Transmission System in ICX (Interconnection Exchange)

An internship (Industrial Training) report submitted to East West University as a partial fulfillment for the B.Sc. degree in Electronics and Communication Engineering.

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Declaration

This is to declare that this internship based on the ICX and development of transmission system in ICX. This is also needed to certify that this internship report work is prepared under the course "ETE498 (Industrial Training)". It has not been submitted elsewhere for the requirement of any undergraduate or graduate program.

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Acceptance of Report

This internship report presented to the department of Electronics and Telecommunications Engineering, East West University as a partial fulfillment of the course ETE 498 (Industrial Training) as well as for the Bachelor of Science Degree in Electronics and Communications Engineering (ECE).

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Acknowledgement

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I have learned some magnificent and realistic experience while doing my Internship in Voicetel Ltd. That's why every person of Voicetel Ltd. deserves thanks for their kind accommodating attitude. Finally I am forever grateful to my parents for their patience and love.

Abstract

It was a great opportunity to work under VOICETEL Ltd. The main purpose of the program was to perceive the real life situation. The academic knowledge is not well enough to compete with real world. This internship program was helpful to face the real working environment. In VOICETEL Ltd. I have spent a good time in learning and was rewarded for my best efforts, learnt to deal with different situations, had experience of corporate working environment which affects an employee performance and attitude towards work, had good time in learning and performing. I have also gathered experience about the turbulence of the trouble times while touchstone was going through one of its major transition phase. Confidence, on time decision making, consistency, hard work, team work, seeking success out of dark, innovation, creativity, organizational survival are the key learning's out of my job and I would like to say that it will be one of my best skill that would remain with me and help me in future which will offer many challenges. I would like to highlight this, that my experience with VOICETEL was very memorable and full of learning's, where I found a lot of positive changes in my attitude, learning and behavior.

TABLE OF CONTENT

Chapter **Page**

Chapter 1: Introduction [1-2]

1.1: Introduction
1.2: Company Profile

Chapter 2: Bangladesh Telecom Network Topology [3-6]

2.1: Structure
2.2: Network topology
2.3: Interconnection Exchange (ICX)

Chapter 3: Transmission System [7-35]

3.1: Definition of Transmission in All Aspects
3.2: Capacity of Transmission
3.3: Parameters of Data Transmission And TDM Transmission
3.4: Technologies Used in Transmission
3.5: Theory of Transmission
3.6: Transmission Medium
3.7: Transmission Architecture
3.8: Topology of Transmission
3.9: Transmission Medium and Capacity Permitted by BTRC
3.10: Transmission in ICX
3.11: Transmission in IGW

Chapter 4: Geographical Device Interfaces [36-38]

Chapter 5: Alarms & Conclusion [39-43]

References [44]

CHAPTER

(1)

Introduction

1. Introduction

1.1. Introduction

Telecom regulators introduced an ICX (Interconnection Exchange) based interconnection regime in 2007 and with that started a new era of interconnection in Bangladesh. The ICX has no subscriber and is not also directly connected with any overseas operator. So the traffic of IGW's (International Gateway) and ANS's (Access Network Services) is also the traffic of ICX's. With the available data from BTRC and BTTB, it is observed that the total international traffic (both incoming & outgoing) ranges from 35 to 45 million paid minutes per day and the inter operator traffic is about 45 millions per day. There is still some dormant international traffic ranging from 3 to 4 million which is considered as illegal traffic. With the coordinated effort among the law enforcing agencies, the new IGW and ICX operators under the guide lines of BTRC, a considerable volume of illegal traffic can be routed back to the legal channel.

It can be assumed that international call will increase considerably every year due to the factors like increasing numbers of Bangladeshi expatriates outside the country. This will also help to enhance the domestic tele-density and increase the business activities.

1.2. Company Profile

Voicetel Ltd. is an Interconnection Exchange (ICX) operator. It has world class network, equipment, best team and international technology partners. Voicetel Ltd. was formed in the year 2011 by a dedicated team of professionals having wide experience in the fields of business and product development. In April 2012, Voicetel Limited has been awarded with Interconnection Exchange Operator license by BTRC to connect all telecom operators in Dhaka, Chittagong, Khulna. Voicetel's goal is to create a nationwide network aiming at creating strong equity through affordable, reliable and efficient services to their strategic partners through continuous technological innovation and allowing progress towards a digital Bangladesh paving the path for them to stand at a global level. The main objective to Voicetel Ltd. is to facilitate telecommunication services to the public efficiently by routing calls and interconnecting telecommunications network in Bangladesh. Bring best quality affordable telecom services to the masses of Bangladesh. Building infrastructure of digital Bangladesh. [1]

CHAPTER

(2)

Bangladesh Telecom Network Topology

2. Bangladesh Telecom Network Topology

2.1. Structure

As define in the National Telecommunication Policy 1998 and international Long Distance Telecommunication Service (ILDTS) Policy 2007, all mobile operators is to interconnect through Interconnection Exchange (ICX) and international calls to be handled by International Gateway (IGW) which is to be connected to the mobile and fixed operators through the ICXs.

The Interconnection Exchange (ICX) will receive all calls from the mobile and fixed operators whenever the call is made to other network and will pass it to the destination network if the call is local, and will pass to the IGWs if the call is international. ICX will also deliver calls received from IGWs where the call is destined. Below illustrate (fig-2.1) the structure of interconnection between different interfaces.

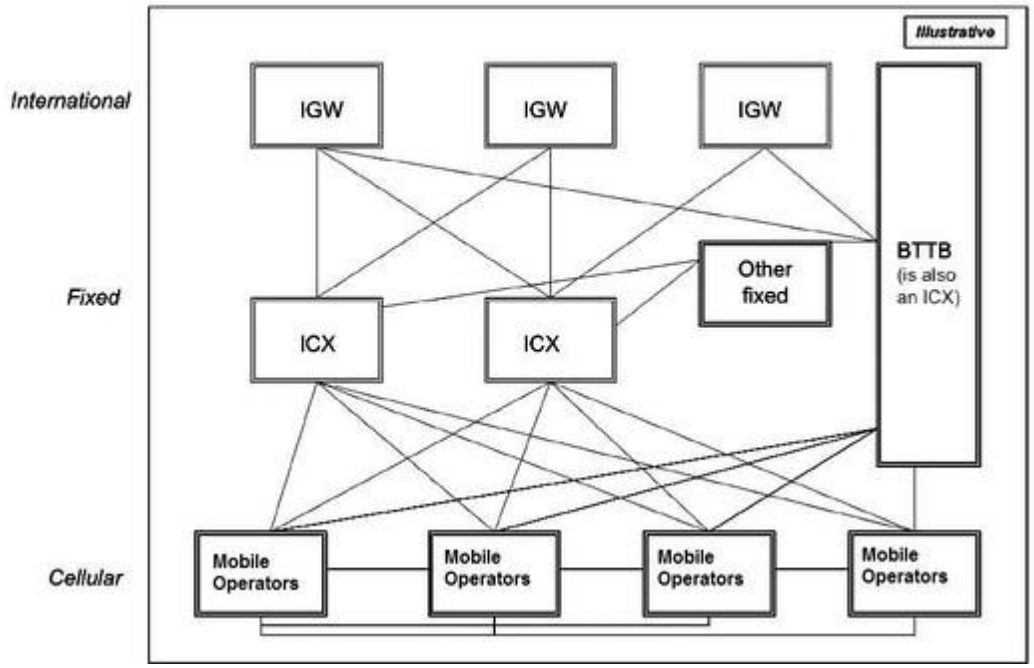


Fig 2.1: Basic structure of network topology.

2.2. Network topology:

Network architecture shall be based on three layers with appropriate equipment and technologies subject to modification as and when required.

- The first layer is IGWs, which will be connected to International Long Distance Cable (ILDC) networks and ICX. IGWs will have satellite earth station or VSAT as backup until alternative ILDC is available.
- The second layer is the ICX, which will be connected with IGWs and access network service (ANS) operators. IPTSPs will be connected to NIX for inter IPTSP for domestic voice traffic. International and inter operators domestic voice traffic will be routed through ICXs.
- The third Layer is the ANS operators who provide services through end users directly. This layer is to ensure the connectivity between the ICX/NIX and the subscribers.

2.3. Interconnection Exchange (ICX):

"Interconnection Exchange (ICX)" is the switching system which provides interconnection among telecommunication networks of operators and allows monitoring, lawful interception (LI) facilities and roaming number portability.

- The number of ICX operators will be determined by the government as per requirement of the telecommunication sector of Bangladesh.
- Location of the ICXs will primarily be at Dhaka. More ICX will be setup in other locations depending on traffic volume and to allow more rural people to be connected with the network as and when required.
- ICXs will have primary backbone connectivity towards international networks through ILDC network.
- IGWs will have physical connection with ICXs. ICXs will develop and maintain interconnection facilities to connect the IGWs to ICXs and ICXs to ANS operators via their POPs.

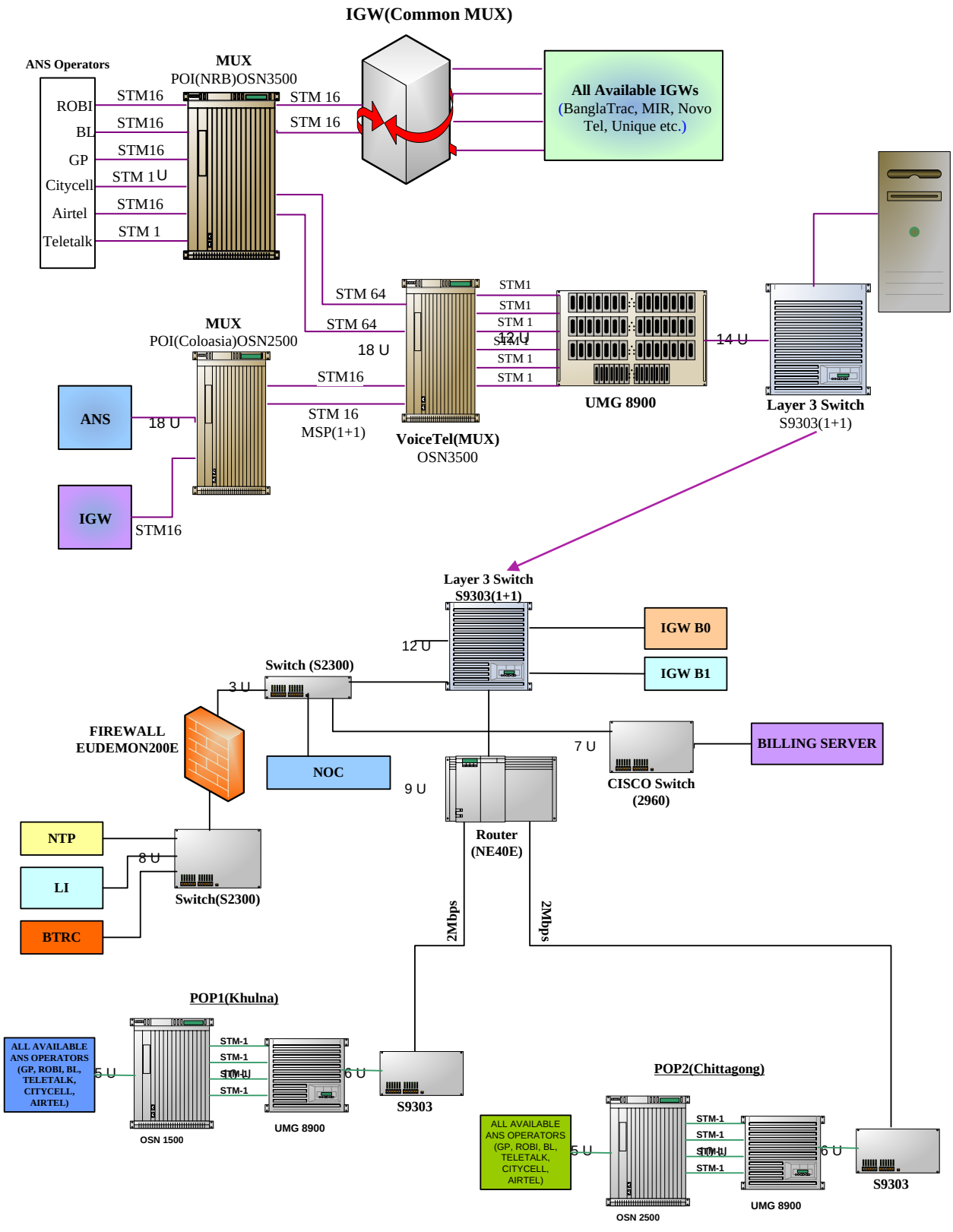


Fig 2.2: Overall Architecture of ICX.

CHAPTER
(3)
Transmission System

3. Definition of transmission in all aspects

3.1. Transmission:

In telecommunications, transmission (Tx) is the process of sending and propagating an analogue or digital information signal over a physical point-to-point or point-to-multipoint transmission medium, either wired, optical fiber or wireless. [2]

– Transmission of a digital message, or of a digitized analog signal, is known as digital communication.

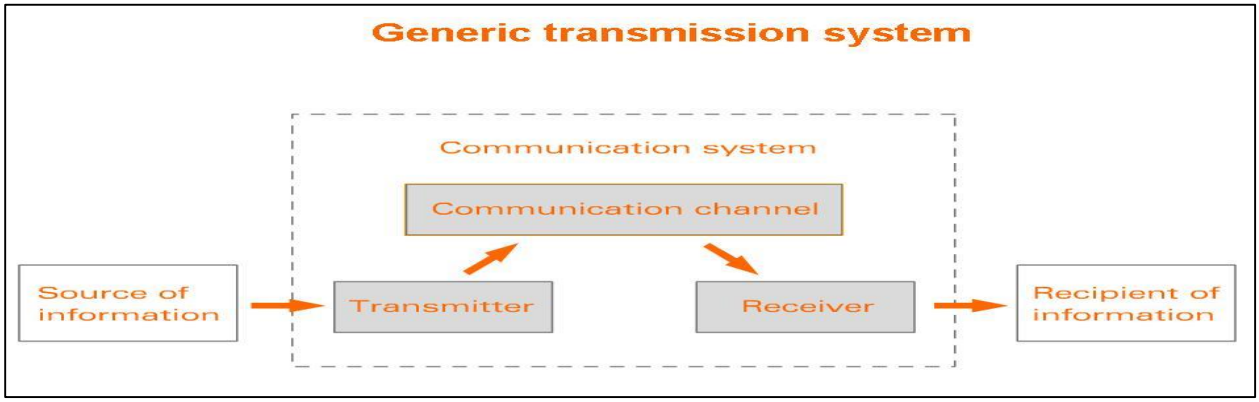
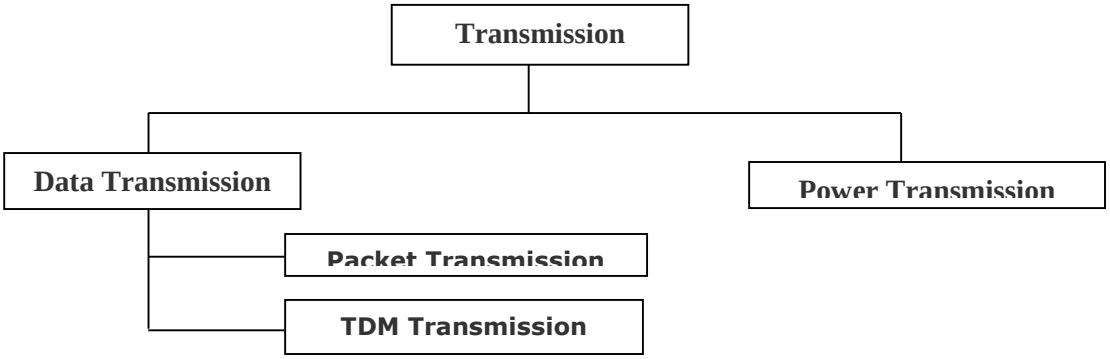


Fig 3.1: Basic Transmission System.

In electrical engineering, there are deals with two types of transmission:



■ 3.1.2. Data transmission:

Data transmission, digital transmission or digital communications is the physical transfer of data (a digital bit stream or a digitized analog signal) over a point-to-point or point-to-multipoint communication channel. [3]

- Examples of such channels are copper wires, optical fibers, wireless communication channels, storage media and computer buses. The data are represented as an electromagnetic signal, such as an electrical voltage, radio wave, microwave, or infrared signal.

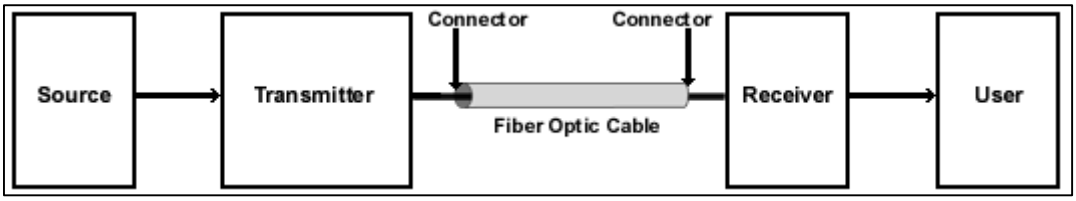


Fig 3.2: Data Transmission.

➢ 3.1.2.1. Packet transmission:

A network packet is a formatted unit of data carried by a packet-switched network. Computer communications links that do not support packets, such as traditional point-to-point telecommunications links, simply transmit data as a bit stream. When data is formatted into packets, the bandwidth of the communication medium can be better shared among users than if the network were circuit switched. [4]

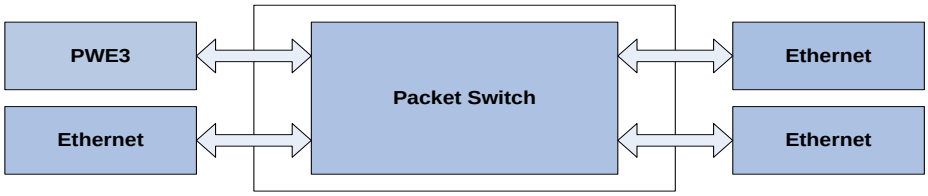


Fig 3.3: Packet Equipment Architecture.

➢ 3.1.2.2. TDM transmission:

Time-division multiplexing (TDM) is a method of putting multiple data streams in a single signal by separating the signal into many segments, each having a very short duration. Each individual data stream is reassembled at the receiving end based on the timing. [5]

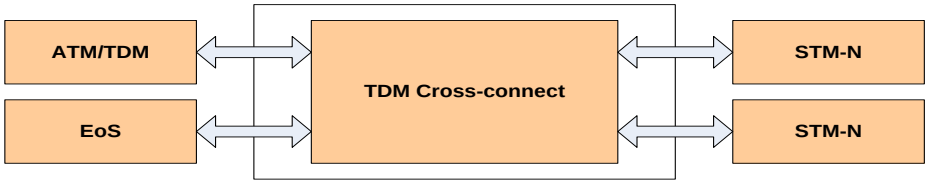


Fig 3.4: TDM Equipment Architecture.

■ 3.1.3. Power Transmission:

Power transmission is the movement of energy from its place of generation to a location where it is applied to performing useful work. Power is defined formally as units of energy per unit time. [6]

Fig 3.5: Power Transmission.

3.2. Capacity of Transmission:

The transmission capacity is based on a formula describing the power between a transmitter and a receiver. The ratio of these two numbers and the formula describes the capacity of the channel. A channel has a certain capacity for transmitting information, often measured by its bandwidth in Hz or its data rate in bits per second.

The different types of channel capacity distributed in transmission system. Those are:

3.2.1. Features of STM-1 (Synchronous Transport Module level-1)

- The STM-1 frame is the basic transmission format for SDH (Synchronous Digital Hierarchy).
- It has a bit rate of 155.52 Mbit/s.
- 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 64kbit/s channel.
- SDH capacity 63 E1.

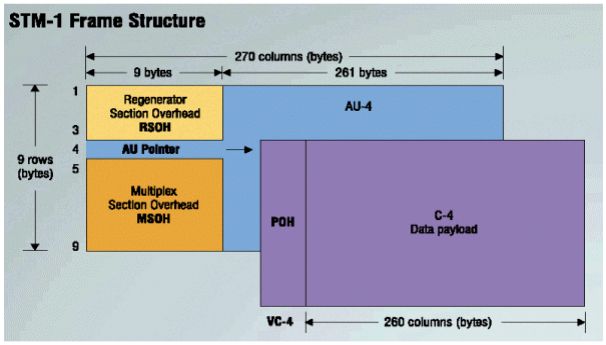


Fig 3.6: STM-1

3.2.2. Features of STM-4 (Synchronous Transport Module-4)

- It is a SDH ITU-T fiber optic network transmission standard.
- It has a bit rate of 622.080 Mbit/s.
- The STM-4 specification is designed to carry 7,680 8-bit "voice" frames every 125 micro-seconds for a total payload bit rate of 491.520 Mbit/s.
- Although STM-4 is comparable to OC-12 the SDH frame structure allocates more space to overhead than that of SONET. Because of this, STM-4's payload bandwidth differs from that of OC-12.
- SDH capacity 252 E1.

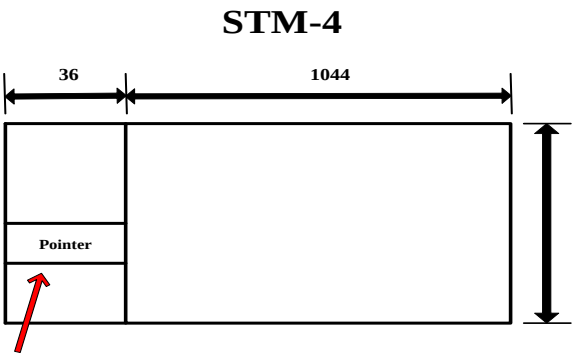


Fig 3.7: STM-4

3.2.3. Features of STM-16 (Synchronous Transport Module-16)

- Is a SDH ITU-T fiber optic network transmission standard.
- It has the bit rate of 2,488.320 Mbit/s (~2.5 Gbit/s)
- SDH capacity 1008 E1.

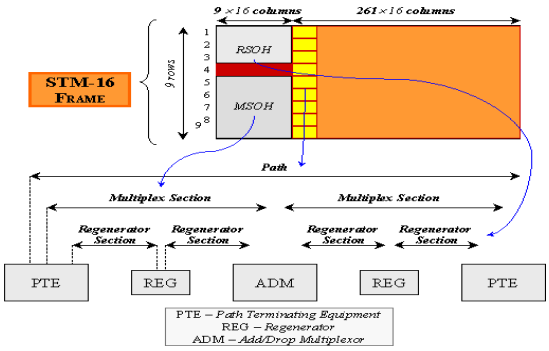


Fig 3.8: STM-16

3.2.4. Features of STM-64 (Synchronous Transport Module)

- Is a SDH ITU-T fiber optic network transmission standard.
- It has a bit rate of 9953.280 Mbit/s(~10Gbit/s)
- SDH capacity 4032 E1.

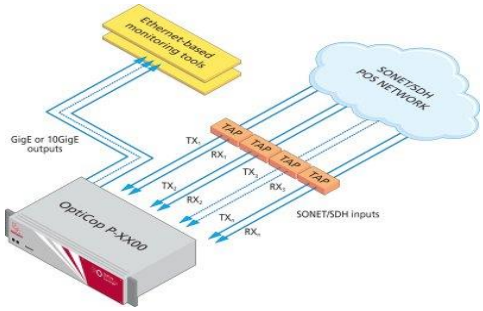


Fig 3.9: STM-64

3.2.5. E-1

- E1 (or E-1) is a European digital transmission format devised by the ITU-TS and given the name by the Conference of European Postal and Telecommunication Administration (CEPT).
- Carries at a data rate of 2.048 Mbit/s.
- It can carry 32 channels of 64 kbps each

3.2.6. Bandwidth:

GSM:

- GSM networks operating in the 900MHz and 1800MHz.

2G bandwidth:

- With GPRS (General Packet Radio Service), theoretical transfer speed of max. 50
  kbit/s (40 kbit/s in practice).
- With EDGE (Enhanced Data Rates for GSM Evolution), theoretical transfer speed of max. 1 Mbit/s (500 kbit/s in practice).

3G bandwidth:

– The bandwidth of 3G is 21 Mbps.

4G bandwidth:

– The bandwidth of 4G is 42 Mbps.

LTE Bandwidth:

– The bandwidth of LTE is 160 Mbps- 5Gbps.

3.3. Parameters of Data Transmission and TDM transmission:

Dara transmission and TDM transmission are deals with OSI (Open System Interconnection) Model: [7]

There are three types of OSI layer used in data transmission:

- ❖ Physical Layer
- ❖ Data-Link Layer
- ❖ Presentation Layer

3.3.1. Physical Layer:

Layer 1, the bottom layer of the OSI reference model, is the physical layer.

- This layer transmits the unstructured, raw bit stream over a physical medium (such as the network cable).
- The physical layer is totally hardware-oriented and deals with all aspects of establishing and maintaining a physical link between communicating computers.
- The physical layer also carries the signals that transmit data generated by each of the higher layers.
- Voltages and data rates needed for transmission is defined in the physical layer.
- It converts the digital bits into electrical signal.

3.3.2. Data-Link Layer:

Layer 2, the data-link layer, sends data frames from the network layer to the physical layer.

- Data link layer synchronizes the information which is to be transmitted over the data.
- Error controlling is easily done.
- The encoded data are then passed to physical.
- Error detection bits are used by the data link on layer.
- It also corrects the errors. Outgoing messages are assembled into frames.
- Then the system waits for the acknowledgements to be received after the transmission.
- It is reliable to send message.

3.3.3. Presentation Layer:

Layer 6, the presentation layer, defines the format used to exchange data among networked computers.

- Presentation layer takes care that the data is sent in such a way that the receiver will understand the information (data) and will be able to use the data.
- Languages (syntax) can be different of the two communicating systems.
- Under this condition presentation layer plays a role translator.

There are two types of OSI layer used in TDM transmission:

- ❖ Physical Layer
- ❖ Data-Link Layer

3.3.4. Physical Layer:

Layer 1, the bottom layer of the OSI reference model, is the physical layer.

- Physical Link transmitted data bits propagates across link.
- Signals propagate in solid media e.g. copper, fiber.
- Signals propagate freely, e.g. radio.

3.3.5. Data-Link Layer:

Layer 2, the data-link layer, sends data frames from the network layer to the physical layer.

- Error detection, correction.
- Sharing a broadcast channel: multiple access protocols and LANs.
- Link layer addressing.

3.4. Technologies used in transmission:

There are different types technology used in transmission and those are-

3.4.1. PDH:

The term plesiochronous means "nearly synchronous" or a call that must be extracted from more than one transmission frame. The plesiochronous digital hierarchy (PDH) is a telecommunications network transmission technology designed for the transport of large data volumes across large scale digital networks. The PDH design allows the streaming of data without having isochronous (clocks running at identical times, perfectly synchronized) to synchronize the signal exchanges. PDH clocks are running very close, but not exactly in time with one another so that when multiplexing, signal arrival times may differ as the transmission rates are directly linked to the clock rate.

PDH supports a data transmission rate of 2048 Kbps. The data rate is controlled by a clock in the device that generates the data. [8]

3.4.2. SDH:

In digital telephone transmission, "synchronous" means the bits from one call are carried within one transmission frame. Synchronous Optical Networking (SONET) and Synchronous Digital Hierarchy (SDH) are standardized protocols that transfer multiple digital bit streams synchronously 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 uses the following Synchronous Transport Modules (STM) and rates: STM-1 (155 megabits per second), STM-4 (622 Mbps), STM-16 (2.5 gigabits per second), and STM-64 (10Gbps). [9]

3.4.3. VPN:

A Virtual Private Network (VPN) is a network technology that creates a secure network connection over a public network such as the Internet or a private network owned by a service provider. Large corporations, educational institutions, and government agencies use VPN technology to enable remote users to securely connect to a private network. A VPN can connect multiple sites over a large distance just like a Wide Area Network (WAN). VPNs are often used to extend intranets worldwide to disseminate information and news to a wide user base.
There are a number of VPN protocols in use that secure the transport of data traffic over a public network infrastructure. Each protocol varies slightly in the way that data is kept secure. [10]

3.4.4. MPLS:

Multiprotocol Label Switching (MPLS) is a mechanism in high-performance telecommunications networks that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table. The labels identify virtual links (paths) between distant nodes rather than endpoints. MPLS can encapsulate packets of various network protocols. MPLS supports a range of access technologies, including T1/E1, ATM, Frame Relay, and DSL. [11]

3.4.5. VPLS:

Virtual Private LAN Service (VPLS) is a way to provide Ethernet-based multipoint to multipoint communication over IP or MPLS networks. It allows geographically dispersed sites to share an Ethernet broadcast domain by connecting sites through pseudo-wires. The term 'sites' includes multiplicities of both servers and clients. The technologies that can be used as pseudo-wire can be Ethernet over MPLS. [12]

3.4.6. DWDM:

Dense wavelength division multiplexing (DWDM) is a technology that puts data from different sources together on an optical fiber, with each signal carried at the same time on its own separate light wavelength. Using DWDM, up to 80 (and theoretically more) separate wavelengths or channels of data can be multiplexed into a light-stream transmitted on a single optical fiber. Each channel carries a time division multiplexed (TDM) signal. In a system with each channel carrying 2.5 Gbps (billion bits per second), up to 200 billion bits can be delivered a second by the optical fiber. DWDM is also sometimes called wave division multiplexing (WDM).A key advantage to DWDM is that it's protocol and bit-rate-independent. [13]

3.4.7. WCDMA:

W-CDMA (Wideband Code-Division Multiple Access), an ITU standard derived from Code-Division Multiple Access (CDMA), is officially known as IMT-2000 direct spread. W-CDMA is a third-generation (3G) mobile wireless technology that promises much higher data speeds to mobile and portable wireless devices than commonly offered in today's market. W-CDMA can support mobile/portable voice, images, data, and video communications at up to 2 Mbps (local area access) or 384 Kbps (wide area access). The input signals are digitized and transmitted in coded, spread-spectrum mode over a broad range of frequencies. A 5 MHz-wide carrier is used, compared with 200 KHz-wide carrier for narrowband CDMA. [14]

3.5. Theory of Transmission:

3.5.1. Multiplexing method

In the present PDH system, only 1.5Mb/s rate signals (including Japanese Series 6.3Mb/s rate signal) are synchronous. All other signals are asynchronous and require code rate for justification for matching and accepting clock difference. As PDH adopts asynchronous multiplexing method, the location of the low rate signals are not regular nor fixed when they are multiplexed into higher-rate signals. That is to say, the location of the lower signals are unable to be identified from the higher speed signals. But this is the key to directly add/drop lower speed signals from the higher speed signals. This is the same when looking for a stranger in a crowd. You can easily find him if you know which line and which row he stays in which crowd

is arranged in a specific order. But if the crowd is in a mess, you have to compare each person with the photo to locate the man.

Since PDH adopts asynchronous multiplexing method, low-rate signals cannot be directly added/dropped from PDH high-rate signals. For example, 2Mb/s signals cannot be directly added/dropped from 140Mb/s signals. Here arises two problems:

1) Adding/dropping low-rate signals from high-rate signals must be conducted level by level. For example, to add/drop 2Mb/s low-rate signals from 140Mb/s signals, the following procedures must be conducted. (Fig 3.10)

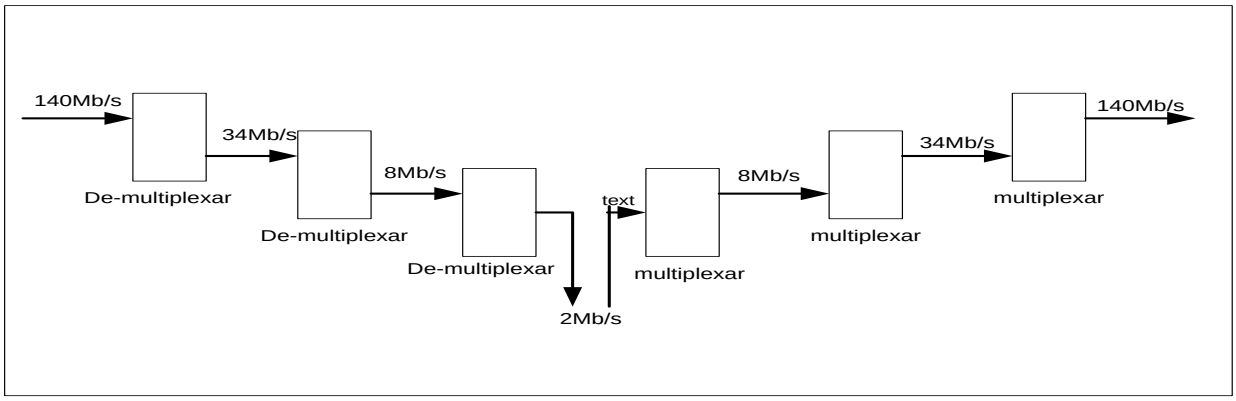


Fig 3.10: Add/drop 2 Mb/s signals from 140 Mb/s

As shown in the figure, lots of "back-to-back" equipment are used during the process of adding/dropping 2Mb/s signals from 140Mb/s signals. Three stages of de-multiplexing equipment are used to drop 2mb/s low-rate signals from 140Mb/s signals and then three stages of multiplexing equipment are used to add 2Mb/s low-rate signals into 140Mb/s. One 140Mb/s signal can be multiplexed into 64 2Mb/s low-rate signals. Multiplexing and de-multiplexing equipment in all three stages are required to add/drop even one 2Mb/s signal from 140Mb/s signals. This not only enlarges the size and increases cost, power consumption and complexity of equipment, but also decreases the reliability of the equipment.

2) Since adding/dropping low-rate signals to high-rate ones must go through many stages of multiplexing and de-multiplexing, impairment to the signals during multiplexing/de-multiplexing process will increase and transmission performance will deteriorate. This is unbearable in large capacity transmission. That's the reason why the transmission rate of PDH system has not being improved further.

3.5.2. Advantages of SDH over PDH

Since SDH transmission system evolves from PDH, it has unparalleled advantages over PDH. Compared with PDH, it is a new transmission system that has radical revolution in technical system.

First, we will discuss the basic concept of SDH. The core of this concept is, in view of an integrated national telecommunication network and international intercommunication, to establish digital telecommunication networks, and to make up important parts of integrated services digital networks (ISDN), especially brand-band integrated services digital networks (B-ISDN). Different from traditional PDH, the network based on SDH system is a high uniform, standardized and intelligent network. It uses universal interfaces to achieve compatibility with different equipment from different vendors. It is also boasts of highly efficient and coordinated management and operation through-out the whole network and transmission process, flexible network and traffic dispatching, and network self-healing function. It greatly enhances the utilization ratio of network resources the OAM costs due to the enhanced maintenance function.

Now give the advantage of SDH (they can be regarded as the features of SDH) in several aspects.

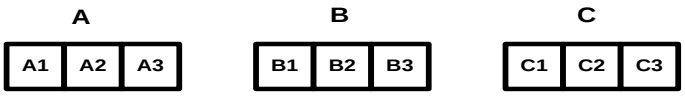
3.5.3. Interface

- ### Electrical interface

Standardization of interfaces determines the possibility of interconnection among different equipment from different vendors.

SDH system provides a set of standard information structure levels, i.e. a set of standard of rate levels. The basic signal transmission structure is a synchronous transfer module --- STM-1 at a rate of 155Mb/s. Digital signal hierarchies of higher levels such as 622Mb/s (STM-4) and 2.5Gb/s (STM-16) can be formed by low-rate information modules (e.g. STM-1)via **byte interleaved multiplexing**. The number of modules to be multiplied is a multiple of 4. For example, STM-4=4xSTM-1and STM-16=4xSTM-4.

Byte interleaved multiplexing method: It can be explain by following example. There are three signals with the frame structure of 3 bytes in each frame.



If signal D is formed by byte interleaved multiplexing method, it will have a frame structure of 9 bytes in each frame and these 9 byte are arranged in the order as shown in the following figure:

D

A1	B1	C1	A2	B2	C2	A3	B3	C3

This multiplexing method is called byte interleaved multiplexing method.

- **Optical interface**

Line interface (here refers to optical interface) adopt universal standards. Line coding of SDH signals are only scrambling, instead of inserting redundancy codes. The standard for scrambling is universal. Therefore the opposite-terminal equipment can be inter connected with SDH equipment of different vendors via standard descrambler alone. The purpose of scrambling is to make the probability of "1" bits and "0" bits occurence gets close to 50% so as to extract clock signals from line signals. As line signals are scrambled only, the lie signal rates of SDH are the same with the standard signal rates of the SDH electrical interface. This will not add extra optical power to the transmitting laser.

3.5.4. SDH Signal------ STM-N Frame Structure

The arrangement of the frame structure shall ensure that the low-rate tributary signals are allocated as evenly and regularly in the frame as possible. Because this makes it easier to implement synchronous multiplexing, cross-connection (DXC), add/drop, switching of tributaries. In a word this arrangement facilitates direct adding/dropping of low-rate tributary signals to/from high-rate signals. Therefore, ITU-T defines the frame of STM-N as rectangle block frames structure in unit of byte (8bit), as illustrated in figure-3.11

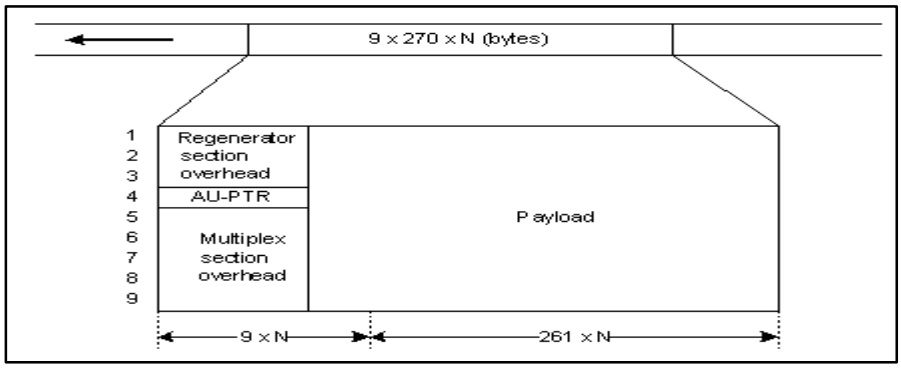


Fig 3.11: STM-N Frame Structure.

3.6. Transmission Media:

Transmission media is a pathway that carries the information from sender to receiver. We use different types of cables or waves to transmit data. Data is transmitted normally through electrical or electromagnetic signals.
Communication is possible only if information is encoded in a signal, and the signal is carried on a transmission the characteristics of the signal and of the medium both determine the quality of communication medium. [15]

3.6.1. Types of Transmission Media: [16]

Transmission media is broadly classified into two groups.

1. Wired or Guided Media or Bound Transmission Media
2. Wireless or Unguided Media or Unbound Transmission Media

3.6.2. Guided Transmission Media:

- Guided transmission media includes everything that 'guides' the transmission. That usually takes the form of some sort of a wire. Usually copper, but can also be an optical fiber.
- Transmission capacity depends on the distance and on whether the medium is point-to-point or multipoint.
- Examples:
    - Unshielded Twisted Pair wires
    - Coaxial Cable
    - Optical Fiber

3.6.2.1. Unshielded Twisted Pair wires:

- A transmission medium consisting of pairs of twisted copper wires arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs.
- Often used at customer facility and also over distance to carry voice as well as data communication.
- Low frequency transmission medium.
- We can transmit 1 Mbps over short distance (less than 100m).
- They are mainly used to transmit analog signals, but they can be used for digital signals.

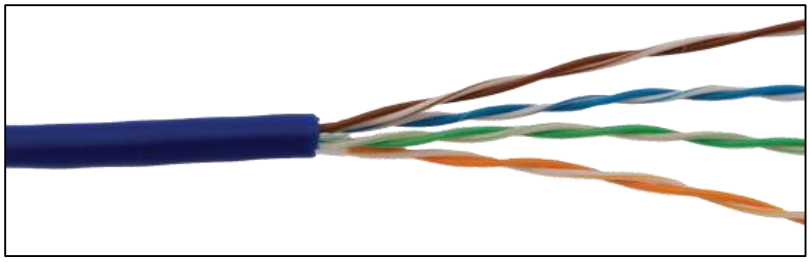


Fig 3.12: UTP Cable.

3.6.2.2. Coaxial Cable:

- In its simples form coaxial consists of a core made of solid copper surrounded by insulation, a braided metal shielding and an outer cover.
- A transmission medium consisting of thickly insulated copper wire, which can transmit a large volume of data than twisted pair.
- It consisting of higher bandwidth.
    - 400 to 600 MHz
    - Up to 10,800 voice conversation.
- It is used in cable TV networks or traditional Ethernet LANs.

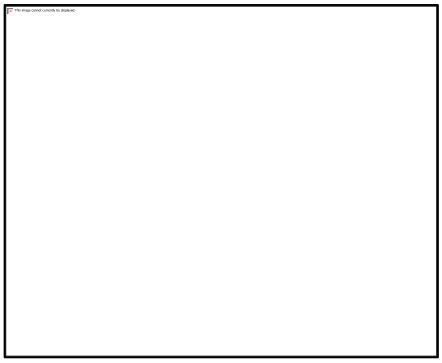


Fig 3.13: Coaxial Cable

3.6.2.3. Fiber Optic Cable:

- An optical fiber (or optical fiber) is a flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair.
- It is relatively new transmission medium used by telephone companies in place of long-distance trunk lines.
- It is also used by private companies in implementing local data communication networks.
- In most networks fiber-optic cable is used as the high-speed backbone.

- Single-mode fibers are used for most communication links longer than 1,000 meters (3,300ft).

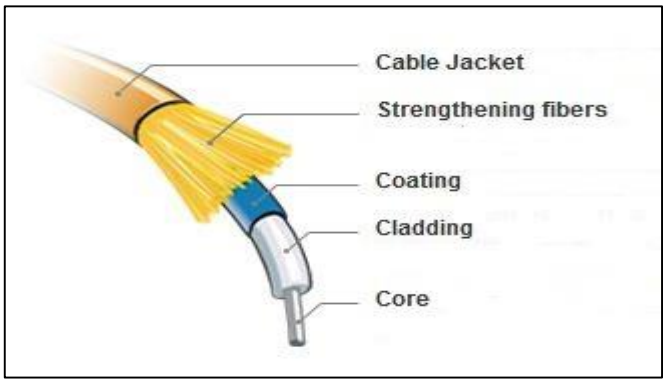


Fig 3.14: Fiber Optic Cable

3.6.3. Advantages of optical fiber cabling compared to Unshielded Twisted Pair (UTP):

Using Fiber over UTP is normally done for distance due to the extremely high costs

- ❖ Fiber is used for various applications, backbone applications being one.
- ❖ In some cases fiber is used inside a building (for instance server to server connections, where the highest levels of security are needed, or for storage area networks). The electronics that operate over fiber are higher than those for copper as an optical conversion is needed to do this.
- ❖ In some cases, fiber may provide lower latency over copper counterparts, but that is dependent on the electronics and protocols in use. Also in some areas where noise is an issue, fiber is not affected by electromagnetic or RF noise.
- ❖ Distance is the main factor, especially with emerging standards for newer UTP standards, because standard cat5 cable can only go 100 meters, (328 feet), before start having signaling problems and it is also susceptible to Electromagnetic interference.
- ❖ Fiber can be used instead of UTP if someone going from building to building and there are storm issues.

3.6.4. Unguided Transmission Media:

- Unguided media transmission and reception are achieved by means of an antenna
- Directional
  - Transmitting antenna puts out focused beam
  - Transmitter must be aligned

- Omnidirectional
  - Signal spreads out in all directions
  - Can be received by many antenna
- Examples:
  - terrestrial microwave
  - satellite microwave
  - broadcast radio
  - infrared

3.6.4.1. Microwaves Transmission:

- Electromagnetic waves having frequency between 1 and 300GHz are called as microwave.
- Microwaves are unidirectional.
- There are two types of micro waves data communication system : terrestrial and satellite
- The microwave band is relatively wide, almost 299GHz.
- They are used in cellular phones, satellite networks, wireless LANs.

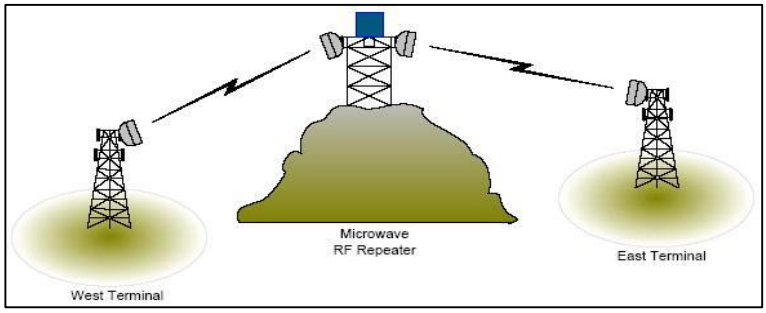


Fig 3.15: Microwave

3.6.4.2. Radio waves Transmission:

- Radio waves are particularly those waves that propagate in the sky mode, can travel long distance.
- Radio waves are omnidirectional.
- The Radio waves have frequencies between 3khz and1Ghz
- Mobile telephony occupies several frequency band under 1 GHz.
- AM and FM radio, television, maritime radio, cordless phone and paging are examples of multicasting.

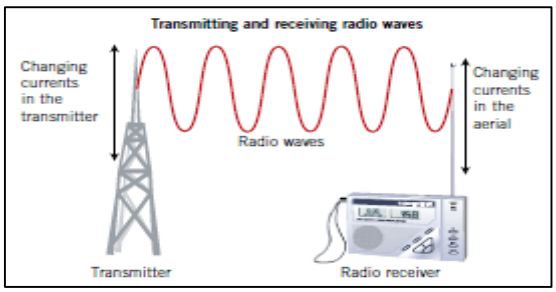


Fig 3.16: Radio Wave

3.6.4.3. Infrared waves:

- Electromagnetic waves having frequencies from 300 GHz to 400 THz are called IR waves or Infrared waves.
- IR waves are used for short range communication and use line of sight propagation.
- Infrared waves cannot pass through solid objects, like walls and be easily contained in a room.
- They are cheap, easy to build and do not require any government license to use them.

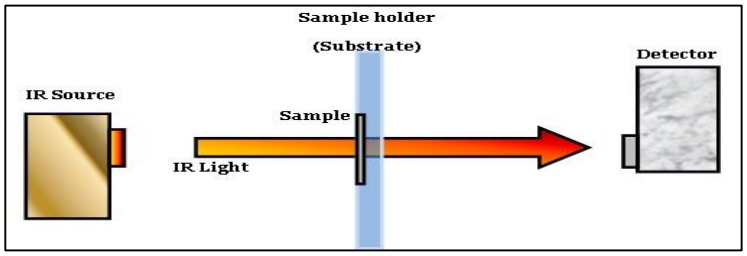


Fig 3.17: Infrared.

3.6.4.4. Laser:

- This type of transmission use thin laser to transfer data up to few kilometers.
- Laser beams are unidirectional, therefore this type of transmission system use line of sight propagation.
- In such a transmission system, a photo detector and laser is set on both sender and receiver side.
- Such a system offer very high band width at a very low cost.
- Other disadvantage is that on hot sunny days these waves are affected by hot turbulent air and miss the detector.
- The major problem in this transmission system is that laser beams cannot penetrate rain or thick fog.

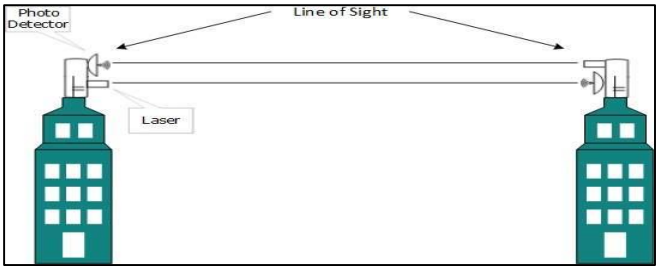


Fig 3.18: Light transmission

3.7. Transmission Architecture:

GSM Architecture [17]

- GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services.
- GSM is the most widely accepted standard in telecommunications and it is implemented globally.
- GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In the US, GSM operates in the bands 850 MHz and 1900 MHz.

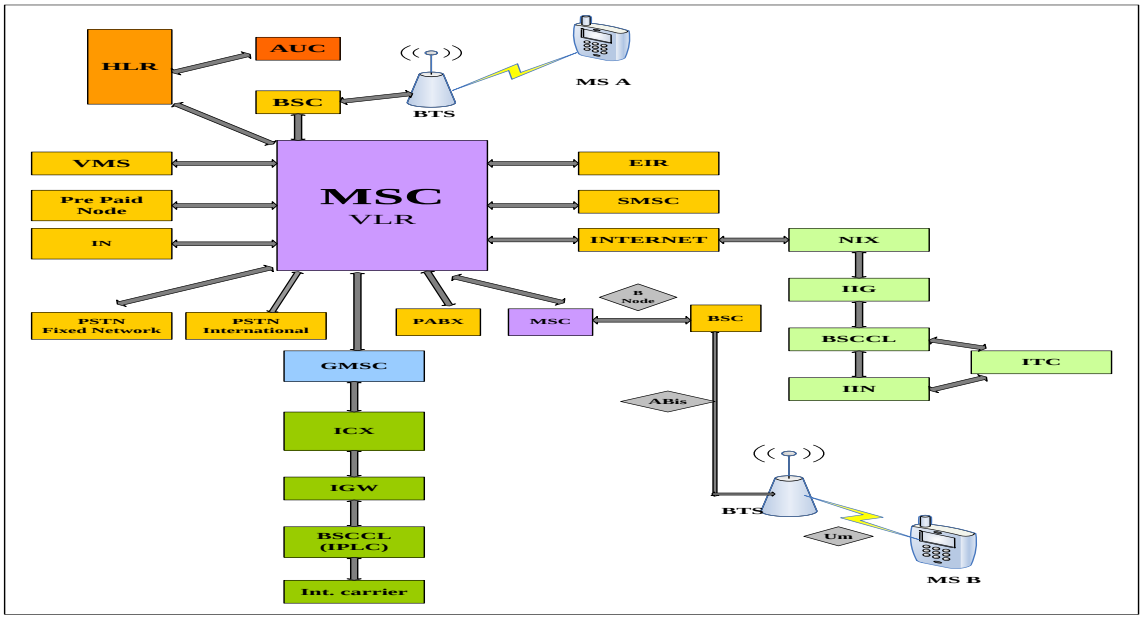


Fig 3.19: GSM System Architecture

GSM operation

Once a Mobile Station initiates a call, a series of events takes place. Analyzing these events can give an insight into the operation of the GSM system.

Mobile Phone to Public Switched Telephone Network (PSTN)

When a mobile subscriber makes a call to a PSTN telephone subscriber, the following sequence of events takes place:

- The MSC/VLR receives the message of a call request.
- The MSC/VLR checks if the mobile station is authorized to access the network. If so, the mobile station is activated. If the mobile station is not authorized, then the service will be denied.
- MSC/VLR analyzes the number and initiates a call setup with the PSTN.
- MSC/VLR asks the corresponding BSC to allocate a traffic channel (a radio channel and a time slot).
- The BSC allocates the traffic channel and passes the information to the mobile station.
- The called party answers the call and the conversation takes place.
- The mobile station keeps on taking measurements of the radio channels in the present cell and the neighbouring cells and passes the information to the BSC. The BSC decides if a handover is required. If so, a new traffic channel is allocated to the mobile station and the handover takes place. If handover is not required, the mobile station continues to transmit in the same frequency.

PSTN to Mobile Phone

When a PSTN subscriber calls a mobile station, the following sequence of events takes place:

- The Gateway MSC receives the call and queries the HLR for the information needed to route the call to the serving MSC/VLR.
- The GMSC routes the call to the MSC/VLR.
- The MSC checks the VLR for the location area of the MS.
- The MSC contacts the MS via the BSC through a broadcast message, that is, through a paging request.
- The MS responds to the page request.
- The BSC allocates a traffic channel and sends a message to the MS to tune to the channel. The MS generates a ringing signal and, after the subscriber answers, the speech connection is established.
- Handover, if required, takes place, as discussed in the earlier case.

To transmit the speech over the radio channel in the stipulated time, the MS codes it at the rate of 13 Kbps. The BSC transcodes the speech to 64 Kbps and sends it over

a land link or a radio link to the MSC. The MSC then forwards the speech data to the PSTN. In the reverse direction, the speech is received at 64 Kbps at the BSC and the BSC transcodes it to 13 Kbps for radio transmission.
GSM supports 9.6 Kbps data that can be channelled in one TDMA timeslot. To supply higher data rates, many enhancements were done to the GSM standards (GSM Phase 2 and GSM Phase 2+).

3.8. Topology of Transmission:

3.8.1. Ring Topology:

A ring network is a network topology in which each node connects to exactly two other nodes, forming a single continuous pathway for signals through each node - a ring. Data travel from node to node, with each node along the way handling every packet. [18]

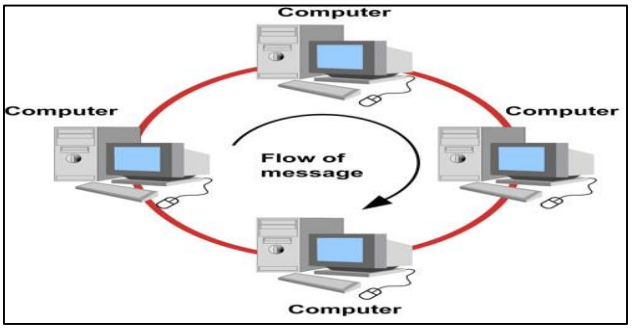


Fig 3.20: Ring Topology

3.8.2. Features of Ring Topology:

- Each packet is sent around the ring until it reaches its final destination.
- A number of repeaters are used and the transmission is unidirectional.
- Date is transferred in a sequential manner that is bit by bit.

3.8.3. Uses of Ring topology:

- The ring topology was most commonly used in schools, offices, and smaller buildings where networks were smaller.
- However, today, the ring topology is seldom used, having been switched to another type of network topology for improved performance, stability, or support.

3.8.4. MSP:

MSP means (Multiplexer section protection) 1+1. In this protection schemes an entire (including all timeslots travelling on that span) is protected. For SDH that span is defined as a multiplexer section. For SONET it is define as a line.

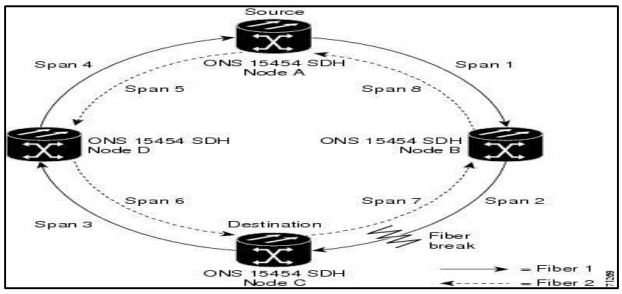


Fig 3.21: MSP protection in SDH

3.8.5. SNCP:

In telecommunications, sub-network connection protection (SNCP), is a type of protection mechanism associated with synchronous optical networks such as synchronous digital hierarchy (SDH).

- SNCP is a dedicated (1+1) protection mechanism for SDH network spans which may be deployed in ring, point to point or mesh topologies.
- It is complementary to Multiplex Section Protection (MSP), applied to physical handover interfaces; which offers 1+1 protection of the handover.
- An alternative to SNCP is Multiplex Section Shared Protection Rings or MS-SPRings, which offers a shared protection mode.
- SNCP's functional equivalent in SONET is called UPSR (Unidirectional path-protection self-healing Ring).

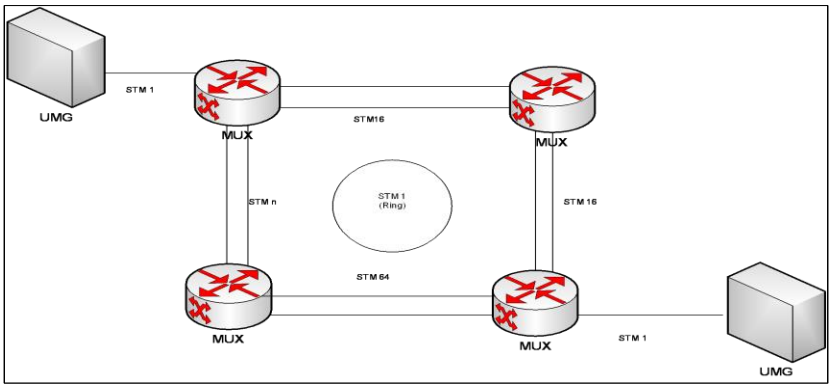


Fig 3.22: SNCP protection in SDH

3.9. Transmission medium and capacity permitted by BTRC:

3.9.1. 3G:

In the 3G spectrum auction, on Sunday ,8th sep 2013, at Ruposhi Bangla Hotel in the capital Dhaka .The operator Grameen phone/GP bought 10 MHz and other operators Robi, Banglalink and Airtel bought 5 MHz each.The auction was concluded with just four calls, selling a total of 25 MHz on the 2100 band. A big chunk of 15 MHz spectrum remained unsold.

- The first phase of the auction for 10 MHz blocks started at 11:15 am and the operator Grameenphone bid for $21m for each MHz within 439 miliseconds.The operator won the bidding as there was no other player for this block. Grameenphone got the chance to choose 10 MHz spectrum in 2125-2135 band for downlink and 1925-1935 band for uplink.
- In the second phase, Robi bid for 5 MHz block within 410 milliseconds. Robi was given the opportunity to choose spectrum band and it took 2140-2145 band for downlink and 1950-1955 band for uplink.
- Airtel bid after 44.792 seconds. Airtel took 2135-2140 band for downlink and 1945-1950 band for uplink.
- Just before the end of the 5 minute period for bidding, Banglalink joined the race. Banglalink got the rest of the block 2145-2150 band for downlink and 1955-1960 band for uplink.
- The state-owned mobile operator Teletalk will get the 3G license by default on 2150-2160 band and it will have to pay $21m, the price fixed by the auction.

3.9.2. LTE:

Long Term Evolution, LTE is a 4G wireless communications standard developed by the 3rd Generation Partnership Project (3GPP).

- It is designed to provide up to 10x the speeds of 3G networks for mobile devices such as smartphones, tablets, netbooks, notebooks and wireless hotspots.
- The 4G technologies are designed to provide IP- based voice, data and multimedia streaming at speeds of at least 100 Mbit per second and up to as fast as 1 GBit per second.
- 4G LTE is one of several competing 4G standards along with Ultra Mobile Broadband (UMB) and WiMax.

On February 12, the Ministry of Post and Telecommunication finalised the licensing policy for the 3G services by fixing the value of spectrum US$ 20 million per MHz.

3.10 Transmission in ICX:

3.10.1. Call Flow Diagram 1

- Generally, calls are transmitted from ANS (Access Network Service) to ICX (Interconnection Exchange).

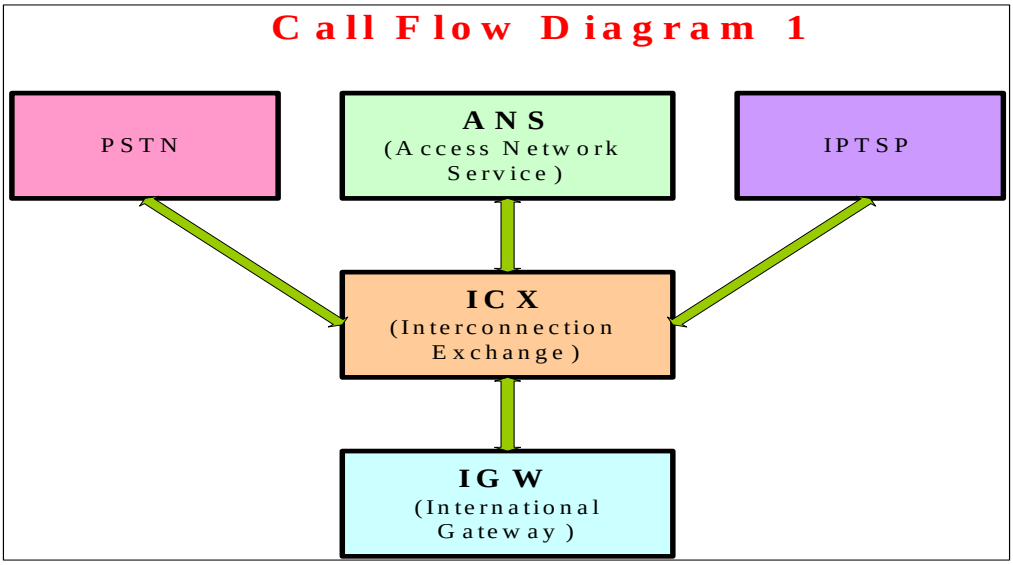


Fig 3.23: Call Flow Diagram 1.

- Then calls are transmitted from ICX (Interconnection Exchange) to IGW (International Gateway).
- Calls are also transmitted from PSTN (Public Switched Telephone Network) and IPTSP (Internet Protocol Telephony Service Provider) to ICX.
- Then calls are transmitted from IPTSP (Internet Protocol Telephony Service Provider) to IGW.

3.10.2. Call Flow Diagram 2

ICX (VOICETEL LTD.) has transmitted two types of call. These are-

- Domestic Call (incoming & outgoing)
- International Call (incoming & outgoing)

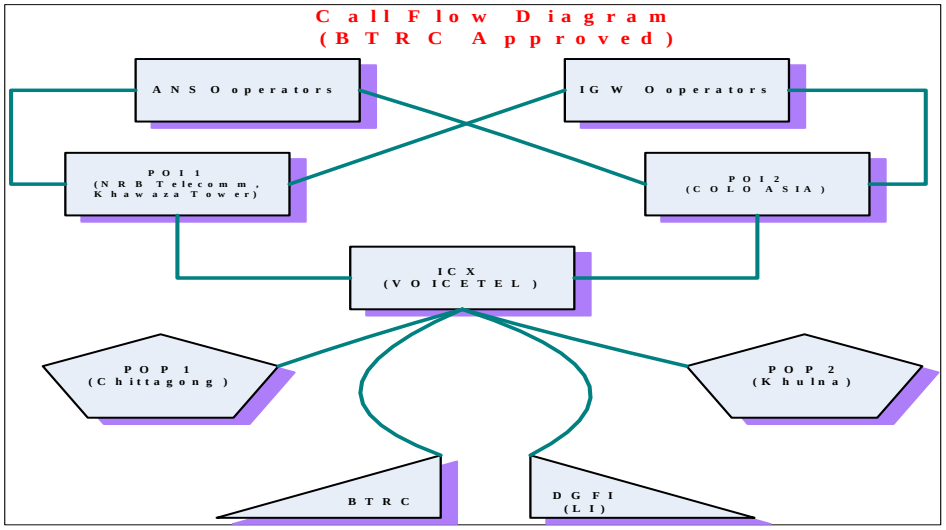


Fig 3.24: Call Flow Diagram 2.

3.10.2.1. Domestic Call (incoming & outgoing):

In domestic area, ICX (VOICETEL ltd.) transmitted calls between different ANS operators not in the same operators. Like GP-Robi, GP-Banglalink etc.

- ICX is connected to ANS operators through POI (point of interconnection). When a call is originated from Dhaka to Dhaka, ICX routed that call to the operators through VOICETEL switch and UMG (universal media gateway).
- ICX (VOICETEL) is connected with two POPs (Point of Presence). One POP is Khulna and another is Chittagong.
- By 2Mbps signaling link these POPs are connected with ICX. When calls are originated from those POPs, those calls does not go to the VT ICX. ICX routed that calls from Dhaka.
- Outgoing calls should be routed by opposite process.

3.10.2.2. International Call (incoming & outgoing):

In case of International call, when anyone calls from Dhaka to any other international country that call will flow from ANS to ICX. Then ICX to POI and then POI to IGW.

- ICX will routed the calls from those IGWs which link performance will be better.
- If any calls originated from POP to any international country, at first call will flow from POP to ANS. Then will go from ANS to ICX. Then from ICX to POI and POI to IGW.

- The ICX will be capable of generating **CDRs** (call detailed record) and recording detail data of all completed calls (both incoming and outgoing) for each of the circuit in any or all circuit groups. Call Detail Record (CDR) is to send out daily BTRC (Bangladesh Telecommunication Regulatory Commission).
- **DGFI** (Directorate General of Forces Intelligence) can access anytime to the UMG, switch, billing for any kind of security purpose.

3.10.3. Point of Interconnection (POI):

"Point of Interconnection (PoI)" shall mean a physical location at which two or more networks interconnect through switches, nodes or other devices, offering access to operators or service providers.

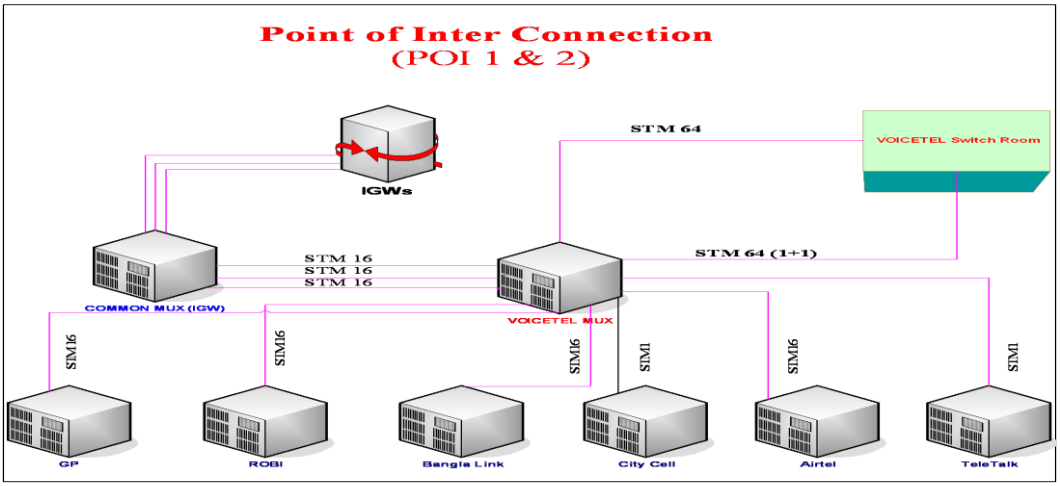


Fig 3.25: POI (Point of interconnection).

In VOICETEL Ltd., there has two POI-

- POI (NRB)
- POI (COLOASIA)

- All IGWs are connected with common IGW MUX.
- In telecommunications and computer networks, multiplexing (sometimes contracted to muxing) is a method by which multiple analog message signals or digital data streams are combined into one signal over a shared medium.
- The aim is to share an expensive resource. The multiplexed signal is transmitted over a communication channel, such as a cable.
- The multiplexing divides the capacity of the communication channel into several logical channels, one for each message signal or data stream to be

transferred. A reverse process, known as de-multiplexing, extracts the original channels on the receiver end. **A device that performs the multiplexing is called a multiplexer (MUX),** and a device that performs the reverse process is called a de-multiplexer (DEMUX or DMX).

- IN POI (NRB), VOICETEL MUX (OSN 3500) is connected to the IGWs common MUX by two STM 16 link, connected to the VOICETEL Switch Room MUX (OSN 3500) by two STM 64 link and connected to the ANS operators (like GP, BL, Robi, Citycell, Teletalk).
- VOICETEL MUX (OSN 3500) is connected with Robi , GP, Banglalink, Airtel by STM 16 link and Citycell, Teletalk are connected with STM 1 link.
- In POI (COLOASIA), VOICETEL MUX (OSN 2500) is connected to VOICETEL Switch Room MUX (OSN 3500) by two STM 16 link. One is redundant STM (MSP (1+1)). POI (OSN 2500) is a low capacity MUX. It provides only domestic calls to those operators which only want.

3.10.4. VOICETEL Switch Room:

In VOICETEL Switch Room-

- POI is connected with VOICETEL Switch Room MUX (OSN 3500) by two STM 64 link.
- MUX is connected with UMG (Universal Media Gateway) by STM 1 links.
- UMG is connected with Layer 3 Switch.
- Layer 3 Switch is connected with NOC, Router and Soft Switch.
- Soft Switch is connected with Billing Server.
- Router is connected with two POPs by 2Mbps signaling links.

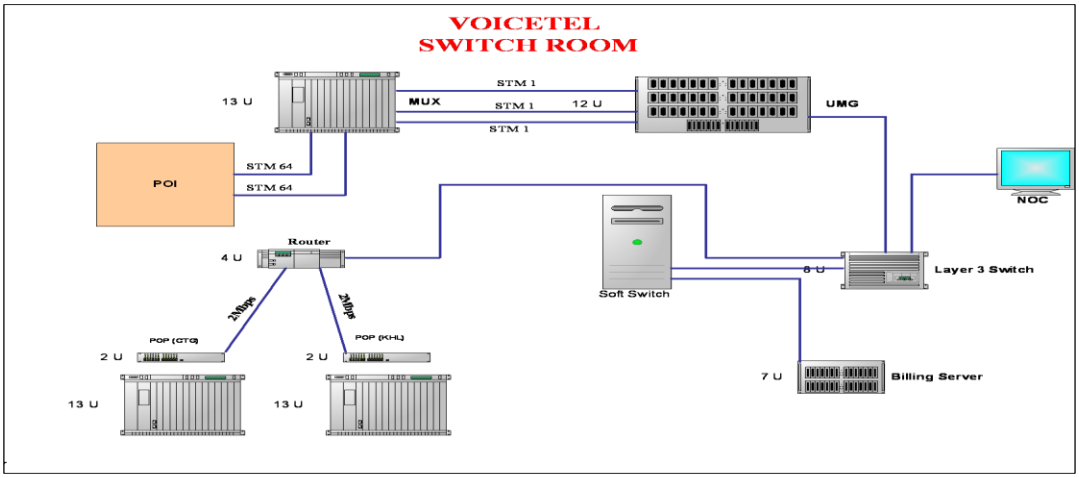


Fig 3.26: VOICETEL Switch Room.

3.10.5. Point of Presence (POP):

"Point of Presence (PoP)" shall mean setting up of switching centre and transmission centre of appropriate capacity to provide on demand service of prescribed quality and grade of service in a non-discriminatory manner.

VOICETEL is connected with two POP:
In case of Chittagong-

- VOICETEL Switch Room (Dhaka) is connected with Switch (S9303).
- The Switch is connected with MUX (OSN 2500) and UMG (8900).
- UMG (8900) is connected with MUX (2500) by many STM 1 link.
- The MUX is then connected with all available operators (GP, BL, ROBI,
- TELETALK, CITYCELL, AIRTEL).

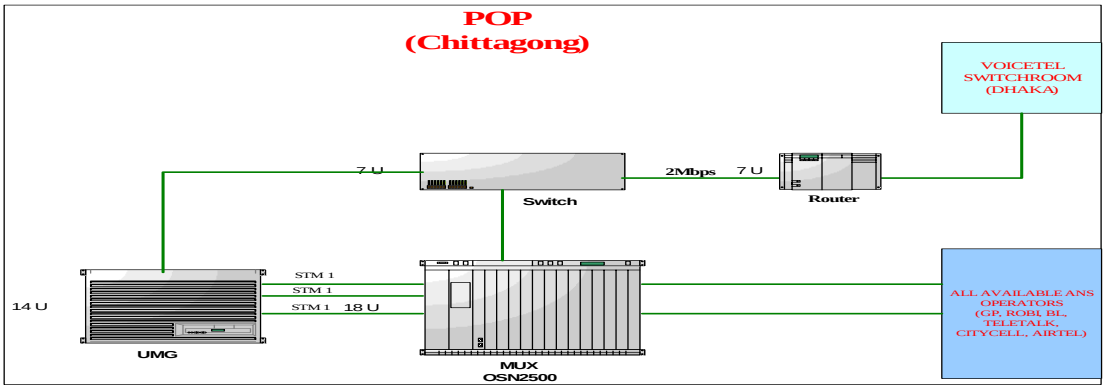


Fig 3.27: Point of Presence (POP) Chittagong.

In case of Khulna-

- VOICETEL Switch Room (Dhaka) is connected with Switch (S9303).
- The Switch is connected with MUX (OSN 1500) and UMG (8900).
- UMG (8900) is connected with MUX (1500) by many STM 1 link.
- The MUX is then connected with all available operators (GP, BL, ROBI,
- TELETALK, CITYCELL, AIRTEL).

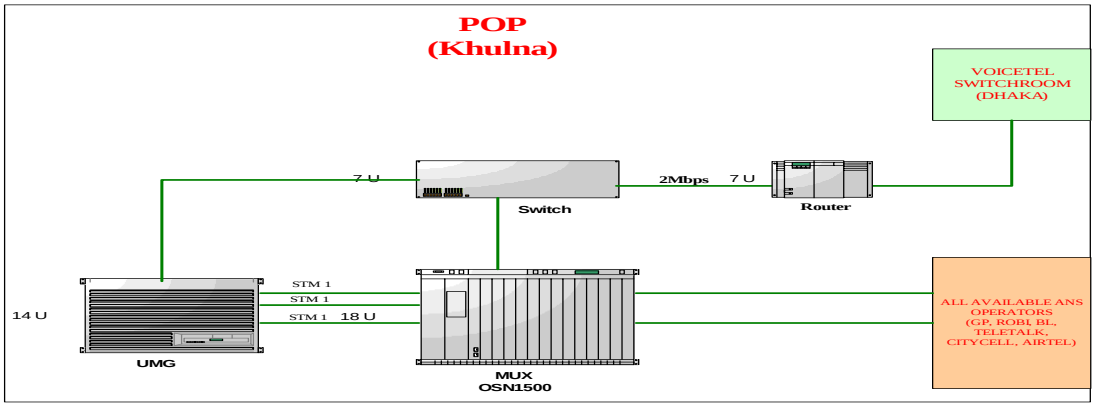


Fig 3.28: Point of Presence (POP) Khulna.

3.11 Transmission in IGW:

IGW will have physical connection with ICX. ICX will develop and maintain interconnection facilities to connect the IGW to ICX which in turn will be connected ANS operators via their POPS as per infrastructure sharing and relevant guidelines and directive /instructions/decisions regarding interconnection issued by the commission from time to time. IGWs will provide international voice call services including VoIP termination and origination and also can provide other services (like ICX) with prior permission from BTRC.

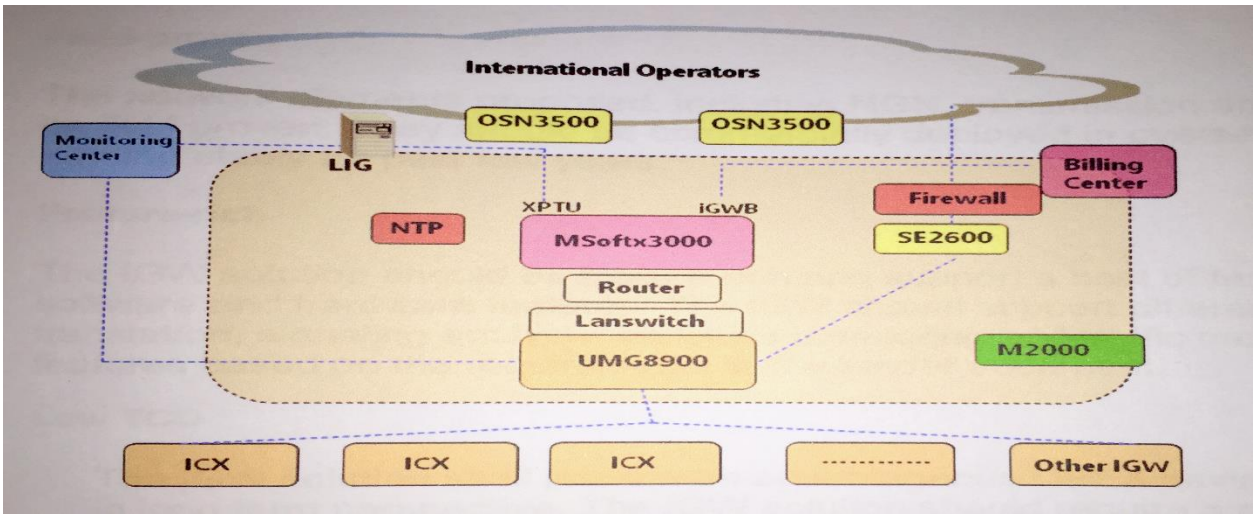


Figure 3.29: IGW Architecture

Table- IGW Solution Product Model

Product	Entity in the Tender	Functionality of Entity
MSoftx3000	Softswitch	Call control
UMG8900	Media Gateway	Media and signaling adaptation
LIG	LI (lawful interception)	LI Gateway
M200	Core Network NMS	NMS
NE40-X3	Router	IP core
S9300	Lanswitch	
NTP Server	NTP	
SE2600	SBC	Session Border Controller
OSN3500	MUX	
Eudemon1000E	Firewall	Security
Billing/Mediation		Billing System

CHAPTER

(4)

Geographical Device Interfaces

4 Geographical Device Interfaces

VOICETEL limited has four types of MUX. Those are following below-

4.1. VOICETEL Switch Room MUX

Fig 4.1: VOICETEL Switch Room Mux

4.2. NRB POI 1 (MUX)

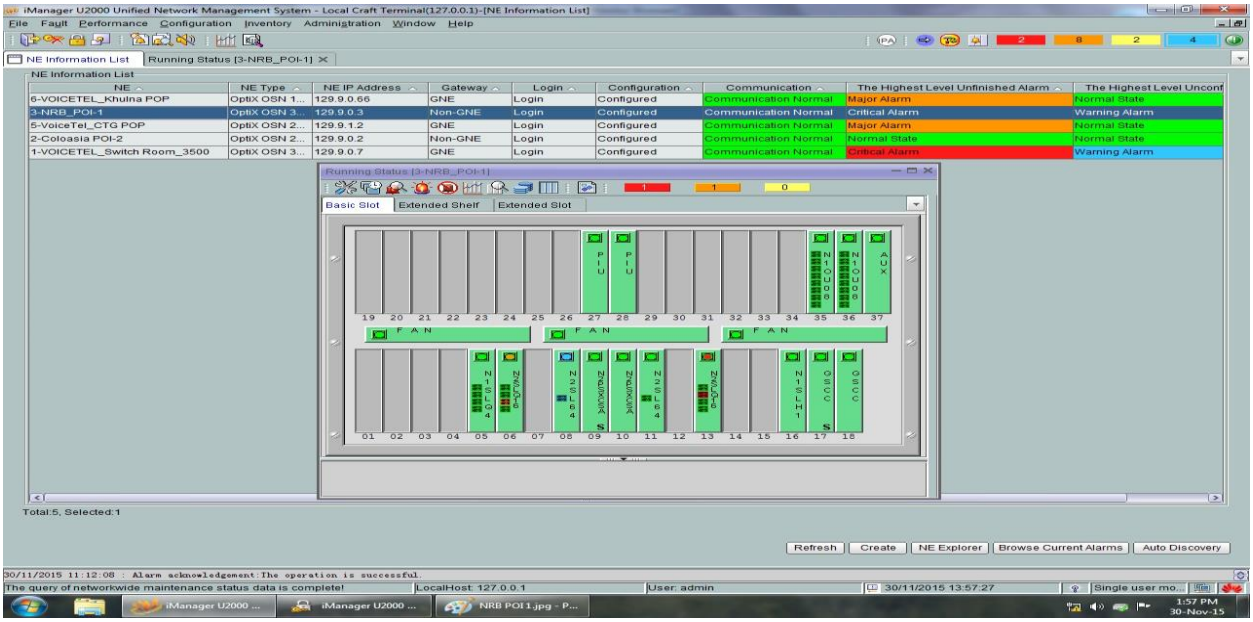


Fig 4.2: NRB POI 1 MUX

4.3. COLOASIA POI 2 (MUX)

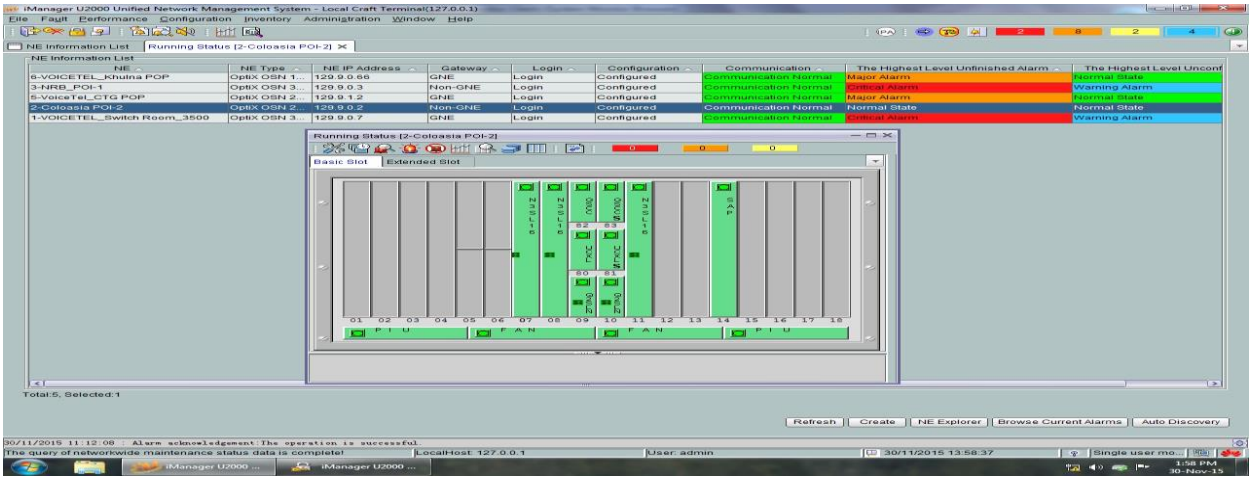


Fig 4.3: COLOASIA POI 2 (MUX)

4.4. VOICETEL_Chittagong POP

Fig 4.4: VOICETEL_Chittagong POP

4.5. VOICETEL_Khulna POP

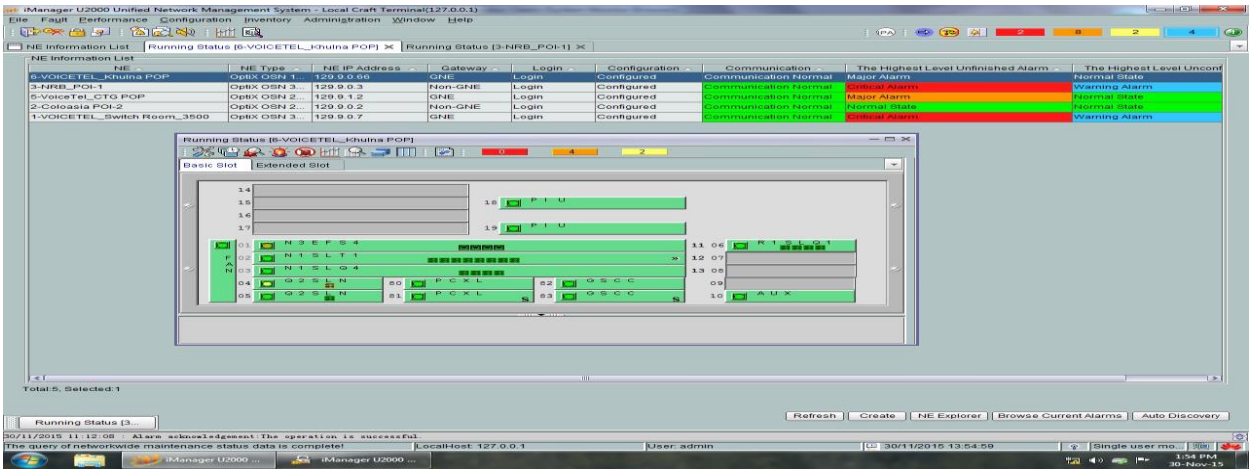


Fig 4.5: VOICETEL_Khulna POP

Chapter
(5)
Alarms & Conclusion

5. ALARM

However working in NOC (Network Operation Center) section, there are getting some following types of common alarms in the physical transmission-

5.1. R_LOS

Description

The R_LOS is an alarm indicating loss of signals on the receive side of the line.

Attribute

Alarm Severity	Alarm Type
Critical	Communication alarm

Possible Causes

The possible causes of the R_LOS alarm are as follows:

Optical Interface Board

- Cause 1: The local optical interface is not in use (in the case of the optical interface board).
- Cause 2: The opposite laser is shut down, and therefore no optical signals are accessed (in the case of the optical interface board).

Electrical Interface Board

- Cause 4: The signal modes of both ends are different (in the case of the STM-1 electrical interface board).

IF Board

- Cause 5: Other alarms trigger the R_LOS alarm (in the case of the IF board).

Common Cause

- Cause 3: A fiber cut occurs or the performance of the line declines.
- Cause 6: The receive board at the local station is faulty, and therefore the signal fails to be received on the line.
- Cause 7: The transmit board (including the cross-connect and timing board) at the opposite station is faulty, and therefore the signal fails to be transmitted on the line.

5.2. R_LOF

Description

The R_LOF is an alarm indicating loss of frames on the receive side of the line. When the correct A1 and A2 bytes are not contained in five consecutive frames received at the receive optical interface of the local station, the R_LOF alarm is reported.

Attribute

Alarm Severity	Alarm Type
Critical	Communication alarm

Possible Causes

The possible causes of the R_LOF alarm are as follows:

- Cause 1: Two boards at different rates are interconnected (in the case of the optical interface board).
- Cause 2: The transmit cable is faulty, and the fiber connector is loose or contaminated (in the case of the optical interface board).
- Cause 3: Other alarms trigger the R_LOF alarm (in the case of the IF board).
- Cause 4: The receive board at the local station is faulty, and thus the frame structure is lost.
- Cause 5: The transmit board (including the cross-connect board) at the opposite station is faulty, and thus the frame structure is lost.

5.3. AU_AIS

Description

The AU_AIS is an alarm indication of the administrative unit (AU). This alarm occurs when the optical interface on the local NE receives the AU pointer of all 1s.

Attribute

Alarm Severity	Alarm Type
Major	Communication alarm

Possible Causes

The possible causes of the AU_AIS alarm are as follows:

- Cause 1: The local NE inserts the AIS alarm to the lower level circuit.

- Cause 2: The upstream NE inserts the AIS alarm to the downstream NE.
- Cause 3: The cross-connect configuration of the service type is incorrect.
- Cause 4: The transmit boards (including the cross-connect and timing board) on the upstream NE are faulty.
- Cause 5: The receive boards on the local NE are faulty.

5.4. HP_RDI

Description

The HP_RDI is an alarm indicating a remote defect in the higher order path.

Attribute

Alarm Severity	Alarm Type
Minor	Communication alarm

Possible Causes

The possible causes of the HP_RDI alarm are as follows:

- Cause 1: The service receive end (opposite end) terminates the HPOH, the section-level or higher order alarm exists.
- Cause 2: The receive end (opposite end) is configured with lower order services, and the HP_SLM, HP_TIM, HP_LOM alarms are reported.
- Cause 3: The service receive end (opposite end) terminates the HPOH, and the alarms that insert the AIS signal exist.

5.5. IN_PWR_LOW

Description

The IN_PWR_LOW is an alarm indicating that the input optical power is very low. This alarm occurs when a board detects that the actual input optical power is lower than the lower threshold of the input power reference value.

Attribute

Alarm Severity	Alarm Type
Critical	Equipment alarm

Possible Causes

The possible causes of the IN_PWR_LOW alarm are as follows:

- Cause 1: The threshold of the optical power is not set properly.
- Cause 2: The fiber connector is loose or dirty.
- Cause 3: The transmit power of the opposite station is very low.
- Cause 4: The model of the selected optical module is incorrect.

5.6. Conclusion

This paper has taken a detailed look at the transmission system of ICX in VOICETEL LTD. ICX is not a worldwide organization, it's having only Bangladesh and Pakistan. ICX is used only to increase the security of telecommunication system and will permitted/licensed by the government.

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