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Establishing High Transmission Bandwidth from Service Providers through SDH

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***Abstract*— Previously, Customers were using two types of services namely Voice and Data. Accordingly customers were having two separate lines for handling both these services. Now, Customers are using multiple services namely Telephone, Internet, Intranet, Virtual Private Networks, Video Conferencing, IP TV, Games on Demand (GOD) etc., where all these services can be combined together into one High speed Transmission Line. So to cater the needs of the Today's customers, it is very much essential to have a one HIGH Band Width Transmission line from Service provider's end to the Customer's End.**

Establishing a High Bandwidth transmission link from any Service Provider can be implemented in many ways. But the Best way to implement is using a Global Standard, which facilitates High Reliability and Flexibility for both the Service provider and Customer. This can be achieved by using Synchronous Digital Hierarchy (SDH) technology. Using this technology, any bandwidth ranging from 2Mbps can be extended to the customers end from Service provider's end. Presently it is restricted to as high as 1Gbps, ascustomer end equipment does not support more than 1Gbps data using 1GE Port.

This project concentrates about Establishing a High Bandwidth Transmission Line between the Service Providers Edge Router (where multiple services need to be enabled and configured) and the Customer's location, using SDH Manageable Add Drop Multiplexers (MADM's) of Various Capacities namely STM-16 and STM-1. This requires hardware as well as the Software operations to be performed (using any Browser). This Project also explores on establishing Automatic Protection scheme for Optical Fibres, in case of any Fibre cuts.

***Index Terms*— High bandwidth,PDH SDH Technology,STM-1,Siemen.**

I. INTRODUCTION

The hierarchy defined by the ITU was adopted and referred to as the Plesiochronous digital hierarchy (PDH). The PDH signals are the 2.048 Mbit/s signal that carries 30 voice channels, the 8.488 Mbit/s signal that multiplexes four 2.048 Mbit/s signals, the 34.368 Mbit/s signal that multiplexes four 8.488 Mbit/s signals, and the 139.264 Mbit/s signal that multiplexes four 34.368 Mbit/s signals. Synchronous Digital Hierarchy (SDH) is standardized protocols that transfer multiple digital bit streams over optical fibre using lasers or highly coherent light from light-emitting diodes (LEDs).The method was developed to replace the Plesiochronous Digital Hierarchy (PDH) system for transporting large amounts of telephone calls and data traffic over the same fibre without synchronization problems. The SDH standard was originally defined by the European. The SDH standard was originally defined by the EuropeanTelecommunications Standards Institute(ETSI),and is formalized as Internatiol Telecommunication Union (ITU) standards G.707, G.783, G.784, and G.803.

The customer wants intra- city bandwidth & last mile connectivity provider. It should consist of significant scale of optical- fibre infrastructure, moreover looking for a more resilient & bandwidth efficient solution in one of its service areas.

II. PLESIOCHRONOUS DIGITAL HIERARCHY (PDH)

A. Introduction

The Plesiochronous Digital Hierarchy (PDH) is a technology used in telecommunications networks to transport large quantities of data over digital transport equipment such as fibre optic and microwave radio systems. The term plesiochronous is derived from Greek 'plēsios', meaning near, and 'chronos', time, and refers to the fact that PDH networks run in a state where different parts of the network are nearly, but not quite perfectly, synchronized. PDH allows transmission of data streams that are nominally running at the same rate, but allowing some variation on the speed around a nominal rate. By analogy, any two watches are nominally running at the same rate, clocking up 60 seconds every minute. However, there is no link between watches to guarantee that they run at exactly the same rate, and it is highly likely that one is running slightly faster than the other.

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B. Frame Structure of PDH

In 1965, that permitted the TDM multiplexing of 24 digital telephone channels of 64 kbps into a 1.544-Mbit/s signal with a format called T1. For the T1 signal, a synchronization bit is added to the 24 TDM time slots, in such a way that the aggregate transmission rate is:

(24channels × 8bit⁄ channel + 1bit) ⁄ 125µs = 1.544 Mbps(125 µs is the sampling period)

Europe developed its own TDM multiplexing scheme a little later (1968), although it had a different capacity: 32 digital channels of 64 kbps (see Figure 1). The resulting signal was transmitted at 2.048 Mbit/s, and its format was called E1 which was standardized by the ITU-T and adopted worldwide except in the U.S., Canada, and Japan. For an E1 signal, the aggregate transmission rate can be obtained from the following equation:

(32channels × 8bit ⁄ channel) ⁄ 125µs = 2.048 Mbps.

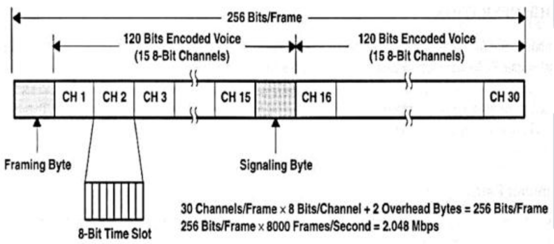

Fig.1 PDH Frame format

III. SYNCHRONOUS DIGITAL HIERARCHY (SDH)

A. Introduction

Synchronous Digital Hierarchy (SDH) is standardized protocols that transfer multiple digital bit streams over optical fiber using lasers or highly coherent light from light-emitting diodes (LEDs). At low transmission rates data can also be transferred via an electrical interface. The method was developed to replace the Plesiochronous Digital Hierarchy (PDH) system for transporting large amounts of telephone calls and data traffic over the same fiber without synchronization problems. SDH, which is essentially the same, were originally designed to transport circuit mode communications from a variety of different sources, but they were primarily designed to support real-time, uncompressed, circuit-switched voice encoded in PCM format.

The primary difficulty in doing this prior to SDH was that the synchronization sources of these various circuits were different. This meant that each circuit was actually operating at a slightly different rate and with different phase. SDH allowed for the simultaneous transport of many different circuits of differing origin within a single Digital Transmission System(DTS) SDH Technology framing protocol. SDH is not itself a communications protocol, but a transport protocol. The SDH standard was originally defined by the European Telecommunications Standards Institute (ETSI), and is formalized as International Telecommunication Union (ITU) standards G.707, G.783, G.784, and G.803.

B. SDH Multiplexing Structure and Principle

The multiplexing principles of SDH follow, using these terms and definitions:

- Mapping – A process used when tributaries are adapted into Virtual Containers (VCs) by adding justification bits and Path Overhead (POH) information.
- Aligning – This process takes place when a pointer is included in a Tributary Unit (TU) or an Administrative Unit (AU), to allow the first byte of the Virtual Container to be located.
- Multiplexing – This process is used when multiple lower-order path layer signals are adapted into a higher-order path signal, or when the higher-order path signals are adapted into a Multiplex Section.
- Stuffing – As the tributary signals are multiplexed and aligned, some spare capacity has been designed into the SDH frame to provide enough space for all the various tributary rates. Therefore, at certain points in the multiplexing hierarchy, this space capacity is filled with “fixed stuffingbits that carry no information, but are required to fill up the particular frame.

C. SDH Frame Format

The STM-1 (Synchronous Transport Module level-1) frame is the basic transmission format for SDH. The SDH standards exploit one common characteristic of all PDH networks namely 125 micro seconds’ duration, i.e. sampling rate of audio signals (time for 1 byte in 64 kbps). This is the time for one frame of SDH. The frame structure of the SDH is represented using matrix of rows in byte units. As the speed increases, the number of bits. Increases and the single line is insufficient to show the information on Frame structure. The STM-1 is the SDH ITU-T fiber optic network transmission standard. It has a bit rate of 155.52Mbit/s.higher levels go up by a factor of 4 at a time. The other currently supported levels are STM-4, STM-16, STM-64 and STM-256. Beyond this we have wavelength-division multiplexing (WDM) commonly used in submarine cabling. A STM-1 frame has a byte-oriented structure with 9 rows and 270 columns of bytes, for a total of 2,430 bytes (9 rows * 270 columns = 2430 bytes). Each byte corresponds to a 64kbps channel (see fig.2)

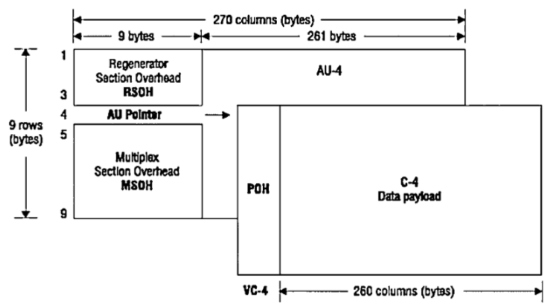

Fig. 2 SDH Frame Format

IV. SDH NETWORK CONFIGURATION

• *Point to Point*

The simplest network configuration is a Point to Point network as shown in figure 3. This involves two terminal multiplexers linked by fibre with or without a regenerator in the link.

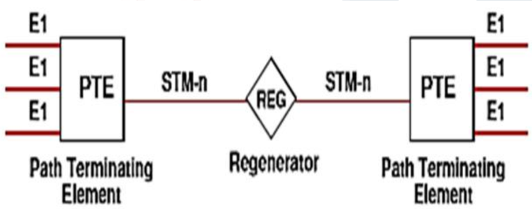

Fig. 3 Point to Point Configuration

• *Point to Multipoint*

If we include an Add/Drop mux we can now have a point to multi-point configuration as shown in figure 4.

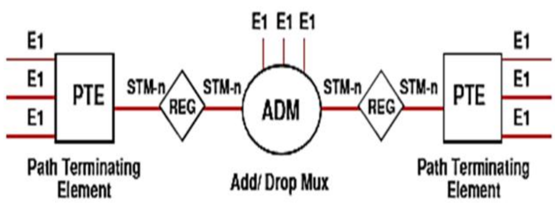

Fig. 4 Point to Multipoint Configurations

• *Meshed Network Architecture*

A meshed network architecture uses a Digital Cross Connect to concentrate traffic at a central site and allow easy re-provisioning of the circuits as in figure. 5

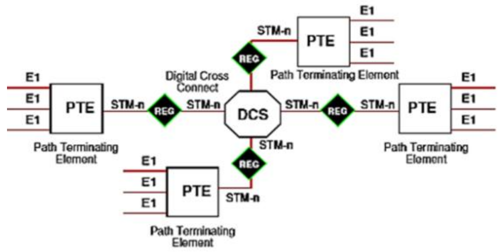

Fig. 5 Meshed Network Architecture

• *Ring Architecture*

The most popular network configuration is the Ring Architecture, here we have four Add/Drop multiplexers interconnected by 2 fibre rings as in figure 6. The main advantage of this architecture is its survivability.SDH rings are of two types:

- Unidirectional Self-Healing Ring (U-SHR)
- Bidirectional Self-Healing Ring (B-SHR)

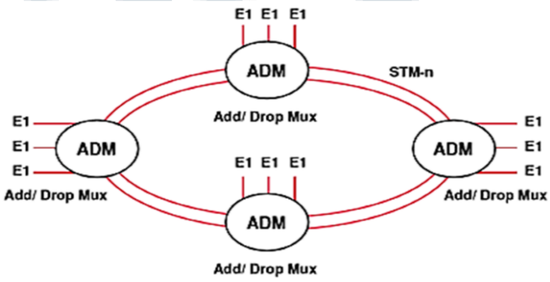

Fig. 6 Ring Architecture

V. RESULTS AND DISCUSSION

The project is restricted to establishment of transmission link through SDH MADM's. The project doesn't concentrate on Protection schemes like Ring implementation and path protection schemes like SNCP and MSSP, the router configurations at the Customer & ISP's end and NMS configurations. As the technology is improving, it will became feasible to begin replacing the microwave radios in the long distance network with optical fibers. Fiber brought some new challenges, but it also offered some critical new opportunities. The early fiber optic systems were built on the existing PDH multiplexing approach, with each vendor typically using its own proprietary multiplexing frame format for the higher rate signals. Hence, there were few economies of scale and almost no cases where different vendors' equipment could inter-work. This meant that at a carrier-to-carrier interface, both carriers would have to agree to a common equipment vendor if they wanted an optical interconnection as shown in figure 7.

The desire for a standard hierarchy for fiber optic signals was one of the primary drivers for the development of the SONET (Synchronous Optical

Network) and SDH (Synchronous Digital Hierarchy) standards.

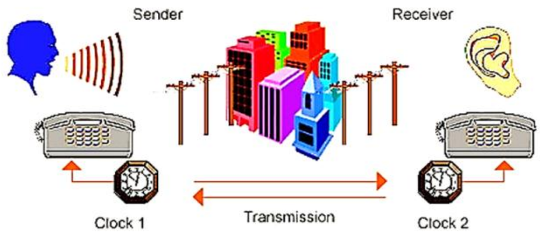

Fig.7 Information Sending/Receiving

VI. IMPLEMENTATION

Hardware

- Manageable Add Drop Multiplexers (MADM's) STM-16: Make: Siemens; Model No: Surpass hit.
- STM-1- Make: Tellabs- Fibcom; Model No: NM2100-1 as shown in figure 8.

The SURPASS hit 70xx series is the new Nokia Siemens Networks Multi-Service Provisioning Platform (MSPP) enabling true multi-service provisioning and serving the requirements of emerging converged networks.

Fig.8 Hardware Implementation

Software

The software used for managing the STM 1(MADM-1) equipment is NM 2100/6300 Element Manager CT 6300 Craft Terminal which is developed by Fibcom Technologies. The FIBCOM 6300 is an open ITU-T compliant TMN system. The product family cover applications ranging from craft terminals over element management systems to complex network management systems. It is divided into two main products:

- FIBCOM 6300NM - the network manager with advanced network layer functions and management of network elements.
- FIBCOM 6300CT - the craft terminal for local operation and maintenance.

The FIBCOM 6300 is a combined element and network management system with a Windows NT-based user interface. It is a very robust, scalable and reliable carrier-class system from which all SDH elements can be managed. A single server can handle several thousand-network.

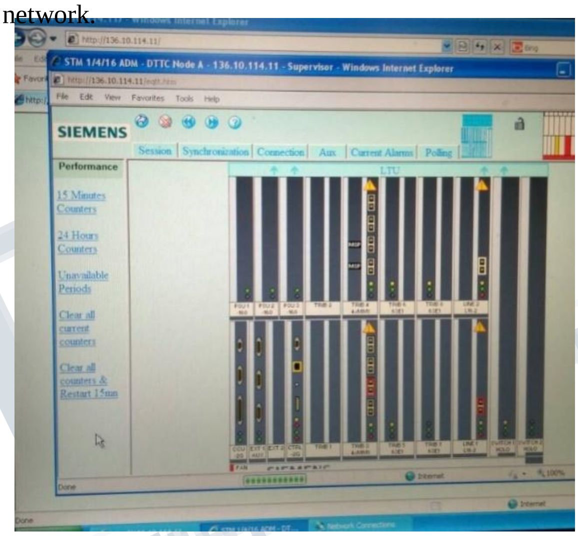

Fig. 9 Software Implementation

VII. CONCLUSION

A few years ago, SDH technology was considered dead as carriers and vendors experimented with a variety of packet- or frame-based transport approaches in an attempt to better serve growing data transport needs. While packet-based transport schemes largely fell by the wayside, SONET Technology remains vibrant as a multi-purpose, highly granular and operationally elegant service delivery vehicle, as well as a highly integrated large capacity infrastructure consolidation tool.SDH is an international standard for high speed telecommunication over optical/electrical networks which can transport digital signals in variable capacities. It is a synchronous system which intends to provide a more flexible, yet simple network infrastructure. SDH (and its American variant- SONET) emerged from standard bodies somewhere around 1990 as shown in figure 9.

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