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Optic Fiber as a Reliable Medium for Metropolitan Area Networking (MAN) Connectivity

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ABSTRACT

This paper presents optic fiber as a more reliable connectivity medium for a robust Metropolitan Area Network (MAN) ,in recent times, network connectivity as been through different levels of accessibility and useability,hence there is need to properly explore a more dependable medium of connectivity in other to achieve a desired output with respect to it's through-put.

Keywords: *optic fiber, traffic analysis, testing for various losses, Optical Power Measurement.*

1. INTRODUCTION

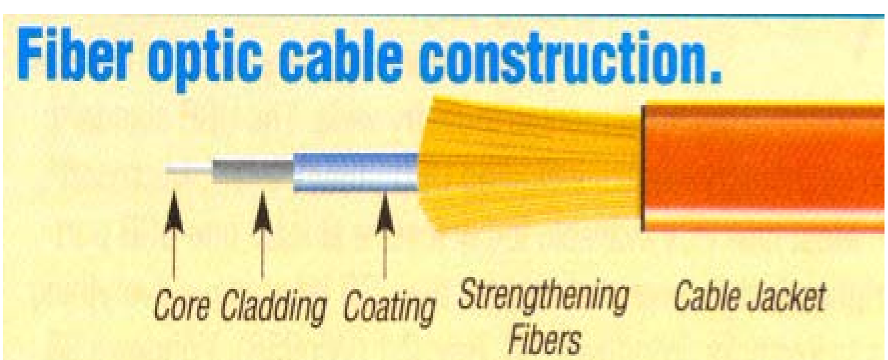
A metropolitan area network (MAN) is a computer network in which two or more computers or communicating devices or networks which are geographically separated but in same metropolitan city and are connected to each other are said to be connected on MAN (IEEE Std 802-2002). A MAN is optimized for a larger geographical area than a LAN, ranging from several blocks of buildings to entire cities. MANs can also depend on communications channels of moderate-to-high data rates. A MAN might be owned and operated by a single organization, but it usually will be used by many individuals and organizations. MANs might also be owned and operated as public utilities. They will often provide means for inter-networking of local networks.

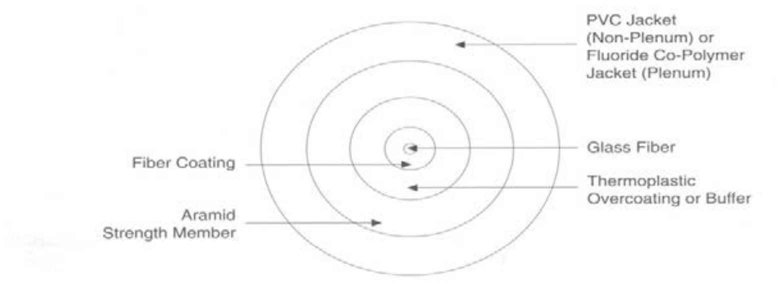
2. OPTIC FIBER

Fiber Optics involves sending signals down hair-thin strands of glass or plastic fiber. The light is "guided" down the center of the fiber called the "core". The core is surrounded by a optical material called the "cladding" that traps the light in the core using an optical technique called "total internal reflection." (Bates, Regis J (2001).). The core and cladding are usually made of ultra-pure glass, although some fibers are all plastic or a glass core and plastic cladding. The fiber is coated with a protective plastic covering called the "primary buffer coating" that protects it from moisture and other damage. More protection is provided by the "cable" which has the fibers and strength members inside an outer covering called jacket.

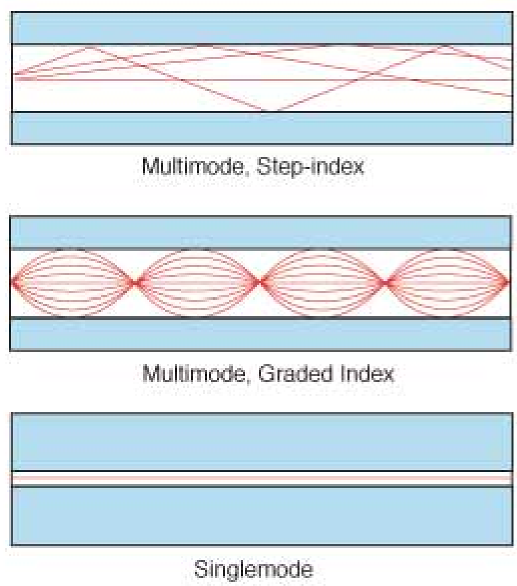
The light stays confined to the core because the cladding has a lower refractive index—a measure of its ability to bend light. Refinements in optical fibers, along with the development of new lasers and diodes, may one day allow commercial fiber-optic networks to carry trillions of bits of data per second.

Total internal refection confines light within optical fibers (similar to looking down a mirror made in the shape of a long paper towel tube). Because the cladding has a lower refractive index, light rays reflect back into the core if they encounter the cladding at a shallow angle (red lines). A ray that exceeds a certain "critical" angle escapes from the fiber.





Tight-Buffered Cable



Backbone Strategy

Three Layer-hierarchical model was adopted in the design. This is suitable for most networks from small office LAN to corporate networks. This layering actually focuses on the hierarchy of the router as it is main device from connecting the networks. The layers include core, distribution and access. The core layer provides the connections between remote sites and acts as the gateway between the internal and external network. Core links are usually WAN connections like X.25, leased line and V-SAT links. Nodes are not usually connected to the router.

Since the main gateway is implemented in this layer, it is usually a place to install the firewall system. The firewall is to protect the internal network from external attacks. The distribution layer is the layer that provides the connections to the various segments of the entire network. In this project, optic fiber provides the distribution link. Nodes are rarely connected to this layer also. The access layer from its name provides the actual links to the end user. It is in this layer that nodes are connected to the switches for the users to have access to both the internal and external network.

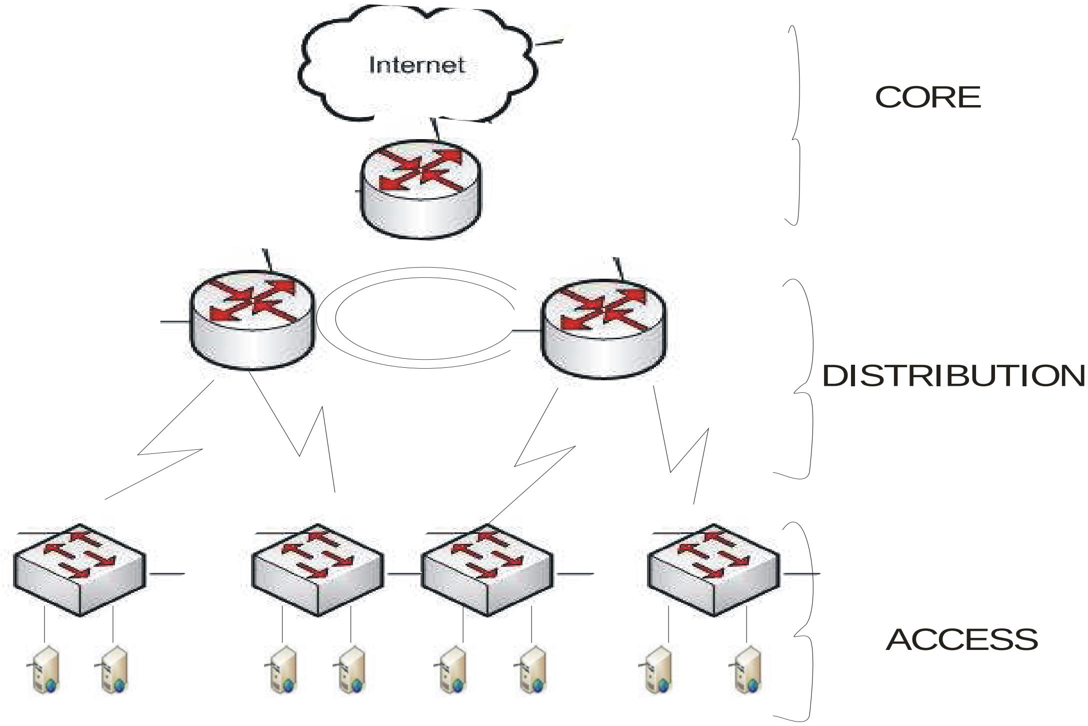


Fig 5.2 Three Layer Hierarchical Model

3. TRAFFIC ANALYSIS

Designer may sometimes find out that user needs constant changes in network functionalities, in response to changing business conditions and changing technologies. Upgrading and redesigning of existing network, rather than designing a network from the scratch is what designer often have to do. For example, the increasing popularity of voice and video-based network application may add pressure to existing bandwidth. In addition to the cost, a designer may have to work out a careful procedure for upgrading so as to avoid disruption of service provided to the users.

It is important to analyze the traffic patterns, between attached clients and servers before swapping one device for another. To minimize inter-switch traffic, which represent a potential bottleneck, the following suggestion will suffice:
It is important to have those workstations and servers that communicate most often with each other on the same switch, since switches differ in cascadability and speed of inter-switch communications connections.
Another benefit of analyzing traffic patterns before installing the switch is the ability to identify those users and workstations that need a dedicated switch port and those that can reside on shared LAN segment attached to a switched port
The following are a few guidelines used for switch port allocation:

1) Servers and Linus working stations were allocated their switch port
2) Distributed computing power users with frequent queries to servers were allocated switch port via shared LAN segment of not more than eight users.
3) Causal or light users accessing only e-mail and terminal, character-based programs can be connected to switch port via shared LAN segment of more than 8-users.

The ability of LAN switches to support multi-workstation LAN segment on a single switch port may vary among switches. The number of workstations addresses which can be supported by a given switch port may vary from switch to switch. 3.2 Guideline for field terminations
Here are a few things to remember when terminating connectors in the field. The following guidelines will save time, money and frustration:

1. Connector choice should be made carefully and cleared with the customer if it is anything other than an epoxy/polish type. Some customers have strong opinions on the types or brands of connectors used in their job. One must find out first, not later!
2. There must be the right tools for the job. Extra care must be taken to have the proper tools and ensure they are in good shape before onehead out for the job. This includes all the termination tools, cable tools and test equipment. Are the test cables good? Without

that, one will test good terminations as bad every time. More and more installers are owning their own tools like auto mechanics, saying that is the only way to make sure the tools are properly cared for.

3. Dust and dirt are major enemies. It's very hard to terminate or splice in a dusty place. Splice and termination must be done in the cleanest possible location. Use lint-free wipes (not cotton swaps or rags made from old T-shirts!) to clean every connector before connecting or testing it. Don't work under heating vents, as they are blowing dirt down continuously.
4. Don't overpolish. Contrary to common sense, too much polishing is just as bad as too little. The ceramic ferrule in most of today's connector is much harder than the glass fiber. Polish too much and create a concave fiber surface, increasing the loss. A few swipes are all it takes.
5. Single-mode fiber requires different connectors and polishing techniques. Most SM fibers are terminated by splicing on a pre-terminated pigtail, but one can put SM connectors on in the field if one knows what one is doing. Higher losses can be expected, approaching 1 dB and high back reflections, so they are not to be used for anything but data networks.
6. Polishing films should be changed regularly. Polishing builds up residue and dirt on the film that can cause problems after too many connectors and cause poor end finish.
7. Put covers on connectors and patch panels when not in use. Keep them covered to keep them clean. Installations should be inspected and tested, then documented. It is very hard to troubleshoot cables when one don't know how long they are, where they go or how they tested originally! So good records should be kept, smart users require it and expect to pay extra for good records (SFF Committee (2001-05-01)),

4. TESTING FOR THE VARIOUS LOSSES

After fiber optic cables are installed, spliced and terminated, they must be tested. For every fiber optic cable plant, there is the need to test for continuity and polarity, end-to-end insertion loss and then troubleshoot any problems. If it's a long outside plant cable with intermediate splices, there is need to verify the individual splices with an OTDR test, this is about the only way to make sure that each splice is good. Designers may also be interested in testing transmitter and receiver power, as power is the measurement that tells whether the system is operating properly. (Robert J. Kohlhepp (2000-10-02)

Testing is the subject of the majority of industry standards, as there is a need to verify component and system specifications in a consistent manner. Perhaps the most important test is insertion loss of an installed fiber optic cable plant performed with a light source and power meter (LSPM) or optical loss test set (OLTS) which is required by all international standards to ensure the cable plant is within the loss budget before acceptance of the installation.

Of great importance is the need to have the appropriate tools to perform the various tests and compare the test results with appropriate typical results acceptable for splice and insertions losses. The tools used are:

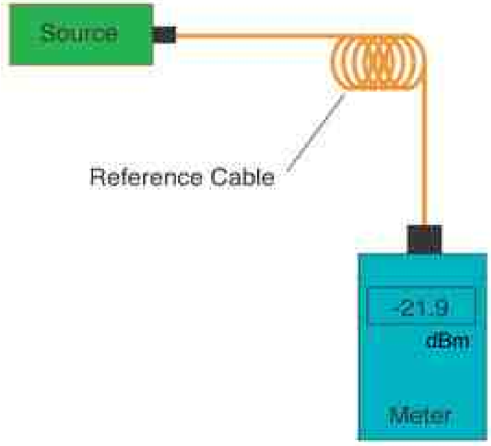
- Source and power meter, optical loss test set (OLTS) or test kit with proper equipment adapters for the cable plant you are testing.
- Reference test cables that match the cables to be tested and mating adapters, including hybrids if needed
- Fiber Tracer or Visual Fault Locator
- Cleaning materials - lint free cleaning wipes and pure alcohol
- OTDR with launch and/or receive cables for outside plant jobs and troubleshooting

5. OPTICAL POWER MEASUREMENT

The most basic fiber optic measurement is optical power from the end of a fiber. This measurement is the basis for loss measurements as well as the power from a source or presented at a receiver. Typically both transmitters and receivers have receptacles for fiber optic connectors, so measuring the power of a transmitter is done by attaching a test cable to the source and measuring the power at the other end. For receivers, one disconnects the cable attached to the receiver receptacle and measures the output with the meter. **(**The Fiber Optic Association, Inc. (C)1999-2008)

While optical power meters are the primary power measurement instrument, optical loss test sets (OLTSs) and optical time domain reflectometers (OTDRs) also measure power in testing loss.
Optical power is based on the heating power of the light, and some optical lab instruments actually measure the heat when light is absorbed in a detector. While this may work for high power lasers, these detectors are not sensitive enough for the low power levels typical for fiber optic communication systems.

Testing is used to evaluate the performance of fiber optic components, cable plants and systems. As the components like fiber, connectors, splices, LED or laser sources, detectors and receivers are being developed, testing confirms their performance specifications and helps understand how they will work together. Designers of fiber optic cable plants and networks depend on these specifications to determine if networks will work for the planned applications.



5.1 Visual Tracing

Continuity checking with a visual fiber tracer makes certain the fibers are not broken and to trace a path of a fiber from one end to another through many connections, verifying duplex connector polarity for example. It looks like a flashlight or a pen-like instrument with a light bulb or LED source that mates to a fiber optic connector. Attach the fiber to test to the visual tracer and look at the other end of the fiber to see the light transmitted through the core of the fiber. If there is no light at the end, one has to go back to intermediate connections to find the bad section of the cable.

A good example of how it can save time and money is testing fiber on a reel before it is pulled to make sure it hasn't been damaged during shipment. For testing, visual tracers help also identify the next fiber to be tested for loss with the test kit. When connecting cables at patch panels, the visual tracer is used to make sure each connection is the right two fibers! And to make certain the proper fibers are connected to the transmitter and receiver, use the visual tracer in place of the transmitter and your eye instead of the receiver.

5.2 Visual Fault Location

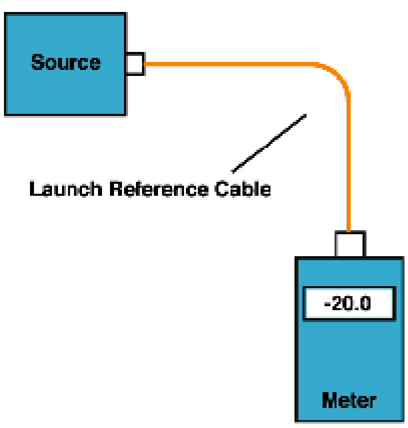
A higher power version of the fiber tracer called a visual fault locator (VFL) uses a visible laser that can also find faults. The red laser light is powerful enough for continuity checking or to trace fibers for several kilometers, identify splices in splice trays and show breaks in fibers or high loss connectors. You can actually see the loss of light at a fiber break by the bright red light from the VFL through the jacket of many yellow or orange simplex cables (excepting black or gray jackets, of course.). Its most important use is finding faults in short cables or near the connector where OTDRs cannot find them.

This gadget can also be used to visually verify and optimize mechanical splices or prepolished-splice type fiber optic connectors. By visually minimizing the light lost you can get the lowest loss splice. No other method will assure you of high yield with those connectors.
Loss of a cable is the difference between the power coupled into the cable at the transmitter end and what comes out at the receiver end. Testing for loss (also called "insertion loss") requires measuring the optical power lost in a cable (including fiber attenuation, connector loss and splice loss) with a fiber optic light source and power meter (LSPM) or optical loss test set (OLTS.) Loss testing is done at wavelengths appropriate for the fiber and its usage. Generally multimode fiber is tested at 850 nm and optionally at 1300 nm with LED sources. Singlemode fiber is tested at 1310 nm and optionally at 1550

nm with laser sources. The measured loss is compared to the estimated loss calculated for the link, called a "loss budget." The insertion loss measurement is made by mating the cable being tested to known good reference cables with a calibrated launch power that becomes the "0 dB" loss reference. Reference cable is used for the following reasons:

a)It is needed to measure the output power of a source for calibration of “0” loss.

b)In order to measure the loss of the connectors, it is required to mate them to a similar, known good, connector. c)Testing with reference cables on each end simulates a cable plant with patchcords connecting to transmission equipment.



In addition to a power meter, there is the need for a test source. The test source should match the fiber type (generally LED for MM or laser for SM) and wavelength (850, 1300, 1550 nm) that will be used on the fiber optic cable that is being tested.

6. CONCLUSION

A metropolitan area network (MAN) is a computer network that links two or more computers or communicating devices separated by a geographical distance. MANs can also depend on communications channels of moderate-to-high speed data rates. Optic fiber remains the most reliable connectivity medium in computer networking base on it’s resistive capability to signal attenuations and electromagnetic interference.

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