already have made this choice.

Note that the question in this slide is asking consumers about the likelihood of future behavior. As a result the data must be interpreted with a conservative bias – consumers may not make this change as fast as they indicated in the survey response.

If half of the 39% make this change in the next two years, that number would result in a doubling of the current rate of wireline "disconnects." One key conclusion from this data is that consumers are becoming better informed about telecom alternatives and increasingly are willing to consider changes.

This survey, released in July of this year, also showed a strong interest in bundled packages, strong sensitivity (inelasticity) to price a willingness to consider TV from the telephone company, and a willingness to consider telephone service from the CATV company.

Verizon and SBC: Two Very Different Approaches to Broadband and Triple Play

	SBC	Verizon
FTT-?	**- Node, for upgrades (94% of homes) - Home for new developments (6%)**	**- Home/premises -- everywhere**
Technology	**FTTN+VDSL, fiber - 3,000 ft from home IPTV with switched video**	**ITU G.893 (BPON) 1550-nm AM overlay for bdcst video**
FTTx Cap-Ex	**$4 B for 2005 – 2007 $250 per FTTN home passed $1000 - 1300 per FTTP home passed**	**$800 M in 2004, $1-1.5 B in 2005 $600 - 1000 per FTTP home passed**
Target	**18 M Homes passed in 2008**	**12 M homes passed by 2008 35 M customers passed by 2020**
Fiber Demand	**1-2 M Fiber-km per year**	**4-8 M Fiber-km per year**
% Aerial Plant	**25%**	**45%**
Other factors	**Acquisition of Cingular, AT&T**	**Cap-Ex increase is small %**

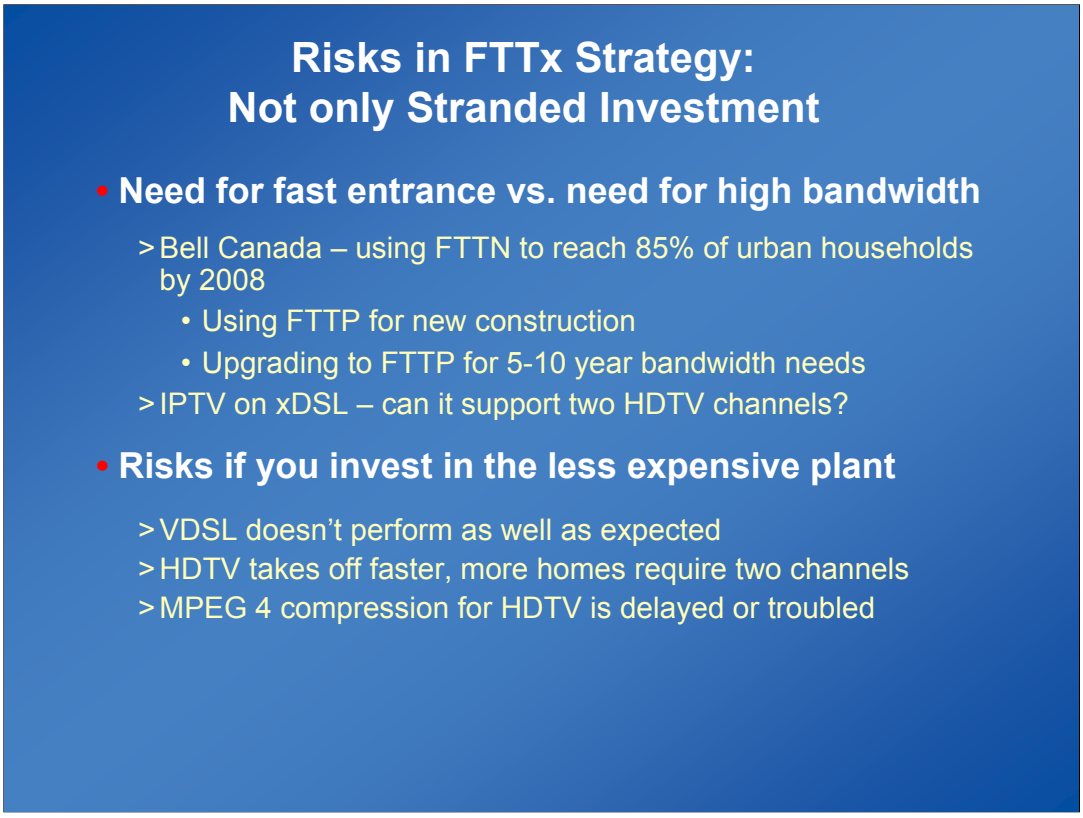
Verizon and SBC face the same regulatory guidelines, and very similar state and local regulatory structures. The competitive situation is basically the same, and with some exceptions, their infrastructure is similar – percent single family homes, etc. This has led some observers to ask why the two have announced such different approaches to broadband access.

Other analysts have suggested various reasons as to why Verizon and SBC have pursued such different strategies:

- percent of aerial plant (one analyst reported Verizon with 60%)
- age of plant
- Verizon has stiffer competition from CATV MSOs
- willingness to combat CATV “franchise laws” in court

KMI disagrees with these, and believes that the main differences are tolerance for risk, cash flow and debt burden, and management’s vision of the future service mix.

Note that the data shown here (percent) for aerial plant is based on FCC data. It is the percent of all aerial plant versus underground (duct/innerduct) and buried, including copper and the previous fiber.



As noted previously, tolerance for risk is considered a key factor in Verizon's choice of FTTP and SBC's choice of FTTN. This can be likened to any manufacturing company's decision as to when to upgrade a production facility, replace it entirely, or squeeze more capacity out of existing lines. Such a decision is complicated by rapid changes in the products being required by the market. In the case of Verizon, however, the decision probably is to upgrade all of the plant, and not localize investments. (Unlike manufacturing companies with more than one factory, Verizon wants to support every product – telecom service – in every geographic market.)

Bell Canada has said that its strategy of FTTN first, then FTTH is to achieve a rapid entrance. It is designing its FTTN "nodes" so that they later can be upgraded by adding an optical splitter and new fiberoptic distribution cables.

Bell Canada also pointed out at a recent conference that there are risks with starting with FTTN – that it doesn't fully support the near-term video service requirements. If these risks materialize, there is the potential loss of share to CATV operators that have been more focused on video and recently on triple-play.

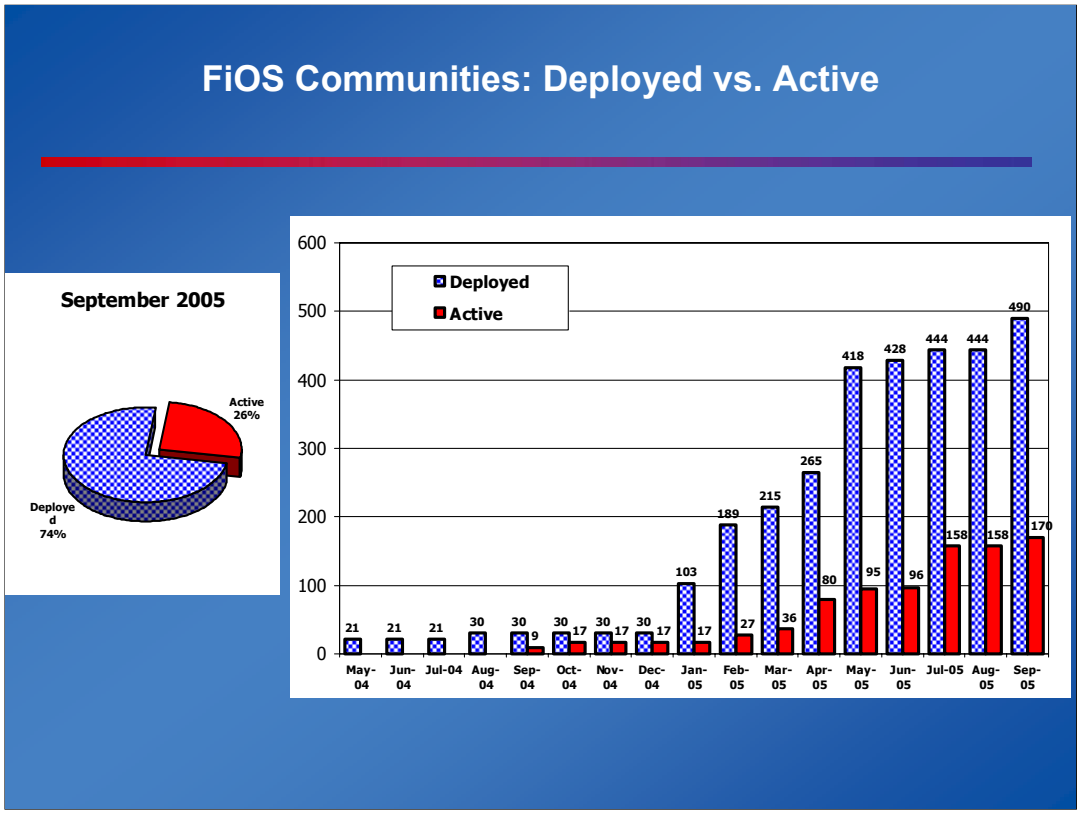
Verizon FiOS Installation




FiOS = Fiber Optic Services

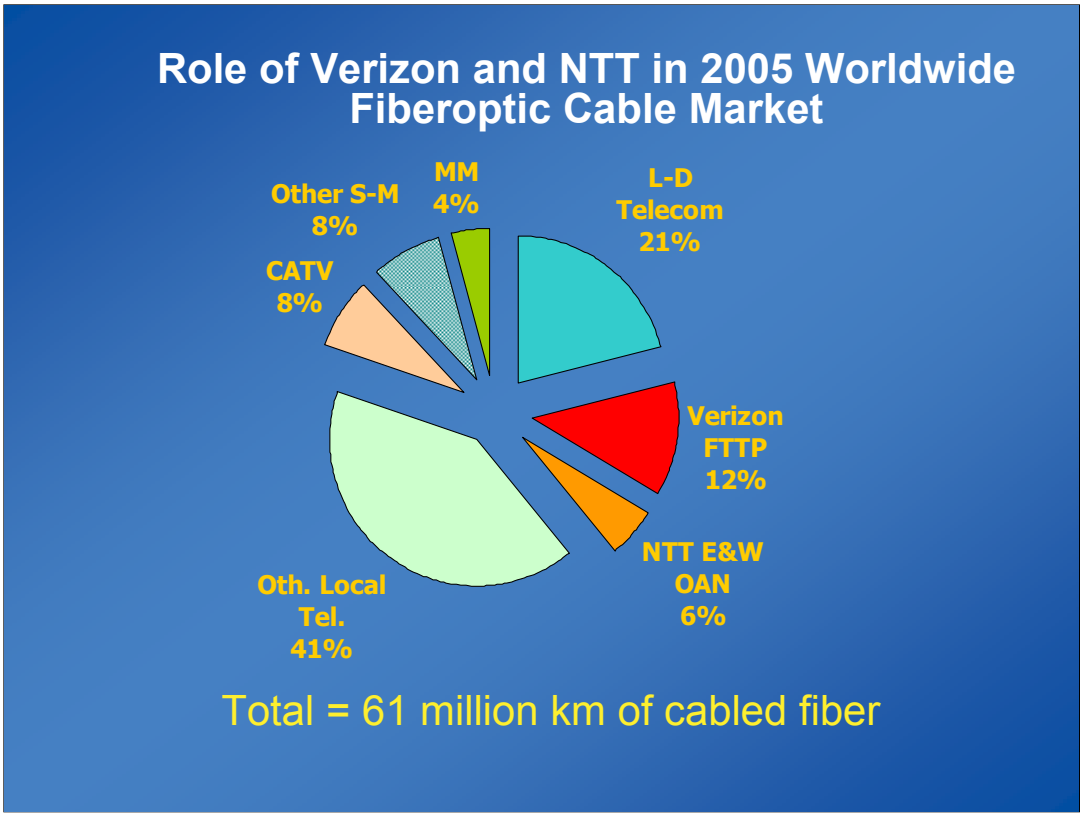
This slide shows some installation craftsmen at work on Verizon's FTTP systems. "FiOS" is the trade name that Verizon uses for promoting services over the FTTP network.

The first (top right) slide shows an aerial closures. The second (top right) shows the optical network terminal mounted on the side of the home. The third (bottom left) shows an aerial cable placement, and the fourth (bottom right) shows the use of underground "drops" in an area of new construction ("greenfield").



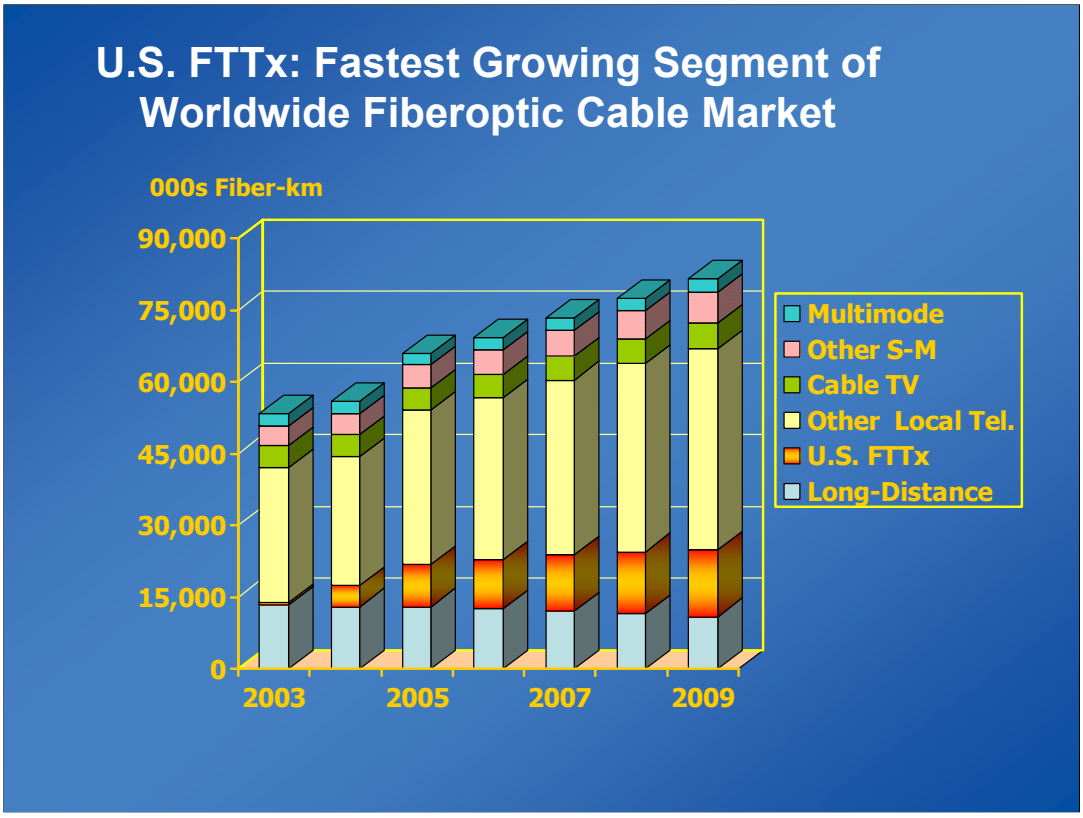
This slide shows the progress that Verizon has made in beginning FiOS network construction projects in 15 states as of the third quarter, 2005. It plans to have construction in another 13 states "soon."

These projects are underway in 490 communities. Most of these communities are smaller cities and suburban areas. So far, Verizon has signed up subscribers in about a third of the communities where it has begun construction – 170 communitiies. This is an indication that Verizon's construction projects are moving rapidly, and are "ahead" of the company's efforts to market the services and sign up subscribers.



The FTTx deployments described so far are having a significant effect on the fiberoptic cable market. There is a new and growing demand for low-count cables, including one-fiber drop cables. A small number of key customers are making a large contribution to demand, such that if they change their strategy, the vendors will have to reduce their production levels again.

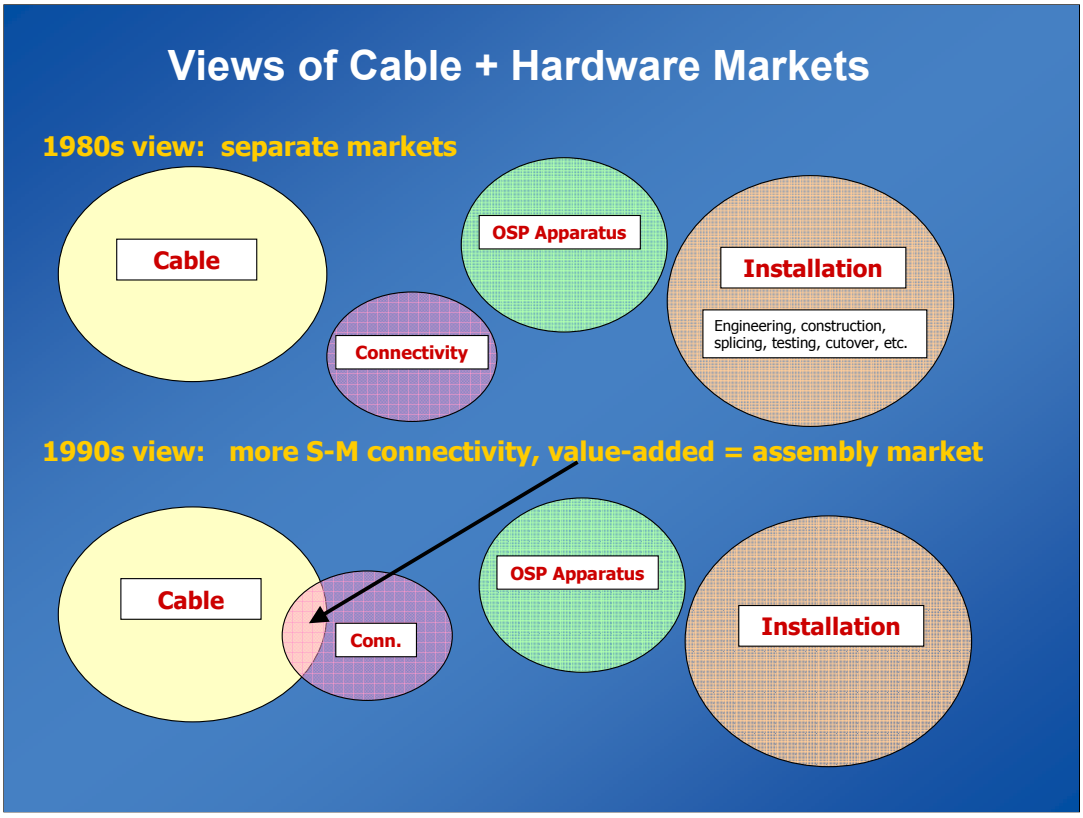
This plot shows the role of Verizon and NTT East and West in 2005 – 18% of worldwide installations of cabled fiber.



In this plot, Verizon's FTTP is combined with SBC's FTTN, BellSouth's FTTC, and all other FTTx installations (municipalities, utilities, real-estate developers, CLECs, etc.) and separated out to show its role in the worldwide cable market. The amount of cabled fiber installed in this U.S. FTTx market will increase with a compound annual growth rate of 25% from 2004 to 2009.

The factors that could affect this forecast negatively include: failure of Verizon to gain share with its video services and subsequent scaling back of construction, problems with the VDSL equipment selected by SBC for its FTTN and subsequent delays in fiber deployment, or other market disruptions.

Factors that could affect this forecast positively include regulatory changes that make it easier for Verizon to launch its video services; rapid shifts in the consumer electronics for digital video viewing, so that the CATV MSOs have less of an incumbent advantage; and a rapid shift of video to IP formats and delivery via Internet, again reducing the CATV MSOs inherent advantage.



One significant development for the cable industry that was triggered by Verizon's FTTP program was the advent of outside (OSP) plant connectors and preconnectorized drop and distribution cables. This was done to eliminate some of the construction and splicing costs associated with FTTP installation.

KMI has arrived at the following estimates for FTTP costs:

Transmission system costs

ONT ranges $175 to $350 (used $225 for U.S. avg. in 2004)

HDT/OLT ranges from $150 to $250 per home passed

Fiber and cable costs

Cable costs per home <$100.00 (Drop cable + the per-home share of distribution and feeder cables (just cable)

Closure, cabinet, splitter, interconnect, and frame costs per home < $150.00

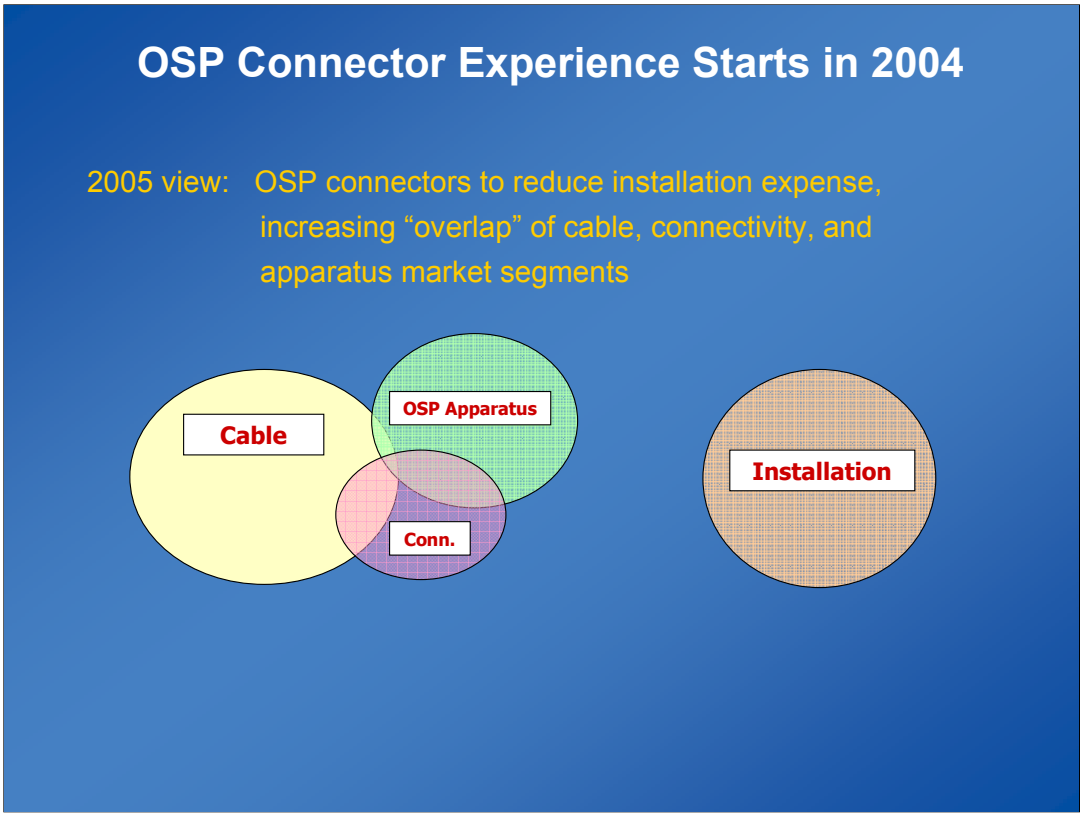
Construction costs

Many variables (aerial vs. underground)

Ranges from $250 to >$750

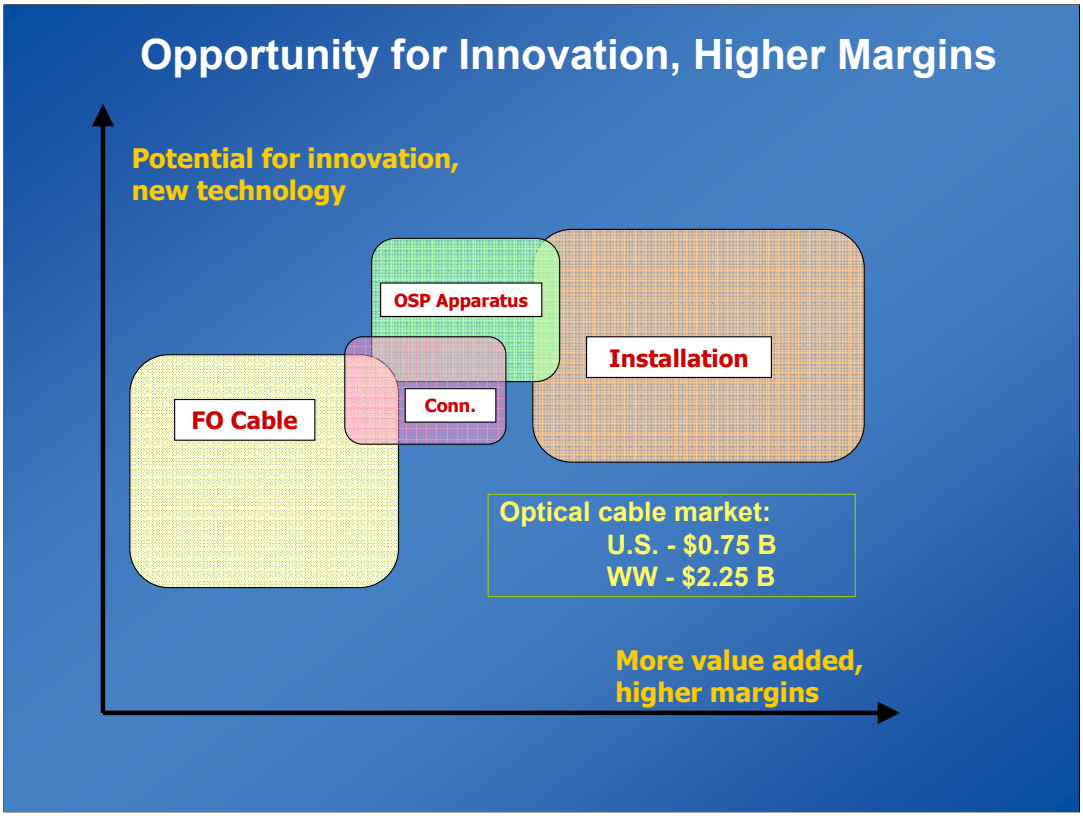
Average in KMI's U.S. market model ~ $500

This means that construction offers a large single area for cost improvement. The strategy pursued was to reduce construction expense by shifting some of it to the factory. The result is pre-stubbed splitter cabinets, connectorized cabinets and closures, pre-terminated cables, and other innovations.



The FTTP-driven advances in interconnect, apparatus (cabinets, closures, panels, etc.) and cable has resulted in a new view of the cable market. This concept will benefit those cable companies that can design and manufacture the requisite interconnect hardware or that can partner with other companies for this capability.

There was the potential that such pre-terminated cable and connectorized hardware will be isolated – a "Verizon-only" phenomenon, but this year, one of the U.S. vendors already has announced several other FITL customers for its connectorized OSP hardware.



Price erosion in fiberoptic cables and evidence from the cable industry suggest that gross margins and profit margins on fiberoptic cable are quite low. The connector industry also has seen similar phenomena – plug price reductions, squeezing cost out of the termination process, and advantages shifting to those companies with large (high-volume), automated facilities in low-cost-labor markets.

This also suggests that the opportunities for adding high-margin products or for achieving innovation to attract telecom customers may be more likely in OSP apparatus or other cable+connector or cable+apparatus products that can reduce installation expenses.

Summary

- "Mass deployment" of FTTx is underway in major markets.
- Fiberoptic cable market has had flat or single-digit growth.
- FTTx will drive cable market growth at rates >10%.
- Some operators are pursuing FTTx for new opportunities: services, packages, and revenue streams.
- Other operators need it to compete with newcomers.
- Trade-offs between FTTP, FTTC, FTTN vary with market factors – regulations, housing density, infrastructure, and competition.
- In the U.S., Verizon and SBC face the same market factors, but have selected different architectures due to risk tolerance.
- One benefit has been new cable and connector concepts, and this suggests a path for future innovations.

Here you can see a summary of my viewpoints on the fiberoptic market and its development.

Thank you for your attention.