

SONET Network Element Mapping for Efficient Communication

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Abstract – The Information over an optical fiber is transmitted by turning light on and off and for extraction of this information from bits the SONET/SDH technique were used. These optical links use a low level framing protocol to transmit information and SONET/SDH is used to define this low level protocol. By “framing”, we mean a block of bits (or octets) which have a structure, and which utilize some technique which allows us to find the boundaries of that frame structure.

Keywords – Approximation algorithm; Wavelength division multiplexing (WDM); Optical networks; Synchronous optical networks (SONET); Add-drop multiplexer (ADM.)

I. INTRODUCTION

An important element of a typical Optical fiber network comprises of a Add-Drop Multiplexer (ADM) the function of which is to combine several lower-bandwidth streams of data into a single beam of light. An ADM is capable of adding one or more lower-bandwidth signals to an existing high-bandwidth data stream and at the same time it is capable of extracting or dropping other low-bandwidth signals, removing them from the stream and redirecting them to some other network path. This is used as a local "on-ramp" and "off-ramp" to the high-speed network. The ADM finds application in long-haul core optical fiber networks as well as in shorter-distance networks like Metro networks. The former application of ADM is much more expensive because of the difficulty involved during scaling of the technology to the high data rates and because of Dense Wavelength Division Multiplexing (DWDM) being used for long-haul communications. The main optical filtering technology used in add-drop multiplexers is the Fabry-Perot etalon. Recent innovations in ADM technology have introduced so-called "multi-service SONET/SDH". It has all the capabilities of legacy ADMs, in addition to that a capability that it can also include cross-connect functionality to manage multiple fiber rings in a single chassis. These new devices can replace multiple legacy ADMs and also allow connections directly from Ethernet LANs to a service provider's optical backbone ring.

II. PLESIOCHRONOUS TRANSMISSION

Digital data and voice transmission is based on a 2.048Mbit/s bearer consisting of 30 time division multiplexed (TDM) voice channels, each running at 64Kbps (known as E1 and described by the CCITT G.703 specification). At the E1 level, timing is controlled to an

accuracy of 1 in 10¹¹ by synchronising to a master Caesium clock. Increasing traffic over the past decade has demanded that more and more of these basic E1 bearers be multiplexed together to provide increased capacity. During this time rates have increased and 140Mbit/s. The highest capacity commonly encountered today for inter-city fibre optic links is 565Mbit/s, with each link carrying 7,680 base channels, and now even this is insufficient. Unlike E1 2.048Mbit/s bearers, higher rate bearers in the hierarchy are operated plesiochronously, with tolerances on an absolute bit-rate ranging from 30ppm (parts per million) at 8Mbit/s to 15ppm at 140Mbit/s. Multiplexing such bearers (known as tributaries in SDH speak) to a higher aggregate rate (8Mbit/s to 1 x 34Mbit/s) requires the padding of each tributary by adding bits such that their combined rate together with the addition of control bits matches the final aggregate rate. Plesiochronous transmission is now often referred to as plesiochronous digital hierarchy (PDH).

DEFINITION : “Synchronous digital hierarchy and synchronous optical network refer to a group of fiber optic transmission rates that can transport digital signals with different capacities”.

III. BASIC SDH PRINCIPLES

The Synchronous Digital Hierarchy (SDH) is implemented on the basis of two principles:

1. Direct synchronous multiplexing of individual tributary signals within the structure of the higher-rate multiplexed signal.
2. Transparent transporting of each individual tributary signal through the network, without any disassembly except at the two network nodes that exchange information through that particular signal.

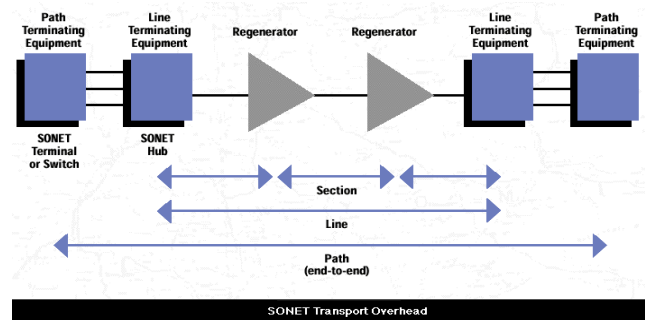


Fig.1. A SONET/SDH Frame

SDH transmission systems have many benefits over PDH:

- Software Control allows extensive use of intelligent network management software for high flexibility, fast and easy re-configurability, and efficient network management.
- Survivability. With SDH, ring networks become practicable and their use enables automatic reconfiguration and traffic rerouting when a link is damaged. End-to-end monitoring will allow full management and maintenance of the whole network.
- Efficient drop and insert. SDH allows simple and efficient cross-connect without full hierarchical multiplexing or de-multiplexing. A single E1 2.048Mbit/s tail can be dropped or inserted with relative ease even on Gbit/s links.
- Standardisation enables the interconnection of equipment from different suppliers through support of common digital and optical standards and interfaces.

Synchronous Transport Signal (STS) multiplexer/demultiplexer: It either multiplexes signal from multiple sources into a STS signal or demultiplexes an STS signal into different destination signals.

Regenerator: It is a repeater that takes a received optical signal and regenerates it. It functions in the data link layer.

Add/drop Multiplexer: Can add signals coming from different sources into a given path or remove a desired signal from a path and redirect it.

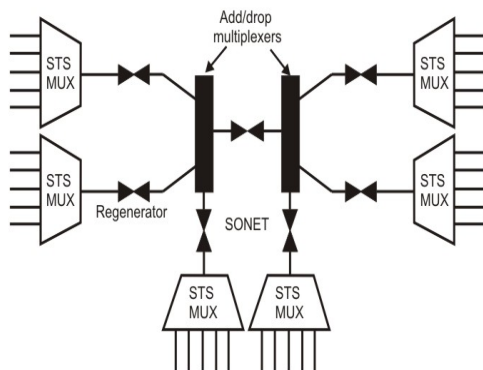


Fig.2. Devices used in the SONET system

V. SONET NETWORK ELEMENTS

1. Add/Drop Multiplexer (ADM)
2. Terminal Multiplexer
3. Regenerator

Definition - Add/Drop Multiplexer (Adm)

An Add/Drop multiplexer (ADM) is a critical element of an optical fiber network. The function of an ADM is multiplexing (i.e. combining) several streams of data of low-bandwidth into a single light beam and simultaneously it is capable of dropping or removing other low-bandwidth signals from the stream of data and direct them to other network routes. The filtering

technology used with ADM is called Fabry-Perot etalon.

The Add/drop multiplexer's finds application in both expensive long-haul core networks and shorter distance networks also called metro networks. The long-haul core networks are quite expensive and the expense comes from adapting or scaling the technology to the high-speed data rates and the use of dense wavelength division multiplexing (DWDM). The Dense Wavelength Division Multiplexing or DWDM is a technology allowing a number of carrier signals of different wavelengths (or colors) of laser light to be carried on a single optical fiber. Recent shift in ADM technology called for a new platform. This brought Multi-Service Provisioning Platform (MSPP) in picture. It is composed of equipment with legacy ADM equipment capabilities but with cross-functionality, allowing direct connections from local area networks (LANs) to ISPs (Internet Service Providers) or other service provider's optical fiber backbone.

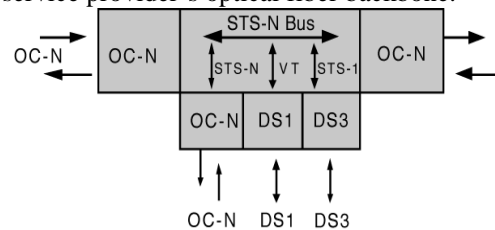


Fig.3. Add/Drop Multiplexer (ADM) TERMINAL MULTIPLEXER

The Terminal Multiplexer is a path terminating element (PTE). It is an entry-level path-terminating terminal multiplexer which acts as a concentrator of DS-1s as well as other tributary signals. Its simplest deployment would involve two terminal multiplexers linked by fiber with or without a regenerator in the link. This implementation represents the simplest SONET link (a section, line, and path all in one link).

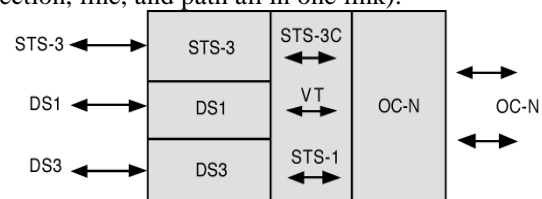


Fig.4. Terminal Multiplexer

Regenerator

As the name suggests a regenerator is used to regenerate a signal. Sometimes because of the long distance between multiplexers, the signal level in the fiber becomes too low and so a Regenerator is needed. The regenerator clocks itself off of the received signal and replaces the section overhead bytes before retransmitting the signal.

During regeneration by a regenerator the line overhead, payload, and POH are not altered.

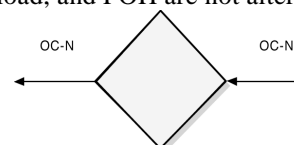


Fig.5. Regenerator

The most common topology in the network is the ring. Rings provide an alternate path to communicate between any two nodes. For example, in the linear network, even if two sets of fiber were used between the nodes, it is possible for all of the fibers to be cut at the same time.

A two-fiber ring can be operated in either of two ways:

- ✓ as a unidirectional ring, or
- ✓ as a bidirectional ring.

With a unidirectional ring, the traffic is limited to one fiber and it always flows the same way around the ring. The second fiber is simply act as the protection fiber and is used in a special way to provide backup .There may be a difference in the transmit and receive propagation delay between two nodes, with the unidirectional traffic.

With bi-directional traffic, data is sent on both fibers so the existence of the concept of “working fiber” and “protection fiber” does not have any meaning – both fibers act as working fibers. When data is sent between nodes A and B, it simply flows over the two fibers connecting the two nodes. Bi-directional rings do not buy us any additional capacity. For providing backup, each fiber in a bi-directional ring can only be used to half of its capacity

– the second half of the capacity is reserved for backup. Unidirectional rings have the disadvantage of asymmetric delay – the time it takes to go one way around the ring is usually different than the time it takes to go the other way around the ring. Because of this, buffering must be done at the path-terminating site.

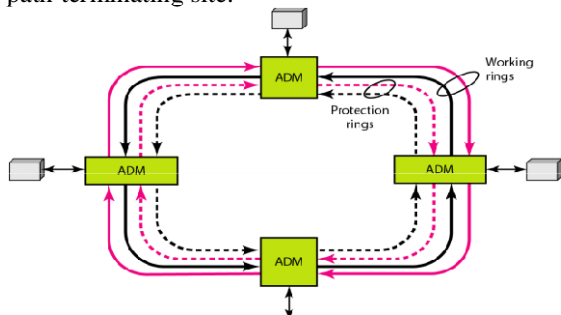


Fig.6. ADM

VI. CONCLUSION

Add-drop multiplexers are devices in high demand. They compatible with both LAN and long haul networks. Due to the number of nodes used in LANs, and thus the number of add-drop multiplexers required, demand for cheap devices is the primary motivation. All-fibre add-drop multiplexer configurations are potential candidates for providing such cheap devices. In summary, this was a review of the existing technologies for routing wavelength channels, with discussion regarding the advantages and drawbacks for each. Parameters, which are used to characterize the performance of add-drop multiplexers.

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