Presentation by The Fiber Optic Association, the professional society of fiber optics.

Seminars in Johannesburg, SA, Nairobi, Kenya and Lusaka, Zambia in May 2011.

If you have questions, contact us at info@thefoa.org.

What Is The FOA?

The Professional Society of Fiber Optics

This training program is approved by The Fiber Optic Association, the professional society of fiber optics.

What is the FOA?

If you have questions, contact us at info@thefoa.org.

What Is The FOA ?

- International professional society of fiber optics
- Chartered with promoting fiber optics through education, certification and standards
- Organized in 1995
- Based in California, USA with a worldwide network of fiber optic professionals
- Non-profit educational/professional corporation
- www.thefoa.org

What is The FOA?

Fiber optics has become the predominant communications medium, not just for telephones, but also for cable television, security systems and computer networks. Workers in all these fields are expected to understand how fiber optics is used and, in many cases, be competent in its installation. Training in these areas has become extremely important and The Fiber Optic Association is prepared to help.

The FOA is a international non-profit educational organization that is dedicated to promoting professionalism in the field of fiber optics. It was founded in 1995 by a dozen prominent fiber optics trainers and industry personnel who felt an industry-wide non-aligned certification program was important for the growth of the industry.

To date, the FOA has approved approximately 125 training programs, including technical high schools and colleges, professional training organizations and companies offering employee training programs. As of the summer of 2006, about 18,000 students have successfully completed requirements for the FOA CFOT Certified Fiber Optic Technician certification.

For more information, see our website http://www.thefoa.org

What Has The FOA Accomplished?

- The FOA has certified
  - >33,000 fiber optic technicians
  - through ~250 schools
  - in ~30 countries
- World's #1 source of technical information on fiber optics

What is The FOA?

Fiber optics has become the predominant communications medium, not just for telephones, but also for cable television, security systems and computer networks. Workers in all these fields are expected to understand how fiber optics is used and, in many cases, be competent in its installation. Training in these areas has become extremely important and The Fiber Optic Association is prepared to help.

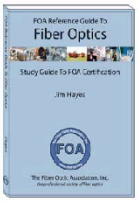
The FOA is a international non-profit educational organization that is dedicated to promoting professionalism in the field of fiber optics. It was founded in 1995 by a dozen prominent fiber optics trainers and industry personnel who felt an industry-wide non-aligned certification program was important for the growth of the industry.

To date, the FOA has approved approximately 125 training programs, including technical high schools and colleges, professional training organizations and companies offering employee training programs. As of the summer of 2006, about 18,000 students have successfully completed requirements for the FOA CFOT Certified Fiber Optic Technician certification.

For more information, see our website http://www.thefoa.org

FOA Certifications

- Why certify fiber optic techs?
- FOA first Level (CFOT, CFospT, CPCT)
- Specialists (design, splices, connectors, testing, FTTx)
- Knowledge and demonstrated skills
- Based on
  - *The FOA Reference Guides*
  - *The FOA Online Fiber Optic Reference Guide: www.foaguide.org*



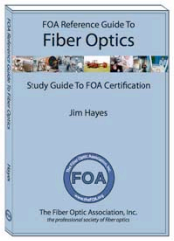
The FOA CFOT exam is a test of your knowledge of fiber optics. The test is basic; it covers the types of materials that should be covered in any basic fiber optic class.

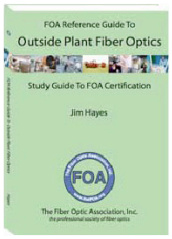
The exam is based on *The Fiber Optic Technicians Manual* and *NECA/FOA-301 Installation Standard. If you have read the textbook and answered the chapter questions, and reviewed the NECA/FOA installation standard, you should have no problem with this test.*

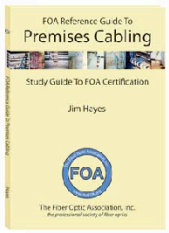
Remember it is an closed-book test and every student must take the test individually THAT IS THE RESPONSIBILITY OF THE PROCTOR. It is NOT a class exercise. 70% correct is a passing grade

FOA Textbooks

- All new
- Aligned to training curriculum & certifications
- Available printed, iBooks, Kindle, Apple App NEW
- Low cost!







FOA websites and textbooks are based on the input of instructors and experienced fiber optic technicians with 25+ years of experience in the business. Much of the material is now in printed form in *The FOA Reference Guide to Outside Plant Fiber Optics for CFospT certification, The FOA Reference Guide to Fiber Optics for CFOT certification* and The FOA Reference Guide to Premises Cabling *for CPCT Certification*. References to the proper chapters are given in the notes. The notes give an overview of what the slide means and provide hints to explaining the meaning of the slide.

The FOA has also created a complete online reference guide for fiber optics aimed at the CFOT certification. The site is at http://www.thefoa.org/tech/ref/. Included in the site are technical pages, including a basic section that includes quizzes on the materials and links to pages with more details. There are also a student guide for studying for the CFOT and an instructor guide to teaching a course based on the website.

Either the textbooks or the website may be used by classes for reference.

FOA Online Resources

- FOA Online Reference Guide To Fiber Optics: www.foaguide.org
- Basic to advanced, including self-study guides, self-test quizzes and Google custom search
- Monthly online and email newsletters
- YouTube channel “thefoainc”
- LinkedIn for certified members
- Facebook for everybody
- ALL FREE!

The FOA Online Reference Guide to Fiber Optics was created to be a single source of technically correct, unbiased information on fiber optics available for everyone for free. It has grown to hundreds of pages of information in sections appropriate for student study and assigned projects as well as material for those looking for a refresher course in fiber or just looking for some particular information.
For those studying for FOA certifications, both basic and advanced, there are study guides to point you to the appropriate materials.

Fiber University

www.fiberu.org

- Online learning site
- Self-study "web-based training" programs
- Online tutorials
- Uses technical resources of FOA Reference Guide
- Preparation for formal training and review for FOA certification exams
- Home work for students

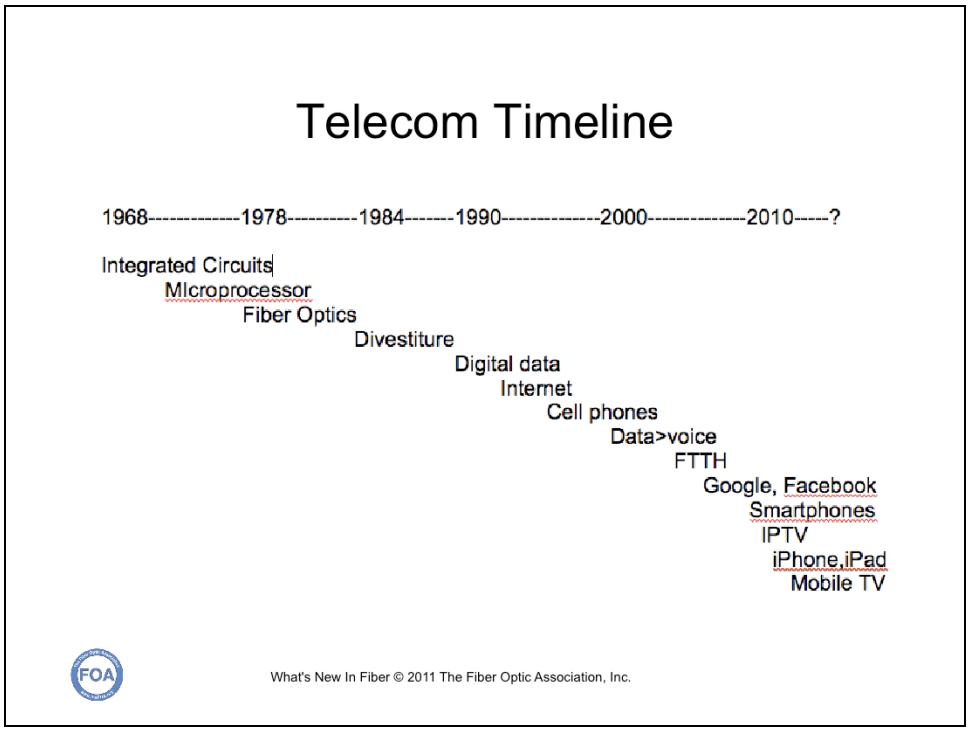
Fiber University (Fiber U at www.fiberu.org) is a focal point for online learning about fiber optics. It's based on the giant FOA Online Reference Guide and hosts self-study programs and tutorials that can make learning about fiber much easier!

What Is New In Fiber Optics?

This training program is approved by The Fiber Optic Association, the professional society of fiber optics.

What is the FOA?

If you have questions, contact us at info@thefoa.org.



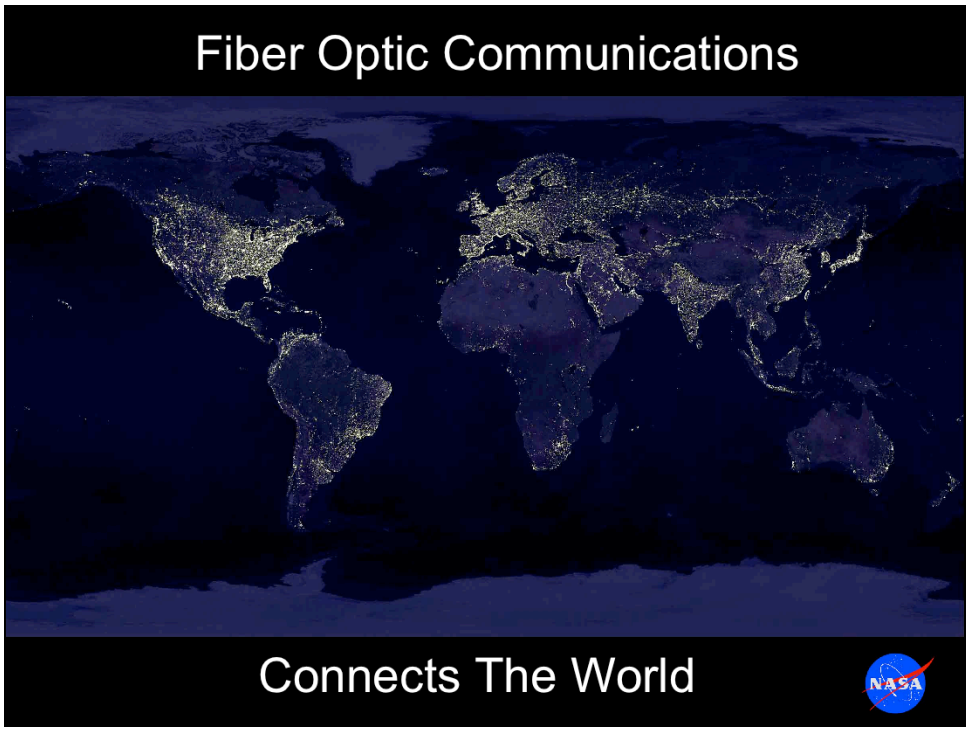
Since I have been involved in communications, it has been digitized and mostly converted to fiber optics. A decade ago, data traffic surpassed voice traffic and has been growing at an exponential rate since. Google alone now accounts for about 7% of all Internet traffic, about half is user searches and half is machine-to-machine traffic updating their local data centers. Now we have video – some nights in the US, Netflix movie downloads account for almost half the Internet traffic. Growth in traffic shows no sign of slowing either!

Is Telecom Dead?

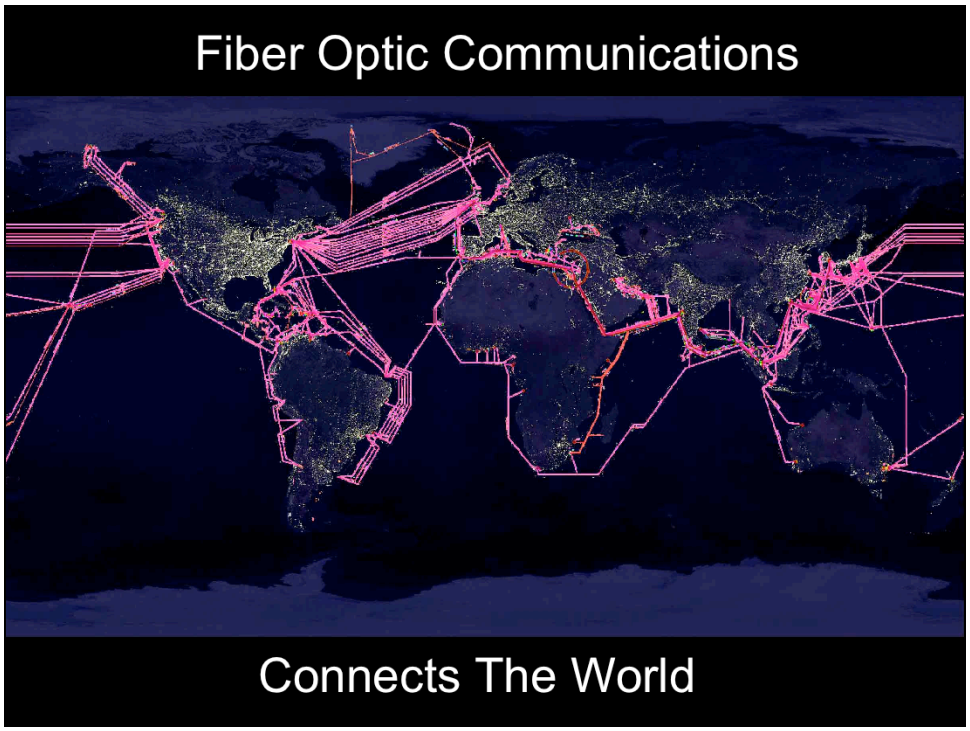
- Is voice obsolete?
- Data traffic exceeded voice for 10 years
- Telecom (AT&T) supports all old tech
- Data oriented companies (Google) are much more efficient – support only new tech
- What will be effects of video?
- Revenue from new services?
- Fiber is the winner!

Voice seems obsolete – it's not telephoning anymore! Data traffic dominates the Internet. At a recent meeting AT&T noted that they still have to support virtually every service they ever offered, making standards like MPLS that can accommodate any type of traffic is necessary for them. But Google only needs to transmit data, so they say they will not pay the additional costs in equipment or traffic overhead that the telcos must live with. Now we have to deal with how to charge for video which uses far more bandwidth than voice or data – where is the revenue coming from to support video growth?

Whatever, fiber is the winner, because only fiber can provide the bandwidth!



And the power of fiber optic communications connects the world.



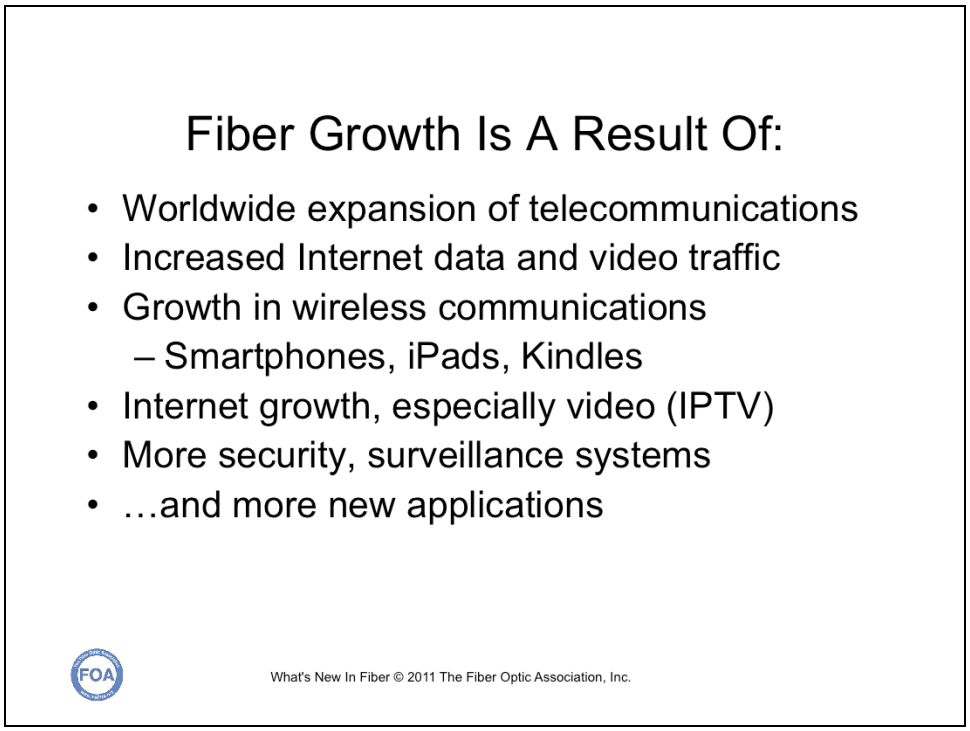
And the power of fiber optic communications connects the world.

Fiber Optic Applications

- Telecom – telephones, fiber to the home, wireless
- Internet, computer networks and data centers
- CATV - for video, voice and Internet connections
- Utilities - management of power grid, private telecom
- Security - CCTV and intrusion sensors, military
- Entertainment - video and audio
- Intelligent Highways

These are but a few of the applications of fiber optics, as we concentrate on communications. Fiber optics are also used for lighting, signs, sensors and visual inspection (medicine and non-destructive testing).

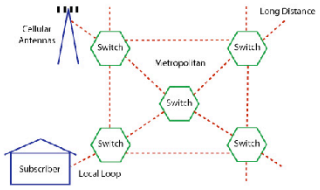
FRG: Chapter 1, 3, FOTM, Chapter 2, DVVC, Chapter 11
FOA Online Fiber Optic Reference Guide, Understanding Fiber Optics, The Basics: Basic Overview

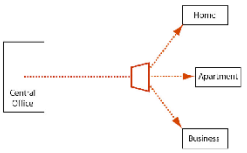


The growth in fiber optics is simply what is needed to accommodate the growth in data.

Telecom Technology

- Fiber replaces copper or radio links
- All digital, 10/40/100 Gb speeds
- Moving to 400G, 1000G, IP and all-optical protocols
- Fiber To The Home (FTTH) using PONs (passive optical networks) to deliver VDV





Fiber optics has become widely used in telecommunications because of its enormous bandwidth and distance advantages over copper wires. The application for fiber in telephony is simply connecting switches over fiber optic links.

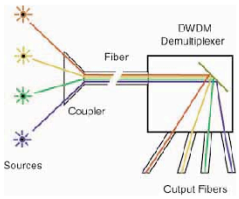
Commercial systems today carry more phone conversations over a single pair of fibers than could be carried over thousands of copper pairs. Material costs, installation and splicing labor and reliability are all in fiber's favor - not to mention space considerations. In major cities today, insufficient space exists in current conduit to provide communications needs over copper wire.

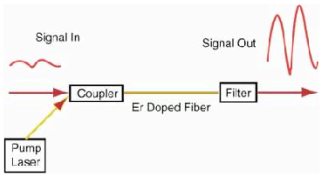
While fiber carries over 90% of all long distance communications and 50% of local communications, the penetration of fiber to the curb (FTTC) and fiber to the home (FTTH) has been hindered by a lack of cost effectiveness until now. The secret to making FTTH cost effective has been the development of the passive optical network (PON).

Telecom systems operate at bit rates up to 40 gigabits per second (100/400/1000G in the future) and many links use WDM - wavelength division multiplexing - to put several channels of signals over one fiber.

Wavelength-Division Multiplexing

- Now commonplace
- DWDM >64 channels with fiber amplifiers for repeaters
- CWDM ~20 channels on low-water peak fiber
- Preferred over more fibers
- Use for bidirectional signals over single fiber in FTTH





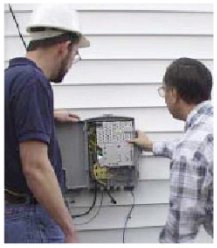
To expand bandwidth, it's now common to add new wavelengths rather than use new fibers.

How Does WDM Work? It is easy to understand WDM. Consider the fact that you can see many different colors of light - red, green, yellow, blue, etc. all at once. The colors are transmitted through the air together and may mix, but they can be easily separated using a simple device like a prism, just like we separate the "white" light from the sun into a spectrum of colors with the prism.

The input end of a WDM system is really quite simple. It is a simple coupler that combines all the inputs into one output fiber. The demultiplexer takes the input fiber and collimates the light into a narrow, parallel beam of light. It shines on a grating (a mirror like device that works like a prism, similar to the data side of a CD) which separates the light into the different wavelengths by sending them off at different angles. Optics capture each wavelength and focuses it into a fiber, creating separate outputs for each separate wavelength of light.

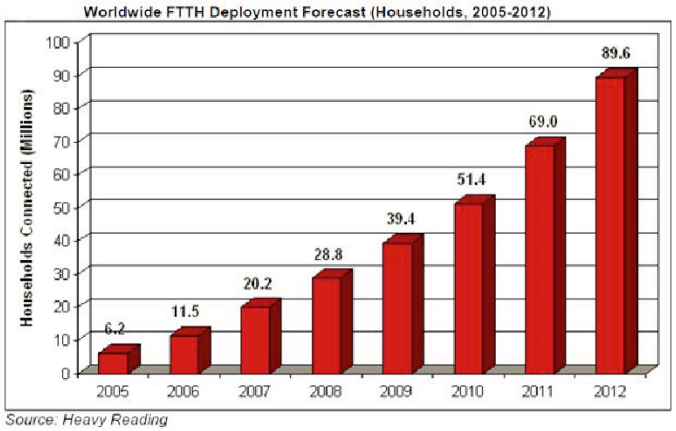
FTTH Economics

- Fiber optic components are getting cheaper
- Passive optical networks cut costs even more
- Fiber is cheaper to maintain than copper
- Fiber offers new services like TV and high speed Internet that increase revenues



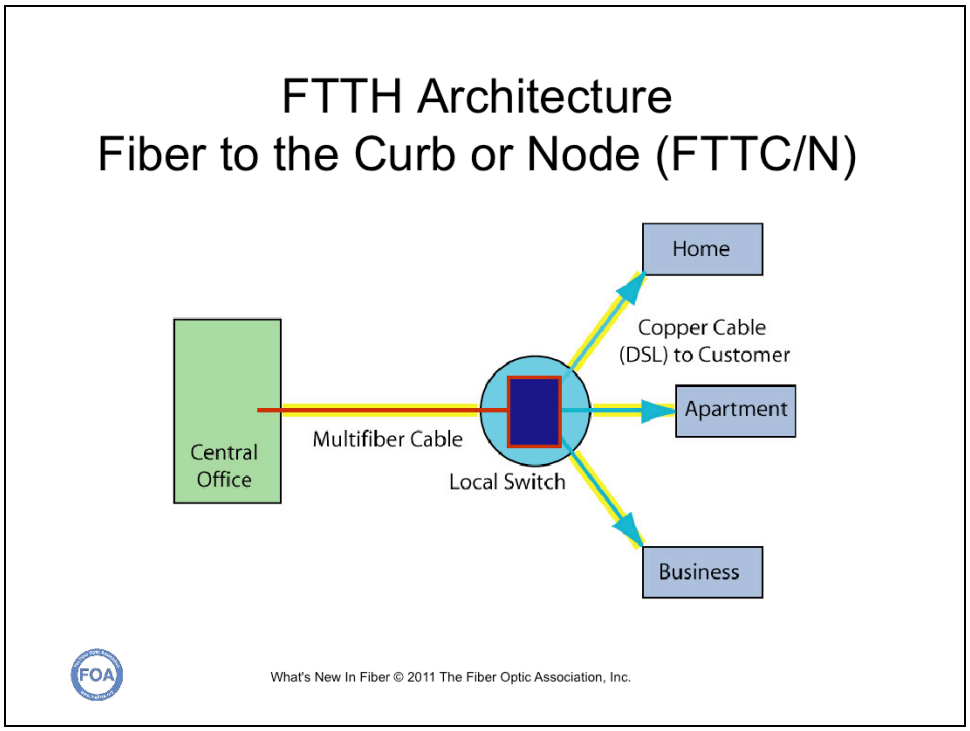
In areas where highest bandwidth is desired, only fiber to the home (FTTH) is a solution. Fortunately the costs have decreased until it has become economically feasible.

FTTH Is Growing

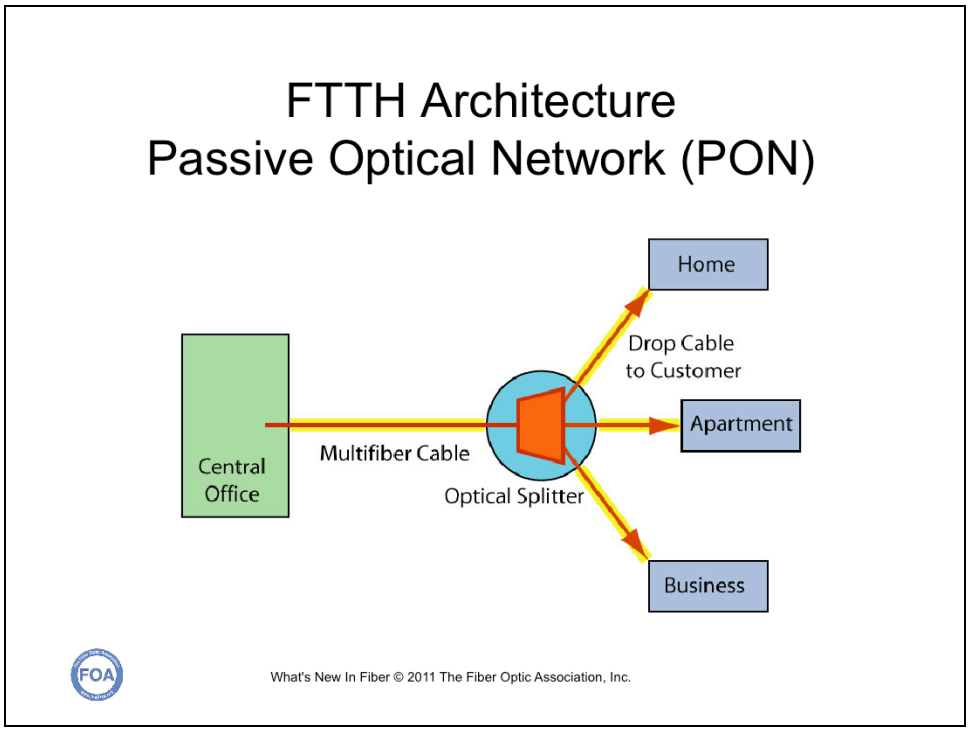


Source: Heavy Reading

And it is being adopted rapidly around the world.



An active star network uses fiber from the central node (CO) to a local active node carrying multiplexed signals to be distributed to all the customers. At the active node, (electronic) switching occurs for each customer and connects to a dedicated optical link to the premises. This may be a more expensive network due to the electronics and powering required, as the node requires uninterruptible local power if support of services like 911 are required, or cheaper for small networks that do not need the size or capability of a PON network. Each system needs to be considered carefully in light of all options.



The passive optical network (PON) uses optical couplers, both wavelength division multiplexers and simpler splitter/combiners, to allow connection of many customers over only one fiber from the CO - like broadcasting TV or radio over air waves. Thus a few fibers can support many customers, typically up to 32 customers on one fiber from the CO to the local splitter.

A PON using wavelength division multiplexing (WDM) can be used two ways: It can provide every customer with a dedicated wavelength, greatly expanding bandwidth to any one customer, but a a much greater cost.

A more popular option is to use WDM to send multiple services, usually voice data and video, as well as upstream signals, over a single fiber, as shown in the slides following.

Upstream data from multiple subscribers is time-division multiplexed so each subscriber has a time window to send data back to the system.

Some people refer to this as a P2MP or point-to-multipoint network.

Passive Optical Network (PON) Options

Type	Description	Standard
BPON Broadband PON	ATM and video on HFC	ITU -T G.983
GPON Gigabit PON	IP + ATM or GEM	ITU -T G.984
EPON Ethernet PON	Ethernet 1-10 Gb/s	IEEE-802.3ah

There are several types of PONs being deployed, categorized by their transport protocol, or how the data is encoded and transmitted.

BPON, or broadband PON, uses ATM as the protocol. ATM is widely used for telephone networks and the methods of transporting all data types (voice, Internet, video, etc.) are well known. BPON operates at ATM rates of 155, 622 and 1244 Mb/s. Video is sent to subscribers using analog transmission like hybrid-fiber coax CATV systems.

GPON, or gigabit-capable PON, uses an IP-based protocol and either ATM or GEM (GPON encapsulation method) encoding. Data rates of up to 2.5 Gb/s are specified and it is very flexible in what types of traffic it carries. GPON enables “triple play” (voice-data-video) and is the basis of most planned FTTP applications in the near future.

EPON or Ethernet PON is based on the IEEE standard for Ethernet in the First Mile. It uses packet-based transmission at 1 Gb/s with 10 Gb/s under discussion. EPON is widely deployed in Asia.

Wireless Phone Usage

- Personal Communications
- Replacing Landline Phones
- Messaging (SMS)
- Internet Access
- Watching Video & TV

The world wants to be mobile, and wireless technology is developing to accommodate it.

What Can Happen!

- AT&T: wireless network data traffic in the US has grown >8000% - that's 80 times - since the introduction of the first Apple iPhone!
- Here comes the iPad!

But wireless systems must grow rapidly to provide adequate bandwidth for new devices and applications.

Wireless Communications

- Cellular
- WiFi
- WiMax
- “White Space”
- Satellite links
- Connect into worldwide networks on fiber

Most wireless systems like cellular systems are not all wireless - most antennas are connected into the worldwide communications networks via buried fiber optic cables.
Likewise, wireless LANs and metropolitan wireless systems require cabling and fiber provides greater distances from hubs and switches and immunity to noise.

FRG, Chapter 3, FOTM, Chapter 3, DVVC, Chapter 11
FOA Online Fiber Optic Reference Guide, Understanding Fiber Optics, The Basics: Basic applications and transmission systems

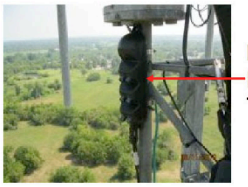
How Do You Connect Towers?

- Bandwidth for wireless is scarce
- Must connect to phone systems which are mostly fiber optics
- So fiber is used for many wireless connections, even WDM and PON

Many wireless towers are connected to the phone system using fiber backbones using standard singlemode optical fiber. Expanded 4G and LTE service requires more antennas on the towers. Traditionally the antennas are connected on large coax cables to stations on the ground. Now fiber, usually multimode fiber for the short links, is being used for it's lower bulk and weight, so only a single fiber optic cable and a power cable needs to run up the tower rather than the big bundles of coax shown on the towers on the upper left.

How Do You Connect Antennas?

- Large coax up the tower to antennas is too big and too heavy
- Use small fiber cable, sometimes with power conductors in the same cable, to connect multiple antennas



Many wireless towers are connected to the phone system using fiber backbones using standard singlemode optical fiber. Expanded 4G and LTE service requires more antennas on the towers. Traditionally the antennas are connected on large coax cables to stations on the ground. Now fiber, usually multimode fiber for the short links, is being used for it's lower bulk and weight, so only a single fiber optic cable and a power cable needs to run up the tower rather than the big bundles of coax shown on the towers on the upper left.

Is This The Antenna Of The Future?

- Alcatel-Lucent has recently shown “lightRadio cube” a small cellular antenna that can be placed anywhere
- Needs only fiber and power connections

Many wireless towers are connected to the phone system using fiber backbones using standard singlemode optical fiber. Expanded 4G and LTE service requires more antennas on the towers. Traditionally the antennas are connected on large coax cables to stations on the ground. Now fiber, usually multimode fiber for the short links, is being used for it’s lower bulk and weight, so only a single fiber optic cable and a power cable needs to run up the tower rather than the big bundles of coax shown on the towers on the upper left.

Mobile Frontier

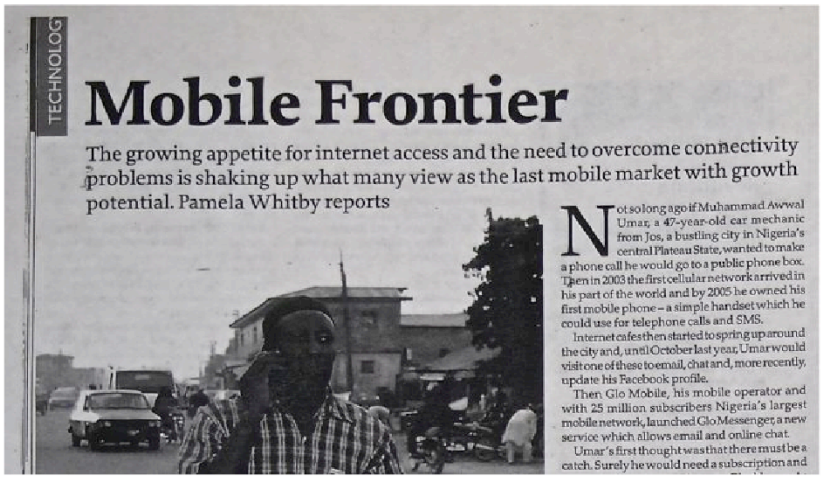
The growing appetite for internet access and the need to overcome connectivity problems is shaking up what many view as the last mobile market with growth potential. Pamela Whitby reports

Life tools
Agriculture
Healthcare
Education
Entertainment
Help
Select Exit

"Developing applications for low-end handsets is a growing market"

From *BBC Focus on Africa*

In Africa, a different mobile system is developing than in the US or Europe.



TECHNOLOG

Mobile Frontier

The growing appetite for internet access and the need to overcome connectivity problems is shaking up what many view as the last mobile market with growth potential. Pamela Whitby reports

Not so long ago if Muhammad Awwal Umar, a 47-year-old car mechanic from Jos, a bustling city in Nigeria's central Plateau State, wanted to make a phone call he would go to a public phone box. Then in 2003 the first cellular network arrived in his part of the world and by 2005 he owned his first mobile phone – a simple handset which he could use for telephone calls and SMS.

Internet cafes then started to spring up around the city and, until October last year, Umar would visit one of these to email, chat and, more recently, update his Facebook profile.

Then Glo Mobile, his mobile operator and with 25 million subscribers Nigeria's largest mobile network, launched GloMessenger, a new service which allows email and online chat.

Umar's first thought was that there must be a catch. Surely he would need a subscription and

From *BBC Focus on Africa*

Simpler phones can still be used for limited web access – and paying bills, an application just appearing in the USA!

Is Fiber A Solution?

- Fiber adds bandwidth to the phone system and wireless backhaul
- Bandwidth allows more data & smartphones
- Smartphones generate revenue – more than voice

For African consumers, who have some of the highest connectivity costs in the world, it will be better still when prices start to fall. This may happen as new fibre-optic cables are laid and internet-based services start to supplant more basic ones.

But one thing is certain, the market for low-end handsets, and applications that work on them, will be around for the foreseeable future.

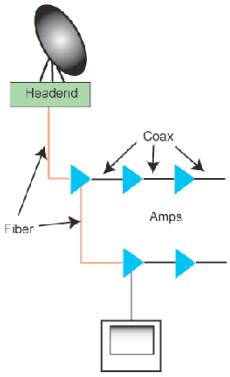
Pamela Whitby is a freelance journalist and the sub-editor of BBC Focus on Africa magazine

From *BBC Focus on Africa*

Fiber backhaul can provide the connectivity the new wireless networks need.

CATV Technology

- Hybrid Fiber-Coax (HFC) backbone
- Overbuild on coax
- Singlemode fiber with Lasers
- Protocol: Analog, going digital
- Mix video/data/voice
- Can extend to home using PON (RFOG)



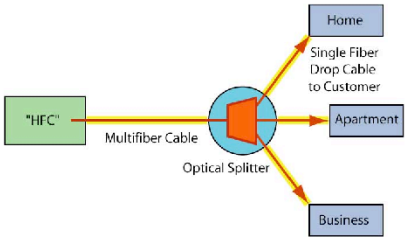
The reason fiber is used in CATV networks is that the fiber pays for itself in enhanced reliability. The enormous bandwidth requirements of broadcast TV require frequent repeaters. The large number of repeaters used in a broadcast cable network are a big source of failure. And CATV systems' tree and branch architecture means and upstream failure causes failure for all downstream users. Reliability is a big issue, since viewers are a vocal lot if programming is interrupted!

Applications in CATV were slow until the development of the AM analog systems. By simply converting the signal from electrical to optical, the advantages of fiber optics, especially reliability, became cost effective. Now CATV has adopted a network architecture that overbuilds the normal coax network with fiber optic links.

The HFC network lets the CATV provider have a two-way connection to the subscriber that allows them to offer broadband Internet connections at a low cost. The fiber network will also allow easy conversion to digital TV when it's ready.

RFOG: CATV's FTTH Solution

- RFOG: RF over Glass
- Basically a local version of a HFC (hybrid fiber coax) system with cable modem service
- Works over PON fiber architecture
- Allows independents to choose telco or CATV solution for FTTH

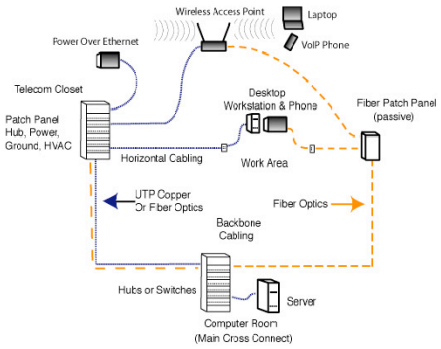


But CATV operators needed something to combat the subscriber's clamoring for fiber to the home, which lead to the development of RFOG, RF over Glass. RFOG is basically nothing more than a HFC/ cable modem system built with less expensive components now available thanks to the volume pricing of components used in FTTH. It's designed to operate over a standard telco PON (passive optical network) fiber architecture with short fiber lengths and including the losses of a FTTH PON splitter.

There is one interesting side effect of this approach. Now telcos and CATV companies can deliver the same services over the same cable plant using totally different technologies. But that means that office or apartment building owners, developers or even whole towns that might be considering installing FTTH infrastructure themselves and leasing the fiber to a service provider can have a choice of service providers. One cable network can support either CATV or telco systems – or even someone else for that matter. That opens up a big market for private fiber optic systems.

Premises or Structured Cabling
For Local Area Networks - LANs

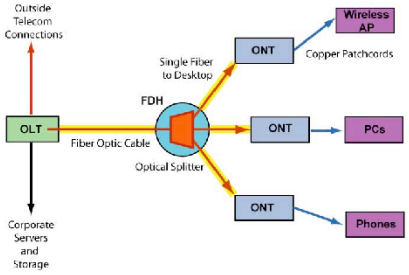
- Ethernet to 10 Gb/s
- Fiber backbones
- Fiber to the desk
- Connect WiFi Access Points
- Centralized fiber



Fiber is widely used in premises or structured cabling, supporting Ethernet to 10 Gb/s and soon 40/100 Gb/s.
Fiber is used for most backbones, some fiber to the desk and to connect WiFi access points, especially 802.11n. A centralized fiber network allows using fiber without telecom rooms near the users, centralizing all the electronics in the computer room. Data centers are another big user of fiber, with connections at 10 b/s where fiber is more reliable and consumes much less power.

Passive Optical LAN (POL)

- FTTH PON adapted to LAN
- Similar to large residential building
- All singlemode fiber
- Prefab cabling
- Cheaper than copper!



Motorola, one of the largest suppliers of FTTH PON equipment is now offering systems similar to those used in large residential buildings for enterprise LANs in companies. They quote system costs that are much less expensive than installing a fiber optic backbone and copper cabling to the desktop.

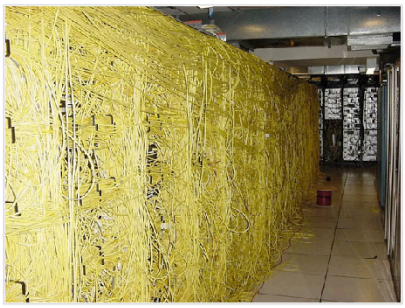
Data Centers - Internet Servers

- Store and switch data on the Internet
- Massive centers
- Use lots of power, create lots of heat, need lots of cooling
- Connections are critical

Data centers are the fastest growing application for computers used as servers. Connections are now at 10 Gb/s and new systems are becoming available at 40 Gb/s and 100 Gb/sis not far away. Fiber links between these computers and storage devices or routers are quite common as fiber saves power, space and is much easier to install.

Data Centers - Internet Servers

- 10 Gb/s now, 40/100 Gb/s coming soon
- Cabling is a problem
- Fiber is cost effective
- Fiber uses 20% as much power as a Category 6A link



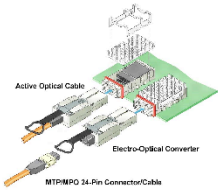
Data centers are the fastest growing application for computers used as servers. Connections are now at 10 Gb/s and new systems are becoming available at 40 Gb/s and 100 Gb/sis not far away. Fiber links between these computers and storage devices or routers are quite common as fiber saves power, space and is much easier to install.

Data Centers - Internet Servers

- 40/100G: Multimode or singlemode fiber?
- MM uses parallel 10G channels
- SM uses CWDM 10G channels
- Google says SM for 100G

	40G	100G
MM Parallel	8 fibers	20 fibers
SM CWDM	2 fibers	2 fibers

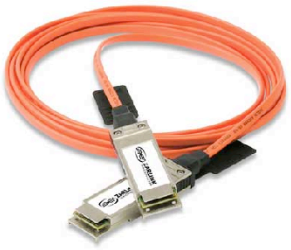
or



Data centers are the fastest growing application for computers used as servers. Connections are now at 10 Gb/s and new systems are becoming available at 40 Gb/s and 100 Gb/sis not far away. Fiber links between these computers and storage devices or routers are quite common as fiber saves power, space and is much easier to install.

Active Optical Cables

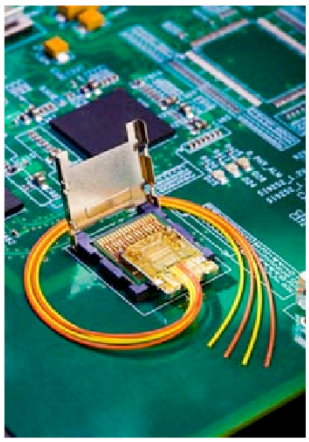
- Interfaces to electrical ports
- Each cable has fiber optic transceiver at each end
- Data - Ethernet and Fibre Channel to 100 Gb/s
- HDMI video



Fiber optic components are becoming less expensive so manufacturers are now offering active cables that have transceivers on each end and fiber for the cable. AOCs are available for Ethernet, Fibre Channel and HDMI connections, with more types in development.

Board Level Interconnects

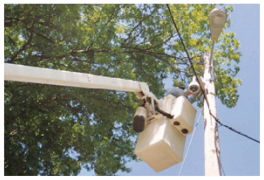
- Fast computers need fast connections
- Copper uses too much power - fiber is faster and lower power consumption
- Intel promoting use as “Light Peak”



Intel is promoting the use of optical fiber on computer boards. Fiber is faster than board connections and uses less power. New low cost components makes it cost effective.

Security & Video Fiber Optics

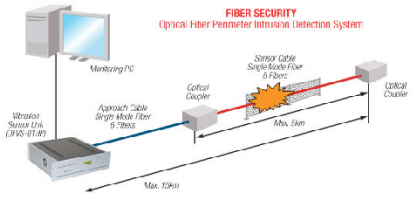
- Closed-circuit TV
- Surveillance cameras
- Intrusion Sensors



Fiber has found many other uses.
Cellular systems are not wireless - most antennas are connected via buried fiber optic cables.
Likewise, wireless LANs require cabling and fiber provides greater distances from hubs and switches and immunity to noise.
Utilities have used fiber for managing their grids and communications throughout their networks for many years. Recent problems have had many upgrading their systems.
Security systems use lots of fiber. CCTV cameras use fiber to extend their reach, for example in large airport terminals, outdoors in power plants or inside and outside big office buildings.
Fibers can also be used as sensors, for example sensing intruders on fences or walking across buried fiber sensors.
And, of course, fiber is very difficult to “tap,” making it popular for secure military and government networks.

Security Fiber Optics

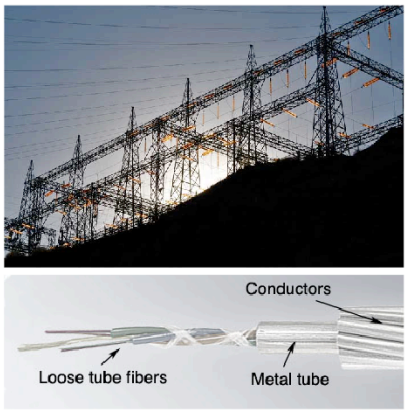
- Intrusion sensors
- Monitor stress on fences
- Buried underground
- Sensitive
- Secure



Fiber has found many other uses.
Cellular systems are not wireless - most antennas are connected via buried fiber optic cables.
Likewise, wireless LANs require cabling and fiber provides greater distances from hubs and switches and immunity to noise.
Utilities have used fiber for managing their grids and communications throughout their networks for many years. Recent problems have had many upgrading their systems.
Security systems use lots of fiber. CCTV cameras use fiber to extend their reach, for example in large airport terminals, outdoors in power plants or inside and outside big office buildings.
Fibers can also be used as sensors, for example sensing intruders on fences or walking across buried fiber sensors.
And, of course, fiber is very difficult to “tap,” making it popular for secure military and government networks.

Electrical Utilities

- Managing electrical power distribution (Smart Grid)
- Fiber is often run inside the ground wire (OPGW - optical power ground wire)



Electrical utilities have been using fiber for many years for communications and to control their electrical distribution systems. Many use optical power ground wire (OPGW) that has fiber running inside of an electrical conductor.

Alternative Energy

- Wind, solar and other alternative energy systems need precise control and management-connected with fiber.

Alternative energy production requires precise control and management to create electrical power compatible to the current grid. Wind and solar systems must be controlled to maximize outputs and control the processes. Solar using heat to generate steam, as well as those involving photovoltaic conversion, have reflectors that follow the sun, maximizing outputs. Windmills, of course, must fact into the wind and control the blades according to wind speeds. All this works on computer systems controlled by fiber. One solar facility in the Mojave has over 750 MILES of fiber!

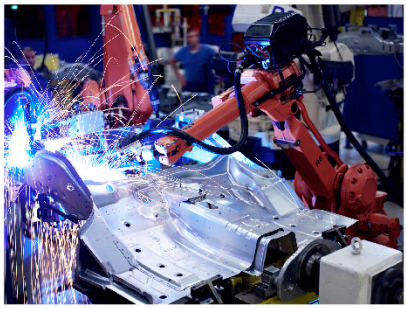
Video and Audio On Fiber

- Analog or digital
- Sporting events
- Concert halls
- Large meeting facilities
- Giant display screens in public places

Many video links are available on fiber optics, from remote security cameras to broadcast TV cameras in studios or on location as in the auto race in Long Beach, CA shown. Audio links are used in concert halls, meeting rooms, or any large auditorium with powered speakers.

Industrial Applications

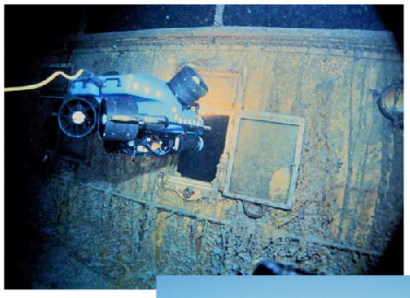
- Fiber is used in many industrial applications
- Immune to electrical noise
- More flexible than copper
- Withstand high temperature

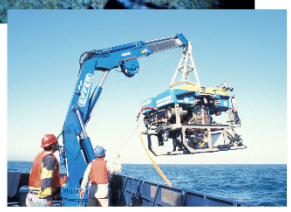


The electrical noise common to industrial environments makes it difficult to use copper data cables. But fiber is immune to electromagnetic interference and more flexible and withstands higher heat also. Industrial robots have fibers running along the arm. The machines are connected to a network, almost always on fiber.

Remote-Piloted Vehicles (RPVs)

- All RPVs use fiber
- Allows longer tethers for greater exploration range
- Used to find Titanic in 1986 (Jason) and revisit last year

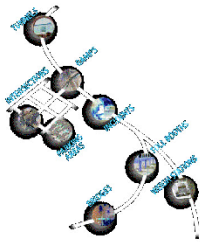


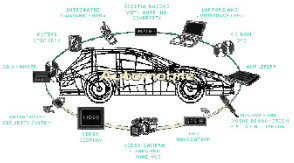


Woods Hole Oceanographic Institute started using optical fiber to connect their underwater robots called remote-piloted vehicles in the 1980s. The most spectacular result was the discovery of the Titanic by Dr. Robert Ballard who developed the technology with Jason, shown in the picture here looking into the window of a stateroom on the Titanic. Using fiber allowed the tether cables to be ten times longer than with copper and produce better signals! Now all RPVs use fiber tethers.

Other Applications of Fiber Optics

- Building Management
- Traffic Control
- Automotive networks
- Sensors
  - High voltage/current
  - Chemicals
  - Hazardous environmer

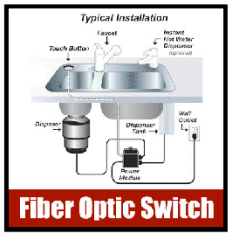




Building management systems can use fiber in place of copper cable for longer distances and greater security.
Industrial networks favor fiber for process control applications due to its distance capability and immunity to electrical noise.
Fiber optic sensors are available for a number of applications, including measuring high voltages and currents as in power grids, dangerous chemicals and can operate in hazardous environments since they are intrinsically safe.

And More!

- Fiber optic switches
- Underwater camera housings
- Artwork
- Rolls Royce



Fiber has many more uses, some quite simple but effective, some just decorative! You can now have a fiber optic starfield headliner in your Rolls Royce!

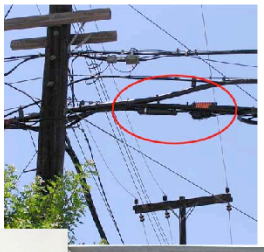
New Products Coming From FTTH

- FTTH required
  - Low cost components
  - Fast and easy Installation
  - Installation indoors in small spaces
- Resulted in development of many new products

FTTH has led to the development of new products as well as lower prices.

Prefabricated Cabling Systems

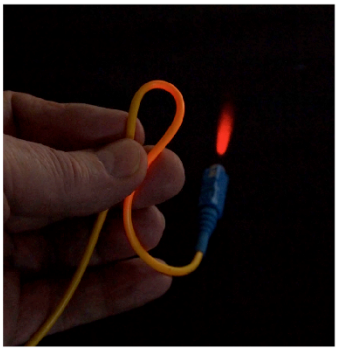
- Factory terminated cables used for drop to home
- Weather-resistant closures used on cables, poles or underground
- Saves time and cost



Many FTTH systems now use prefabricated cables for the drop to the house. Crews come into the neighborhood and install the drop closures on poles or in underground vaults and splice the fibers into the backbone fiber network that terminates in the central office or a local PON distribution hub. The tech doing the actual FTTH install merely plugs in the cables between the closure and the optical network terminal and spends the bulk of the time connecting the user to telephone, Internet and TV services.

Bend Insensitive Fiber

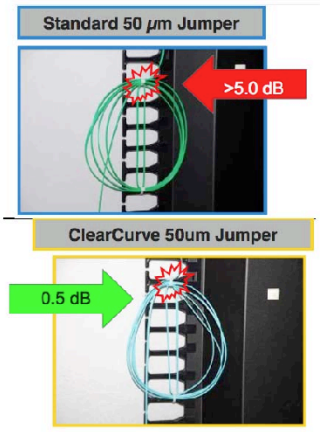
- Normal fiber has high loss when bent
- New "bend insensitive fiber" can be bent tightly without loss - or long term harm
- Use indoors to fit fibers in small spaces



Most optical fiber manufacturers are now offering bend-insensitive fibers that can be bent tightly without much loss. This allows them to be used in close spaces like cable trays or run around the edge of a wall in a room.

How Effective Is B-I Fiber?

- DO NOT TRY THIS YOURSELF!



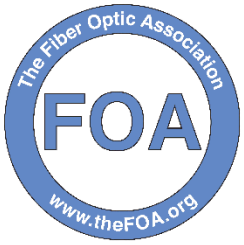
All generalizations,
with the possible exception of this one,
are false!

Kurt Godel, *philosopher*

Sufficiently advanced technology is indistinguishable from magic.

Arthur C. Clarke

"Profiles of The Future", 1961



- The Fiber Optic Association, Inc.
  - 1119 S. Mission Road, #355, Fallbrook, CA 92028
    - Tel: 1-760-451-3655 Fax: 1-781-207-2421
  - Email: info@thefoa.org http://www.TheFOA.org

Contact us with any questions.