



Physical-Layer Attacks in SDH Optical Networks

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Abstract - Network survivability is the ability to protect and restore the data in optical network after nodes and/or links fail. Till now, many kinds of protection/restoration mechanisms proposed, but their realizations depend in part on triggering of fault alarms and corresponding detection of fault location. If a failure occurs in the network without being detected or the failure cannot be localized exactly, it will lead to network's inability to start the normal protection/restoration mechanism. Hence, fault detection and location is a direct impact on network survivability. Fault location problem in optical network has been difficult to deal with, because when network failures happen, all related nodes and detection points will report alarms. When many alarms reach the manager through the management communication network, it becomes difficult to locate the multi failures exactly without much troublesome manual checking and measuring.

Keywords- Survivability, SDH, ATM, LAN, Reliability, Fiber Fault.

I. Introduction

It is an international standard networking principle and a multiplexing method. The name of hierarchy has been taken from the multiplexing method which is synchronous by nature. The evolution of this system will assist in improving the economy of operability and reliability of a digital network. Simplified multiplexing/demultiplexing provides direct access to lower speed tributaries, without need to multiplex/demultiplex the entire high speed signal. Its enhanced operations are administration, maintenance and provisioning capabilities. Easy growth to higher bit rates in step with evolution of transmission technology is possible in SDH. It is capable of transporting existing PDH signals and transporting future broadband (ATM) channel bit rates. Moreover it is also operational in a multi-vendor and multi-operator environment.

The demand for complex fiber optic cable networks and flexible IP data traffic increases exponentially concurrently with the demand for network services-thus requiring constant and high transfer rates. Cable management affects a network's reliability, performance, cost and maintenance. It provides the ability to reconfigure network, restore service and implement new services quickly. Following are some goals to achieve:

- A. Protect fiber optic cable from micro bends and macro bends loss.
Micro bends are small deformities in the optical fiber and macro bends are larger bends of the fiber cable. Fiber bends beyond the specified minimum bending radius can cause signal loss or even break the fiber, causing service disruption.
As a rule of thumb, the minimum bending radius should be bigger than ten times the outer diameter of the fiber cable. Telcordia recommends a minimum 38mm bending radius for 3mm fiber optic patch cords.
Fiber cable management system should provide bend radius protection at all points where a fiber optic cable makes a bend. This helps ensure the network's long-term reliability; thus reduces the network operation cost by reducing network down time.
- B. Well defined cable routing paths.
The leading cause of fiber optic cable minimum bend radius violation is improper routing of fibers by fiber installation technicians.
In a proper cable management system, routing paths are clearly defined and easy to follow; such that the technician has no other option but to route the cables properly.
Well defined routing paths reduce the training time required for technicians and increase the uniformity of work done. It also makes accessing individual fibers easier, quicker and safer.
- C. Easy access to installed optical fibers.
Allowing easy access to installed fibers is critical in maintaining proper bend radius protection. The system should be designed to ensure that individual fibers can be installed or removed without inducing a macro bend on an adjacent fiber. Accessibility is critical during network reconfiguration.
- D. Physical protection of installed optical fibers.
Well defined fiber optic cable management system physically protects the fibers from accidental damage by technicians and equipment throughout the network.

II. Procurement

When making the decision on purchasing your cable management system, the goal is getting the most cost-effective system that provides the best cable management, flexibility, and growth capabilities. Going with the

cheapest approaches can cost more money in the long run. A strong fiber cable management system will enable you to extract the maximum value from your installed optical fiber networks.

Along with the rapid development of optic communication in recently, the length of fiber cable increases rapidly. So the problems of maintenance and management of the fiber cable increase too. The conventional modal of maintaining fiber cable cannot help engineers easily to find the trouble of the fiber cable, and not easily solve the problem, which affects the normal communication and the economy is damaged greatly. So the fiber cable should be monitored and inspected instantly. It is important to predict or find the hidden trouble, shorten the time of abnormal state of fiber cable. This issue is raised by the Jilin Provincial Bureau of Telecommunications Transmission projects. The wide range of geographic information resources and resource characteristics describe the properties of the data collection, storage, management, computing, analysis, query, statistics and other functions of the technology systems. It will target spatial geographic location and associated attributes the organic integration of spatial and attribute data from a geographic reality in terms of resource object query, retrieval, statistics and analysis, and results to the image, expressed in visual form, for maintenance, analysis, provide important support for decision-making platform for long-distance transmission line maintenance network infrastructure to an integrated management of resources in the province's trunk transmission network equipment, a variety of graphical information / non-graphic information and Location information on equipment resources database system. Jing Yong fault location, compression of the barrier took to establish a GIS based long distance optical fiber telecommunications computer management system based on the actual geographical topographic map as the background layer. Long-distance optical cable lines layer, according to the actual fiber direction, superimposed on the geographic layers and to use the database for resource management, then even non-professional long-distance optical cable lines maintenance personnel may also be through a unified system platform within their jurisdictions Quick View range of fiber optic cable into and accurately locate cable fault risk of hidden places, based on GPS positioning, quickly and accurately determine where failure occurred, to facilitate maintenance personnel quickly reach failure occurred, and greater maintenance of quality.

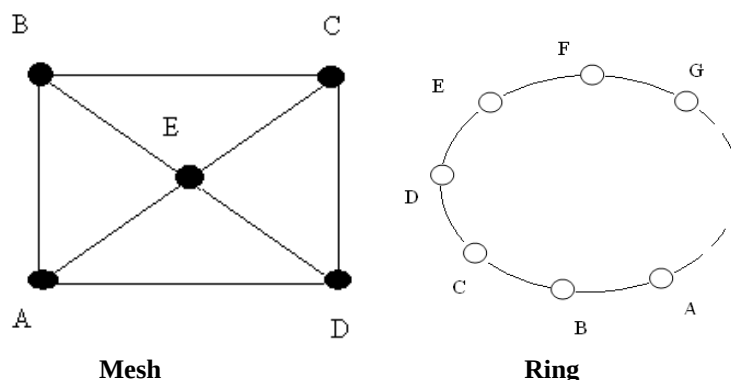
III. Different Types of Rings

Fiber optic cable has been used widely in network communications system. It has being a favorable choice since it offers many advantages, such as immunity to electrical interference, lightening, high bandwidth and security. Due to the massive deployment of optical fiber cable, networks based on this medium needs significantly good monitoring and protection scheme to ensure its availability, especially for critical networks. Current approach uses a system known as Remote Fiber Testing System (RFTS) or Remote Fiber Monitoring System (RFMS). RFMS allows an operator to remotely monitor the condition of a fiber cable by using Optical Time Domain Reflectometer (OTDR). The requirements to place OTDR permanently for continuous monitoring force the line owners to place a high investment to the system. Moreover, placing OTDR is overkill since most of the faults in the fiber optic cable are due to the fiber break.

Following are the network topologies in which optical fiber cable fault management system will work Point-to-point link, Bus Topology, Ring Topology (Collapsed ring Nested ring Hub Topology), Star Topology, Mesh Topology,

A. Mesh & Ring Topology

Having identified and explained the current set of network building blocks, we will now look at the various methods of constructing SDH networks in practice.



Initially, SDH technology will be deployed in new installations and then to replace or upgrade existing systems when they reach maximum capacity. At the simplest level, new point-to-point systems will use SDH Terminal muxes with the ability to expand to more complex SDH constructions later. We will now examine each possible topology in turn.

SDH Line Systems are natural successors to the 140 Mb/s and 565 Mb/s line systems currently deployed in backbone networks. In new installations, these

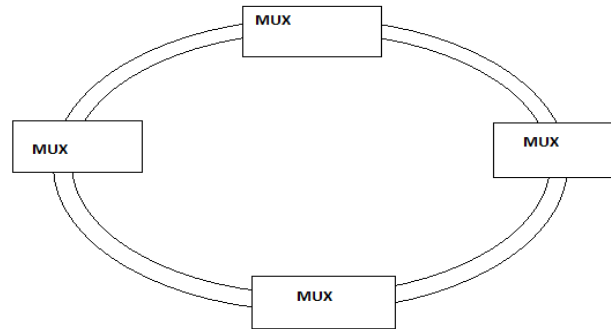
PDH capacities will commonly be replaced by STM-4 (622 Mb/s) line systems. Increasingly, STM-16 (2.4 Gb/s) line systems will be required to cater for the ever increasing bandwidth requirements of backbone networks.

B. Linear Network (Bus Topology)

SDH NEs and be joined to form the Linear network as shown. The Network has LTM which marks the start of the SDH network and in between there can be add drop offices. The line protection can be given with the standby line for failure against fibre. The payload can be any of the PDH rate or the SDH line lower rate.

C. Rings

The definition of the Add-Drop Multiplexer function makes SDH special because it allows operators to make rings of ADMs which can add and drop channels at any node. Rings are great because they give greater flexibility in the allocation of bandwidth to the different users and they allow rerouting of traffic should a link fail.



STM Topology –Ring Topology

Under normal operation, a 2 Mb/s tributary is sent round the ring in both the directions. The ADM assigned to drop the 2 Mb/s tributary monitors the two SDH signals for errors and delivers the one with better performance. This is known as path switching.

When a catastrophic failure occurs, for example, when the fibre is cut by a road digger, the nodes either side of the failure loop the clockwise ring to the anticlockwise ring, allowing traffic to avoid the failed ring segment. This forms an extended ring which carries all the traffic to each node in the ring, allowing service to continue.

D. STM Topology –Ring Topology

This will be a new approach of monitoring and detecting fiber break by using a simpler device, significantly less expensive yet gives measurement to the distance break in place of the OTDR-based RFMS. The design and development of the system, namely Fiber Break Monitoring System (FBMS) will continuously monitor the optical signals in the live fiber cable. The device automatically detects the break in every SDH topologies. The distance is measured by any type of OTDR.

IV. Conclusion

The vulnerabilities of fundamental optical network physical components, as well as the associated attack techniques, demand for new, tailored attack detection, localization and network restoration mechanisms. In addition to upgrading existing ways of dealing with optical fiber cable network failures and attacks, significant attention should be paid to prevention mechanisms taking physical-layer vulnerabilities into consideration in the network planning. This approach, i.e., prevention oriented network planning, is a very new concept aimed at increasing all-optical network security in an economically more viable way.

References

- [1] C.H. Lee, W.V. Sorin and B.Y. Kim, "Fiber to the home using a PON infrastructure", *Journal of Lightwave Technology*, Vol. 24, No. 12, pp. 4568- 4583, 2006.
- [2] M.S.A. Rahman and B.C. Ng, "MATLAB-based graphical user interface development for Centralized Failure Detection System (CFDS) in SCAN Network," *J. of Opt. Commun.*, vol. 29, no. 3, pp. 152-156, 2008.
- [3] Telcordia GR-253-CORE, Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria (October 2009). Issue 5.
- [4] Ramamurthy S, Mukherjee B. A review of fault management in WDM mesh networks: basic concepts and research challenges. *IEEE Network* 2004; 18(2)
- [5] Ramamurthy S, Sahasrabudde L, Mukherjee B. Survivable WDM mesh networks. *Journal of Lightwave Technology* 2003; 21(4): 870-883.