FIBRE OPTICS - MYTHS & FACTS

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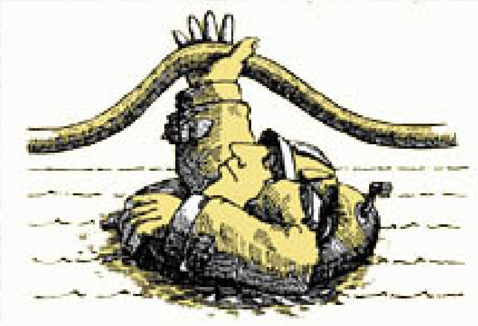
The Indian CATV industry has grown in rapid strides over the past few years, averaging a growth rate of 25 - 35 % per annum. The Indian Cable Operator has proved himself to be a very enterprising business man and has rapidly moved from small local "mollah" networks to large networks covering almost entire cities.

The giant Department of Telecom has provided a meagre 15 Million Telephone connections of 3 Khz. audio bandwidth (many of which do not function throughout the year !) in the past 52 years with an investment running into of crores of Rupees. This task was well supported by the benefits of being a Government Department operating in an infrastructure Industry.

In contrast the "poor cousin" cable operator working within the difficult parameters of lack of Institutional Funding, high taxation, lack of proper regulations, lack of security and no concessions of any nature, today delivers 550 Mhz of Audio & Video signals to approx. 22 Million homes (working 365 days) at a fraction of DOT's investment !

The Indian CATV networks have gone through many levels of upgrades, from narrow RG - 6 drop cable to the thick QR 540 Trunks, from transistorisedAmplifiers to Amplifiers with Dual Hybrids, from 300Mhz too 550 Mhz, from Analog to Digital Receivers....and so on. For many networks, the time has now come to take the next step, to move higher in the Technology curve and migrate into the realm of Fiber Optics. The long awaited convergence of Data, Voice & Video is now here to happen and the future of CATV networks is in Hybrid Fibre Coaxial (HFC) Networks. The Fibre Optics technology, like any new technology, carries around it a "halo" of misconceptions. This article attempts to clear some common myths regarding Fiber Optics.

FIBER OPTIC MYTHS



Once upon a time, a new technology burst upon the scene and took the com- munications industry by storm. Optical fiber-thin strands of glass capable of transmitting voice, data and video transmissions by pulses of light - quickly revolutionized the nation's long-distance telephone networks. The presence of fiber has also emerged in cable TV plant as fiber supertrunks become standard practice and new concepts emerge for optical distribution of programming.

With more than 5 million miles of fiber installed in North America, many of the myths that surrounded the technology have been put to bed. Yet, there are a few nagging concerns regarding the installation and care of fiber that seem to have taken on almost mythical qualities. Obviously the same applies for the Indian HFC networks.

MYTH : FIBER IS FRAGILE

All of us have been repeatedly reminded since we were children to be careful with glass. But now glass can be made much stronger than you think. An optical fiber without flaws has a theoretical strength of more than 2 million pounds per square inch. Although it is not recommended, field crews have been known to accidentally run over fiber cable with a truck, with no discernible effect to the fiber.

MYTH : GLASS "FLOWS" OVER TIME

Not so. Glass is an amorphous solid. It is not a liquid and does not flow over time. We have often heard the science teacher's example of windows in old buildings that seem to have settled to the bottom. That's a myth. Old windows were handmade glass and in those days thickness was difficult to control. Panes were installed with the thickest part at the bottom. In the Coming Museum of Glass in Coming, N.Y., there are examples of glass that date from 1,500 B.C. None has deformed from long-term effects of gravity.

MYTH: WATER CAUSES OPTICAL FIBER TO DETERIORATE

Personnel who work with fiber may have concerns about "stress corrosion. "In the presence of moisture, if an optical fiber is under tension, a flaw may grow, causing the fiber to break. This is true, but a break requires the presence in sufficient intensity of each of all three ingredients: moisture, tension and a flaw. Without tension or stress as a factor, moisture will not cause fiber to corrode, even if there is a flaw.

Splice cases should be sealed to prevent the entry of large amounts of water, especially in climates where deep freezes occur. If a large quantity of water should freeze inside a splice enclosure, expansion forces might put stress on the fiber. But field experience indicates that small amounts of water, such as atmospheric concentration, should not be a problem.

However, water can affect fiber coatings. Since the coatings may soften slightly when wet, care should be taken not to handle any fiber when it is wet. When dried, its original mechanical properties are unchanged. Exposure to some chemicals or extreme environments may darken the color of the coating but does not affect the fiber's performance or strength.

MYTH: CABLE CUTS WILL CAUSE CRACKS TO PROPAGATE IN FIBER

If an optical cable is inadvertently dug up by a backhoe, there may be enough force applied to the cable to break the fiber inside. The break, however, may not occur at the point of the sheath cut. When sufficient tension is applied to a length of fiber, the fiber will break at its weakest point along the length. That point may be some distance down the cable, but the fiber will break at only one point. It is called an "offset break" and no other cracks are induced in the fiber.

MYTH: IN A CUT CABLE, LASER LIGHT CAN LEAK OUT AND BLIND YOU

If a backhoe accidentally breaks a fiber cable, could the operator be blinded by the laser light? If the fiber is held directly to the eye for a prolonged period, there might be enough optical power present to cause injury; otherwise, the danger is quite remote. Power at the laser is usually about 1 mill. While that is considered hazardous if stared at directly, light intensity in the cable decreases considerably with distance. Also, the rough end face on the broken fiber helps to diffuse the laser's energy. In any event, prolonged staring into the end of a cut cable should be avoided.

MYTH: YOU CAN'T SPLICE ONE MANUFACTURER'S FIBER TO ANOTHER'S

Despite the differences that exist among glass fibers of various manufacturers, all fibers of a similar type can work together, spliced by either mechanical or fusion methods. Splicing can be done with low losses, high strengths and without significant resetting of commercially available splicing equipment. The fibers should be substantially alike (i.e, single-mode to single-mode), but even multimode fibers of different core sizes have been successfully fusion spliced.

MYTH: FIBER HAS A HOLE DOWN ITS CENTER

Many people think that light travels through a small tunnel in the center of the fiber; actually, the fiber is solid glass. The core glass in the center is surrounded by a cladding glass, which has a lower index of refraction. The two different indices of refraction create a reflective light trap, keeping the light pulses confined to the core glass.

EVALUATION OF AN HFC NETWORK

For the street-smart and hardworking Indian Cable Operator, there should no problem adjusting to the fascinating world of Fiber Optics. After all using Fibre Optics is in reality only an upward shift in operating Radio Frequency from 550 Mhz to 229,007,633 MHz (See box). All basic principles apply to the so called "magical world" of Fiber Optics also, including the principle of cable loss.

In the Indian Cable TV environment, Fiber Optics can be deployed in at least two major applications :

Frequency & Wavelength

Any Electromagnetic wave, such as light or radio frequency
is governed by the simple formula c = n x l , where
c = 3 x 10*8 mts/sec, which is the speed of light
n = Frequency in Hz
l = Wavelength in Metres
Hence as frequency increases,the wavelength decreases.

Using the above formula,
48.25 MHz (CH 2) equates to 6.217 mts
550 MHz equates to 545 mm
1750 MHz (SAT IF) equates to 171 mm

Similarly 193,548,387 MHz equates to 1550 nm
229,007,633 MHz equates to 1310 nm.
Obviously, it is more convenient to use 1310 nm
or 1550 nm instead of the cumbersome figure in MHz !

HFC NETWORKS : To build a hybrid network where the trunk lines will be of Optical Fiber and the so called "last mile" will be the local Co-axialnetwork. The MSO would in effect "wholesale" the CATV signals through Fiber to the local cable operator who would "retail" the signal to the subscriber through Co-axial cable, which will enter the subscriber's house. With the current technology, the Fiber will NOT enter the subscriber's house.

POINT TO POINT CONNECTIVITY : This is another application of Fiber Optics where in it's simplest form can link-up 2 control rooms seperated from each other. Hence instead of running 2 seperate headends at 2 distant locations, a single headend with a better performance can be installed at one of the control rooms, and the signals transferred to the other control room with minimum degradation.

With 1310 nm technology, the typical distance that can be covered under ideal conditions is 25-30 Kms. In contrast 1550 nm technology can transfer signals to 60 -65 Kms under ideal conditions without splitting for both the above applications. Any Transmission Network can be judged on the basis of following parameters :

QUALITY ISSUES - Almost 50 % of noise contribution in a cable system comes from the trunk amplifiers (see diagram 1). The only way to reduce the number of amplifiers in cascade is to use a mix of Fiber & Co-axail cables. This would result in an improvement of the C/N at the subscribers point.

RELIABILITY ISSUES - System reliability is measured in terms of the number of outages per subscriber per month. High system reliability results not only in improved customer satisfaction , but also lower maintenance costs.

The tree-and-branch architecture of co-axail networks can result in a large number of subscribers being affected by an outage, if it occurs at the first amplifier in a cascade. One solution to this problem is to divide the entire network into smaller areas each serviced by "nodes" with independant links to the headend. This nodal architecture, using Fiber Optics, results in a fewer subscribers being affected in case of any component failure.

BANDWIDTH ISSUES - New technologies for video formats like EDTV, HDTV etc not only require improved C/N but also put pressure on currently available bandwidth. Compared to the 7 Mhz bandwidth, other proposed systems require 8 - 12 Mhz per acannel. Also new services like Pay-Per-View, Data Communications require additional bandwidth to provide new sources of revenue.

This wider bandwidth puts further demand on the system C/N. Fiber Optics, free from the ever difficult line balancing problems, provides the necessary bandwidth for above expansion.

REVERSE BANDWIDTH : To date the Indian operators have been using the reverse path for transmission of "live coverage" signals over a limited part of the network. In contrast, new services like Data Transfer, Internet connectivity etc require substantial reverse bandwidth over the entire network i.e. from each subscriber to the Control room. Once again, HFC comes to the rescue by providing a seperate Fiber strand from each node to the control room. This does away with the problem of convergence of all reverse signals on a single length of cable, as in a Co-axial network. Using the up- conversion technique, up-to 5 bands of 5 - 40 Mhz can be used in reverse over a single strand of Fiber using a reverse Transmitter with 5 - 200 Mhz bandwidth.

MARKETING ISSUES : Certain system architectures lend themselves to the concept of dividing the system into small areas served from nodes (i.e receivers). Such segmentation has the following potential advantages

- System upgrades can be taken up more selectively, allowing a closer match of investments with financial returns .

- The possibility of narrowcasting programmes as well as advertisement increases manyfold.
- Set-top terminals can be deployed on an area-wise (node-wise) basis.
- New services such as Internet connectivity, Pay-per-view etc can be provided on a selective basis, providing effective market trials without disrupting the entire network.

From the above it is evident that Fiber Optics is application driven and in those applications will perform certain functions that the tree-and-branch Co-axial networks simply cannot undertake. In most other cases, a Fiber Optics network will out-perform a Co-axial network in a similiar application.

Fiber Optic networks have already been deployed on large scale by MTNL, Western Railway etc for inter-exchange telephone connectivity, data & control applications. The price of a 4 core Fiber Optics cable is now comparable to that of a half inch Co-axial cable.

Also the prices of Fiber Transmitter & Receiver are dropping across the world due to large scale deployment and improved laser yields. The overall effect of decreasing prices is that a Fiber Optic network's investment is now comparable to that of a Co-axial network, there by exploding the most common myth that Fiber Optic systems are prohibitively expensive !

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