Summer Internship/Training Report

Telecommunication Services

A report submitted in requirement for the Industry Internship/Training Program offered by Bharat Sanchar Nigam Limited (BSNL).

Submitted

By

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Introduction And Overview On BSNL

Bharat Sanchar Nigam Limited (BSNL) is a leading public sector telecommunication company in India, established on 1st October 2000 headquartered at New Delhi, to provide comprehensive communication services across the nation. As a government-owned entity BSNL plays a vital role in bridging the digital divide, particularly in rural and remote areas, by offering affordable and reliable telecom solutions. In addition to its telecom services, BSNL also provides a range of value-added services, including SMS, MMS and mobile banking services. The company provides a wide range of services, including landline, mobile, broadband, fiber-to-the-home (FTTH), and enterprise solutions, catering to individual and corporate customers. Known for its extensive network infrastructure, BSNL continues to enhance connectivity and contribute to India"s digital transformation through initiatives such as Bharat Net and 5G integration. Despite facing intense competition in the telecom sector, BSNL remains committed to innovation, striving to maintain its position as a key player in the Indian telecommunications industry.

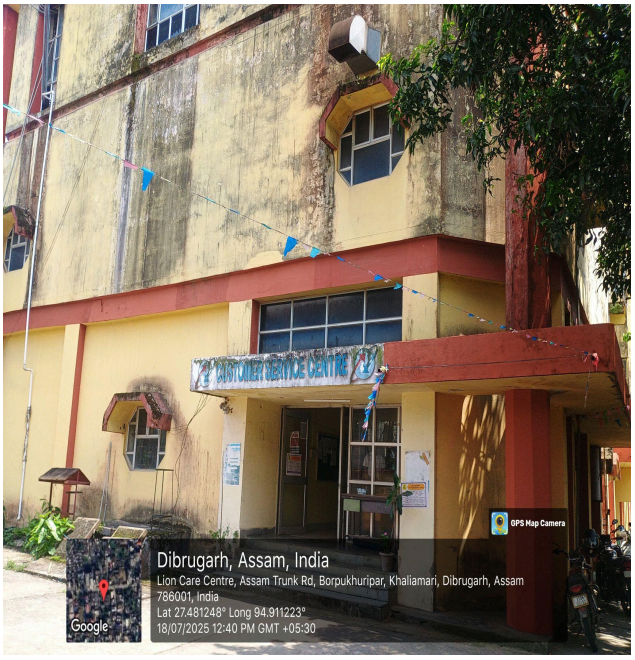
In the 1980s, the Post and Telegraph Department, which were merged initially, got bifurcated leading to the creation of the Department of Telecom (DoT) which eventually led to the foundation of BSNL in the early 2000s.This marks 25 glorious years of BSNL as a thriving “Miniratna” Central Public Sector Undertaking Enterprise.

Overall, BSNL is a major player in India"s telecom sector, providing a wide range of telecom services to its customers. With its strong brand presence, large customer base, and commitment to innovation and customer service, BSNL is well-positioned to continue playing a vital role in India"s telecom sector for years to come.

BSNL has a significant presence in India and is extensively known for :-

- **Largest Telecom Service Provider in India**
- **Wide Network Reach**
- **Affordable Services**
- **Government Public Sector Ownership**
- **25 years of trust among Costumers**

GMTD Office,Graham Bazaar,Dibrugarh



Khaliamari Telecom Exchange,Dibrugarh

Evolution Of Telecom

Telecommunications refers to the exchange of information over distances through electronic means. From ancient smoke signals to 5G and fiber optics, telecommunications has dramatically evolved, reshaping economies, societies, and global connectivity.

->Ancient Communication Methods(Before 19th Century)

- **Smoke Signals**: Used by Native Americans and Chinese armies for long-distance signaling.
- **Drums and Horns**: Employed in Africa and Europe to send coded messages across distances.
- **Semaphore Towers**: Introduced in the 18th century (e.g., Claude Chappe's system in France) using visual signals from tower to tower.

->Telegraphy and the Birth of Modern Telecom (1830s–1870s)

Electric Telegraph (1837)

- **Inventors**: Samuel Morse and Alfred Vail.
- **Morse Code**: Encoded messages as short and long signals (dots and dashes).

Undersea Cables

- First transatlantic telegraph cable completed in 1858.
- Enabled intercontinental communication.

->Telephony and Wireless Communication (1870s–1920s)

Invention of Telephone (1876)

- **Inventor**: Alexander Graham Bell
- Voice transmission over wires.

- Rapid adoption due to personal and business utility.

Radio Waves and Wireless Telegraphy

- **Heinrich Hertz** proved the existence of electromagnetic waves (1887).
- **Guglielmo Marconi** developed the first practical wireless telegraph (1895).
- First transatlantic radio signal: 1901.

->The Age of Broadcast and Early Networks (1920s–1950s)

Radio Broadcasting

- Began in the 1920s (e.g., KDKA in Pittsburgh, USA).
- AM and FM technologies emerged.

Television

- Experimental broadcasts in 1920s-30s.
- Mass adoption post-WWII.
- First color broadcasts: 1954 (USA).

Long-Distance Telephony

- Manual copper switchboards evolved into automated exchanges.
- Microwave transmission and coaxial cables extended network reach.

-> The Digital and Satellite Era (1960s–1990s)

Digital Switching and Signaling

- Replaced analog systems.
- Enhanced reliability and allowed integration with computers.

Satellites

- **Telstar 1 (1962)**: First active communications satellite.
- Enabled real-time international TV and phone calls.

Mobile Telephony

- First generation (1G) analog mobile phones in late 1970s/early 1980s.
- Large, expensive, and limited in coverage.

The Internet

- ARPANET (1969) as precursor to the Internet.
- TCP/IP protocols adopted in 1983.

->Internet and Mobile Revolution (1990s–2010s)

Second Generation (2G) Mobile

- Introduced digital encryption of conversations.
- SMS (text messaging) and GSM standardization.

3G and 4G Networks

- Enabled mobile internet, video calling, and streaming.
- Smartphones emerged (e.g., iPhone in 2007).

Fiber Optics

- Massive data capacity and high-speed transmission.

- Backbone of modern telecom infrastructure.

->5G and the Future of Telecom (2020s–Present)

5G Networks

- Launched globally from 2019 onwards.
- Speeds >1 Gbps, ultra-low latency (~1 ms).
- Enables applications like:
    - Smart cities
    - Autonomous vehicles
    - Massive IoT deployments

Satellite Internet

- Starlink (SpaceX), Kuiper (Amazon): Low Earth Orbit (LEO) satellites for global broadband coverage.

6G (Emerging)

- Research ongoing; expected by 2030.
- Focus on holographic communication, AI-native networks, and sub-millisecond latency.

Overview Of Material Management

Material Management in BSNL encompasses the strategies, planning, procurement, storage and utilization of materials and equipment essential for its telecommunications operations. This involves a multi-faceted approach that aims to ensure the availability of necessary resources while optimizing costs and maintaining operational efficiency.

The process of Material Management is given as follows-

1. **Planning:** Forecasting demand, identifying material requirements and developing procurement strategies.

2. **Sourcing:** Identifying and selecting suitable suppliers.

3. **Purchasing:** Negotiating contracts, placing orders and receiving material.

4. **Inventory Control:** Tracking inventory levels, managing stocks and preventing stockouts.

5. **Warehousing and Storage:** Storing materials safely and efficiently.

6. **Transportation and Logistics:** Moving materials between different locations.

7. **Material Handling:** Handling and moving materials within the warehouse/factory.

8.**Scraping:** Material scraping occur in the same manner as the material purchasing.

The primary items or materials required by BSNL for the telecom operations are:-

1.Telecom tower materials (poles, towers, cross arms, etc.),

2. Fiber optic cables ,

3. Switches,multiplexers,modulators, routers, and other networking equipment ,

4. Spare parts and consumables.

GSM Technology Overview

GSM:

GSM (Global System for Mobile Communication) is a digital mobile telephony system that is widely used around the world. It is a 2nd Generation (2G) wireless technology that provides voice and data services over mobile networks.

->Evolution of GSM Technology:

Evolution from 1st Generation to 2nd Generation primarily took stage on the fundamental change of switching technology.

There are two types of switching in GSM Technology:

1. Circuit Switching
2. Packet Switching

Circuit Switching: It has a direct, physical or virtual connection between the caller and recipient. The caller has exclusive use of the bandwidth allocated to the circuit that ensures consistent quality of service. It is mainly used in voice calls, SMS etc.

Packet Switching: The data is divided into smaller units called PACKETS that is it transmits data in smaller units. It is more efficient for intermittent data. It is mainly used in data services, multimedia etc.

Here's the various stages of evolution of Global System for Mobile Communication (GSM),which is shown in the table given below:

GSM : Global System for Mobile Communication

GPRS : General Packet Radio Service

EDGE : Enhance Datarate for GSM Evolution

UMTS : Universal Mobile Telecommunication Service

HSDPA/HSUPA : High Speed Downlink/Uplink Packet Access

LTE : Long Term Evolution

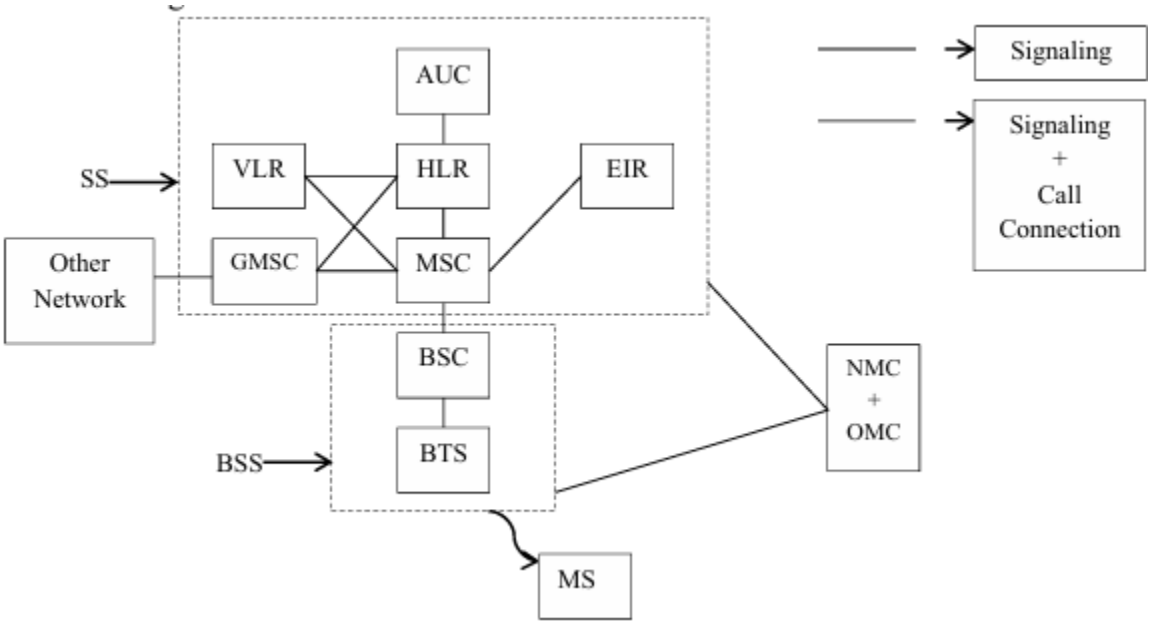
NR : New Radio

Generation	Category	Year	Data Speed	Frequency	Cellular Network Technology
1G	Analog	1979	-	800 MHz	-
2G	Digital	1980	9 kbps	900 MHz	GSM
2.5G	Digital	Mid 90s	171 kbps	935 MHz	GPRS
2.75G	Digital	1996	384 kbps	1710 MHz	EDGE
3G	Digital	2000	2 mbps	2100 MHz	UMTS
3.5G	Digital	2006	14 mbps	3300 MHz	HSDPA/HSUPA
3.75G	Digital	2008	21 mbps	3750 MHz	H^+
4G	Digital	2010	• Calls- 50 mbps • LTE Advanced- 50-100 mbps	600MHz-2.6GHz	LTE
5G	Digital	2020	1 Gbps	600MHz-3.5GHz	NR

->GSM Architecture:

The GSM Architecture is a complex but efficient system that has been able to support the rapid growth of mobile telephony around the world. It is also a flexible system that can be adapted to support new services and technologies.

The GSM architecture can be briefly described using the following block diagram representation-



1. Switching Subsystem (SS): The Switching Subsystem, SS is a crucial component of the GSM Architecture. It is responsible for managing and switching calls within the GSM network, ensuring seamless communication between mobile devices.

2. Base Station Subsystem (BSS): The Base Station Subsystem, BSS is a critical component of the GSM Architecture. It is responsible for managing the radio interface, ensuring that mobile devices within its coverage area can connect to the network efficiently.

3. Mobile Switching Centre (MSC): The Mobile Switching Centre, MSC is the heart of the GSM Network. It's the central point of control and management for mobile calls, ensuring that calls are routed to their intended destinations and handling various functions related to call setup, switching, and management.

4. Authentication Centre (AUC): The Authentication Centre, AUC is a vital security component. It's primary role is to enhance the security of mobile communications by authenticating mobile devices and preventing the use of stolen or cloned devices.

5. Home Location Register (HLR): The Home Location Register, HLR is a crucial component of the GSM Architecture. It serves as a central database that stores

essential subscriber information and network-related data for each mobile subscriber.

6. Visitor Location Register (VLR): The Visitor Location Register, VLR is a crucial component of the GSM Architecture. It's a dynamic database that stores temporary information about mobile subscribers who are currently roaming within the coverage area of a specific MSC.

7. Equipment Identity Register (EIR): The Equipment Identity Register, EIR is a crucial security component within the GSM Network. It plays a significant role in combating mobile phone theft and unauthorized usage.

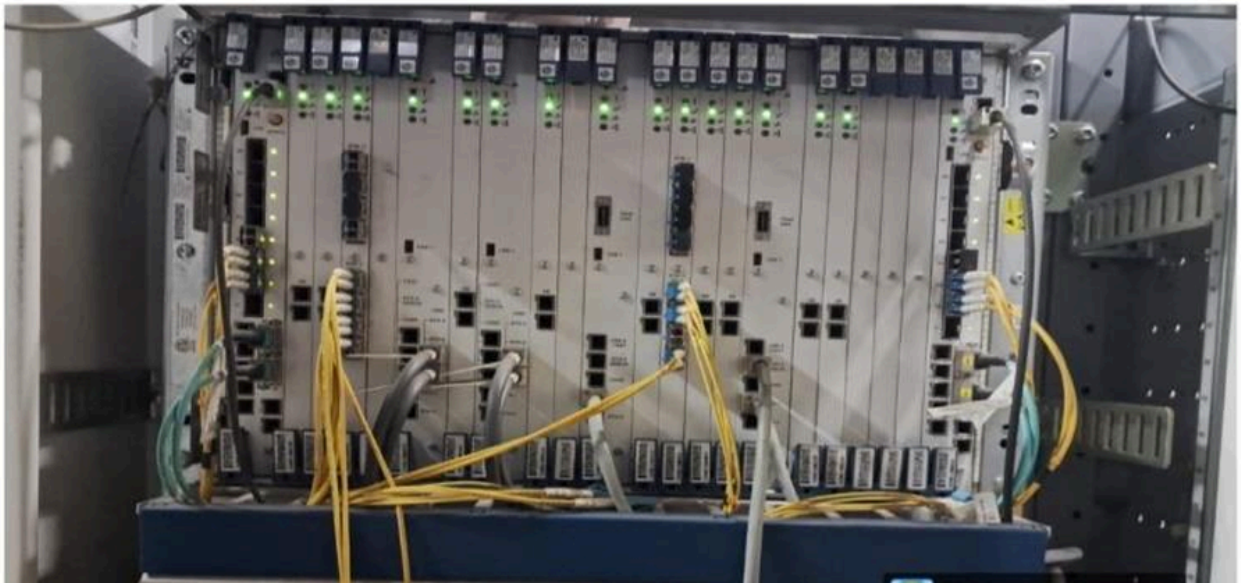
8. Base Station Controller (BSC): The Base Station Controller, BSC is a crucial component of the GSM Architecture. It acts as the "BRAIN" for a group of Base Transceiver Station (BTS), managing their operations and ensuring efficient communication with mobile devices.

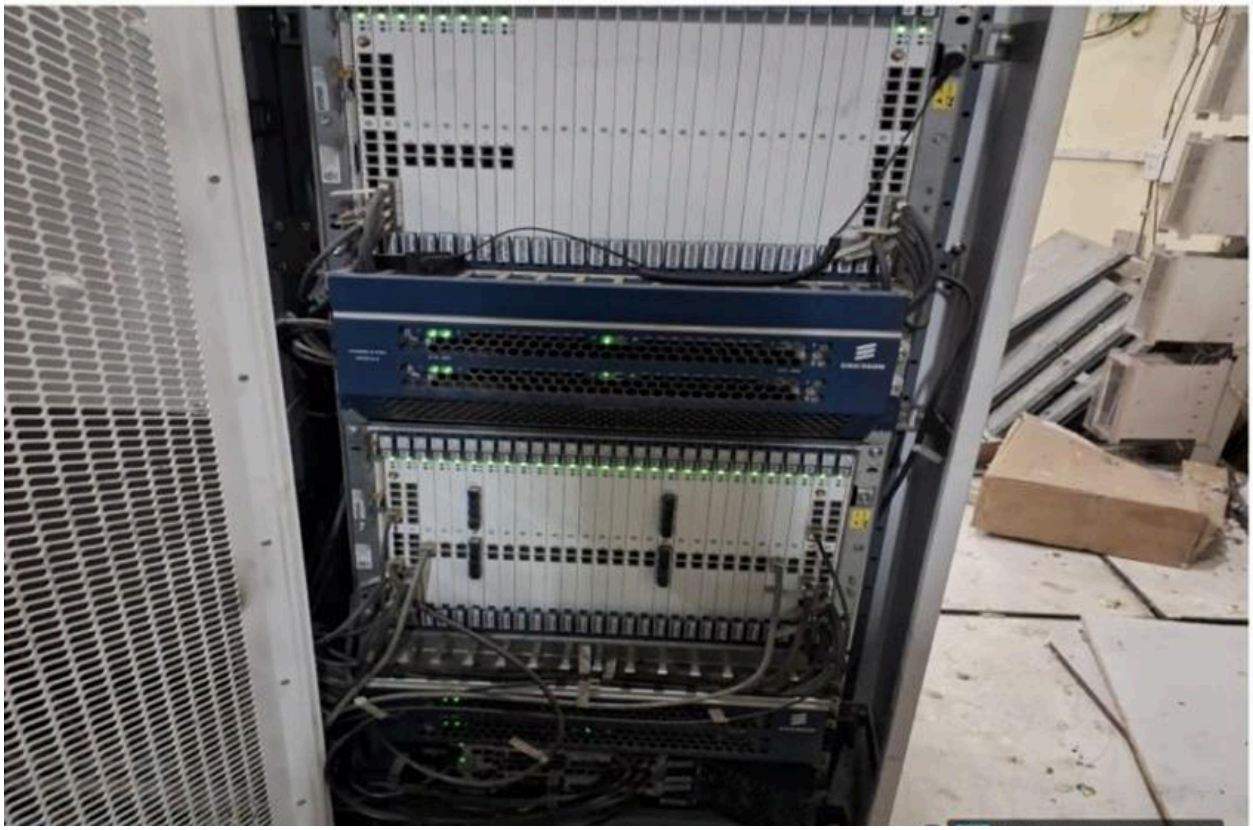
9. Base Transceiver Station (BTS): The Base Transceiver Station, BTS is the physical unit that enables communication between mobile devices and the core GSM network.

10. Mobile Station (MS): In the GSM Architecture, the Mobile Station, MS refers to the mobile device used by subscribers to access the network.

11. Network Maintenance Centre (NMC) / Operation Maintenance Centre (OMC): The Network Maintenance Centre, NMC also known as the Operations and Maintenance Centre, OMC is a crucial element within the GSM network architecture.

12. Gateway Mobile Switching Centre (GMSC): The Gateway Mobile Switching Centre, GMSC is a specialized type of Mobile Switching Centre (MSC) in the GSM network. It plays a crucial role in enabling communication between the GSM network and other external networks.





BSC(Base Station Controller) & MSC(Mobile Switching Centre)

Transmission Overview

And Practical

In communication, transmission refers to the act of sending a message or signal from one point to another. Its the physical movement of information.

The types of transmission are as follows:

Simplex Half-Duplex Full-Duplex

1. Simplex: Direction- Unidirectional (one-way) Data Flow- Data can only travel in one direction Example- Television Broadcasting The TV Station sends signals to viewers, but viewers cannot send data back to the station.

2. Half-Duplex: Direction- Bidirectional (two-way) but alternating Data Flow- Data can travel in both directions, but only one direction at a time Example- Walkie-Talkie Only one person can transmit at a time, the other must wait for their turn

3. Full-Duplex: Direction- Bidirectional (two-way) and simultaneous Data Flow- Data can travel in both directions at the same time Example- Telephone Conversations Both parties can speak and listen simultaneously

->Transmission certainly depends upon the medium.Earlier Copper wires were used to transmit data electrically.However this method saw high losses both economically and data wise.

With advent of time and advancement in technology,optical fibres came to field which could transmit data way faster than copper cables and further did not inccur the economic and data losses.

->Transmission Lines:

Transmission Lines are essential components that facilitate the efficient transfer of electromagnetic signals over varying distances. These specialized structures are designed

to minimize signal loss and distortion, ensuring the integrity of the information being transmitted.

There are two types of transmission line-

1. Plesiochronous Digital Hierarchy

2. Synchronous Digital Hierarchy

1. Plesiochronous Digital Hierarchy (PDH): It is a popular technology that is widely used in the networks of telecommunication in order to transport the huge amounts of data over the digital equipment for transportation like microwave radio of fiber optic systems. The characteristics of PDH are as follows:

- Plesiochronous Operation: PDH devices operate with “almost” synchronized timing, allowing for slight variations in clock frequencies between different parts of the network. This flexibility makes it easier to integrate devices from different manufacturers.
- Multiplexing: PDH uses Time-Division Multiplexing (TDM) to combine multiple lower-speed data streams into a single higher-speed signal. This allows for efficient use of transmission capacity.
- Hierarchical Structure: PDH defines a hierarchy of data rates, with each level multiplexing lower-level signals into a higher-level signal.

  Common Levels include: E1 (2mbps)

  E2 (8mbps)

  E3 (34mbps)

  E4 (139.264mbps)

2. Synchronous Digital Hierarchy (SDH): It is a standard technology for synchronous data transmission on optical media.

The characteristics of SDH are as follows:

- Synchronous Operation: All SDH equipment operates with a common clock signal, ensuring precise timing and synchronization across the network.
- High Speed: SDH supports a wide range of data rates, from 155 Mbps to 10 Gbps and beyond, making it suitable for high-bandwidth applications.This uses Synchronous Multiplexers for operation.
- Hierarchical Structure: SDH uses a hierarchical structure to multiplex multiple lower-speed signals into a single higher-speed signal, optimizing bandwidth utilization.

***Synchronous MUX:-**

Synchronous MUX or Synchronous Time Division Multiplexing (STDM) is a technique used to combine multiple digital data streams into a single channel for transmission. There are two types of Synchronous MUX :-

Terminal Multiplexer (TM) Add drop Multiplexer (ADM)

1. Terminal Multiplexer: A Terminal multiplexer is a software application that allows you to manage multiple terminal sessions within a single window or terminal.

TM accepts a number of tributary signals and multiplexes them to appropriate optical/electrical aggregate signal via STM1, STM4, STM16 etc.

2.Add-Drop Multiplexer (ADM): Add-Drop Multiplexer (ADM) is a key component in optical fiber communication 21 systems, particularly those employing Wavelength-Division Multiplexing (WDM). It allows for the selective addition and removal of specific optical wavelengths (channels) from a multi-wavelength signal traveling along a single fiber.

Synchronous Transfer Mode (STM):

Synchronous Transfer Mode (STM), is a high-speed digital transmission standard used in telecommunications networks. It's a crucial component of the Synchronous Digital Hierarchy (SDH) protocol, primarily designed for transmitting voice, data, and video signals over fiber optic cables.

->STM-1 was independently developed from E-lines of PDH inculcating Synchronous Transmission Techniques.

Further 4 STM-1s were multiplexed together to create STM-4 and 4 STM-4s were multiplexed together to create STM-16, further STM-64s were developed and so on.

- We know that in modern day communication systems,we primarily use **Digital Signals** for Transmission.But how to convert analog singals into digital signals?

->**Pulse Code Modulation (PCM)**, is a method for converting analog signals (like sound or video) into digital signals. It involves sampling the analog signal at regular intervals, quantizing the amplitude of each sample, and then encoding each quantized sample as a binary code.

The process of conversion of PCM is given below:

1. Sampling: The continuous analog signal is measured at regular intervals (sampling rate). This creates a series of discrete amplitude values.

2. Quantization: Each sampled value is rounded off to the nearest value within a predefined set of levels. The number of levels determines the quantization resolution.

3. Encoding: Each quantized value is assigned a unique binary code (a sequence of 0s and 1s). The number of bits per sample determines the dynamic range and signal-to-noise ratio.

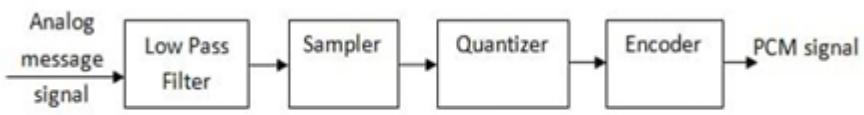


Fig: PCM Transmitter

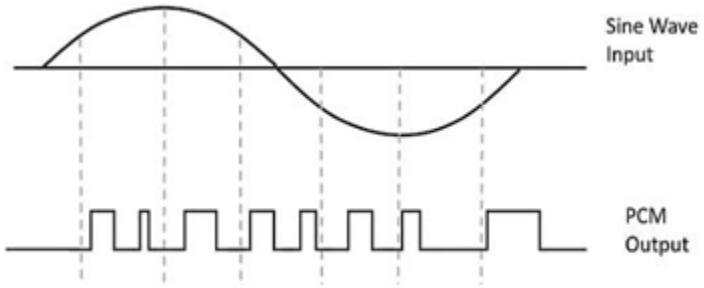


Fig: PCM Output

Modern Transmission Systems use optical fibres for transmission.The following operations are done while dealing with optical fibres:-

->Splicing Machine:

A splicing machine, also known as a fusion splicer, is a specialized tool used to join two optical fibers end-to-end. This is essential for creating long-distance optical fiber networks used in telecommunications and internet infrastructure. The process involves precisely aligning the two fiber ends and then fusing them together using an electric arc. The result is a continuous optical path with minimal signal loss.

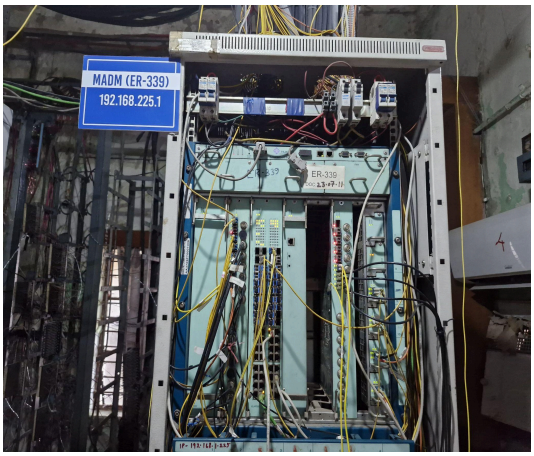
Optical Fibre Diamond Cutter

Splicing Machine

->Optical Time Domain Reflectometer (OTDR):

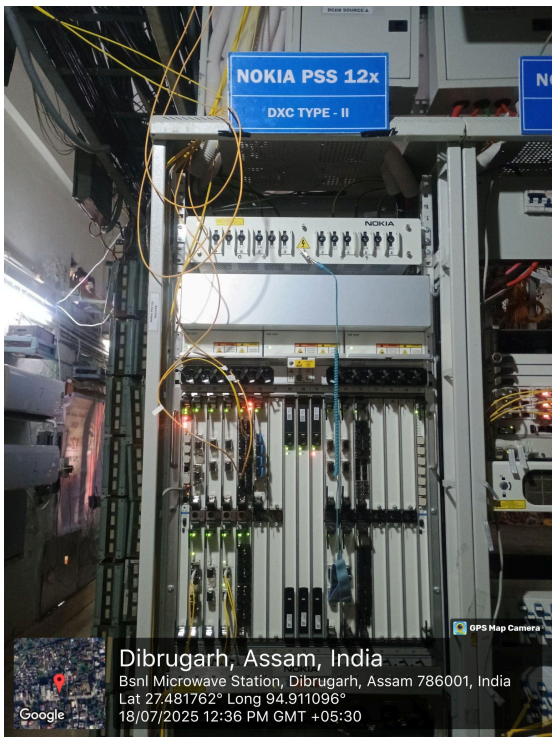
An Optical Time Domain Reflectometer (OTDR), is a sophisticated testing instrument used to evaluate the integrity and performance of fiber optic cables. It functions by sending pulses of light down the fiber and analyzing the light that is reflected or scattered back. This information helps technicians identify issues like breaks, bends, or excessive signal loss within the fiber optic network.

- Some Transmission Equipments discussed aboved are shown here-



MADM(Multi Attribute Decision Maker with Control Card)

DWDM(Dense Wavelength Division Multiplexing)



New 100G Super Fast Router & Transmitter (For Long Distance Transmittance)

+MSTP

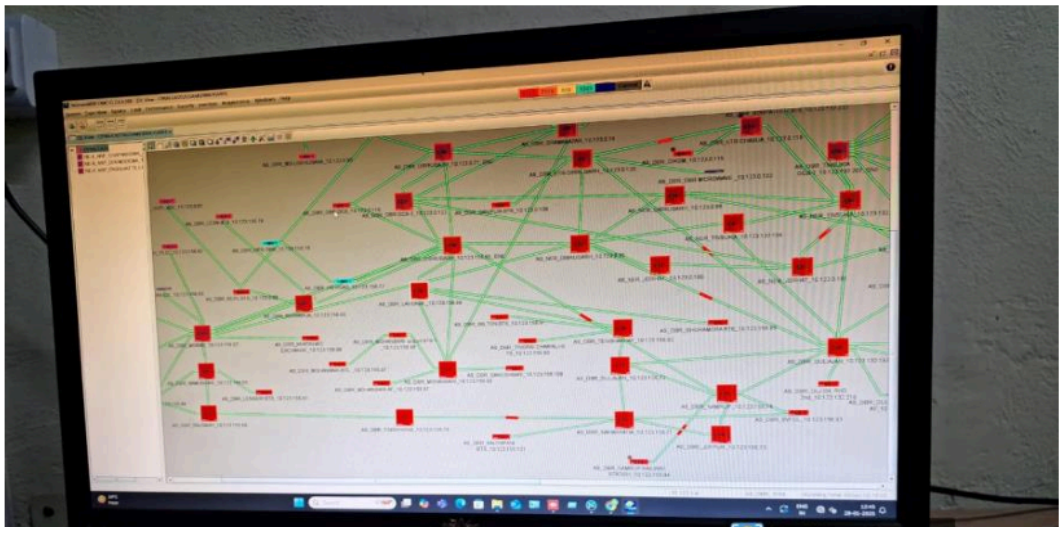
->Converged Packet Access Network (CPAN): A Converged Packet Access Network (CPAN) is a telecommunications network architecture that integrates various types of network traffic, such as voice, video, and data, onto a single platform using packet switching technology within the access network.

Converged: This means that different types of communication services (voice, video, data) are all carried over the same network infrastructure.

Packet: CPAN uses packet switching, a method of breaking down data into small units (packets) for efficient transmission across the network. This is the same technology that powers the internet.

Access Network: The access network is the portion of the telecommunications network that connects end-users (homes, businesses) to the core network. CPAN specifically focuses on this part of the network.

In essence, CPAN is a way to streamline and simplify how we receive our communication services. Instead of having separate networks for phone lines, cable TV, and internet, CPAN brings them all together onto one unified network. This leads to greater efficiency, cost savings, and flexibility for both service providers and consumers.



CPAN Network Software

Drive Test And Analysis

A drive test is a systematic process of assessing the performance of a wireless network while moving through a specific geographical area. It is done using software aided tools and includes physical involvement of an expert who moves in a specified area with a device within which the suitable software tool is installed.The tool further access the test cases and shows the required results of the several parameters which helps to determine the overall quality of the network within that particular geographical area.

The data that are collected in a drive test are as follows:

1. **Signal Strength**: Measures the intensity of the radio signal received from the base station.

2. **Signal Quality**: Evaluates the quality of the received signal, often measured by parameters like RSRP (Reference Signal Received Power) and RSRQ (Reference Signal Received Quality).

3. **Data Throughput**: Measures the speed of data transfer, typically in Mbps.

4. **Latency**: Measures the delay in data transmission, typically in milliseconds.

5**. Call Setup Success Rate**: The percentage of successful call attempts that connect to the network. The call setup success rate must be greater than 95%, i.e., the ratio of no. of successful call attempts to the total no. of calls attempted must be > 0.95 .

6. **Call Drop Rate**: The percentage of calls that are unexpectedly terminated before their intended end. The call drop rate must be less than 2%, i.e., the ratio of no. of failed call attempts to the total no. of calls attempted must be < 0.2 .

7. **Handover Success Rate**: The percentage of successful transitions between cells or sectors as the device moves. The handover success rate must be greater than 95%, i.e. ,the ratio of no. of successful hand over transition attempts to the no. of transition attempts must be > 0.95 .Thus,HOSR > 95% .

->In order to understand the concept of Handover we need to understand the concept of networking layout.

A cellular network also known as mobile network, is a wireless communication system that uses a network of base stations(cell sites) to provide connectivity to mobile devices over a geographic area.These networks enable mobile communication,both voice and data,by dividing the area into smaller hexagonal regions called “cells”,each served by a base station.

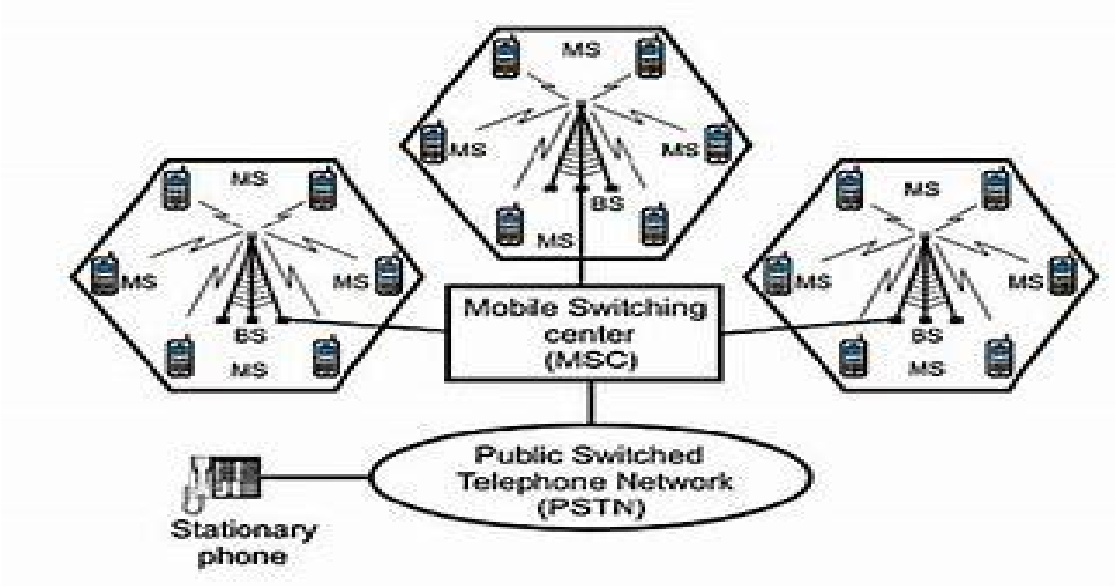
Components:-

1.Hexagonal Cells

2.Base Stations(Cell Sites)(BTS)

3.Mobile Switching Center(MSC)

4.Radio Frequency(RF)



Handover:-

Handover refers to the seamless transfer of a mobile connection from one network resource to another without interrupting an ongoing voice or data call. So when a mobile is in motion and switches from one cell to another cell,the connectivity of that handset is also switched from the previous cell’s antenna to the new cell’s antenna and Base Station(BTS).

Overview Of Infra Equipments (Power Plant/Battery UPS)

A **Power Plant/Battery UPS**, also known as a power station, is an industrial facility that generates electricity for distribution to the general public or to a specific customer or group of customers. Power plants employ diesel generators that convert mechanical energy into electrical energy.

This type of power plant setup is common in critical applications where uninterrupted power is essential. It combines various components to ensure a reliable and continuous power supply.

Construction of the Power Plant:
1. Alternating Current (AC): It is the primary source of power, typically from the utility grid. It provides power to the rectifier and other equipment during normal operation.

2. Rectifier: It converts AC power from the mains into DC power. It charges the battery bank. It may also provide DC power directly to some loads.

3. Battery Bank: It stores electrical energy in chemical form. It provides backup power during AC main failures or when the load demand exceeds the rectifier's capacity.

4. Diesel Generator (DG): A backup power source that starts automatically when the AC main fails. It provides AC power to the rectifier, which then charges the batteries and supplies DC power to the loads.

->Working of the Power Plant:
There are three cases for the working of the Power Plant:

1. Normal Operation
2. AC Main Failure
3. Additional Components

1. Normal Operation: AC mains power is available. The rectifier converts AC to DC and charges the battery bank. Loads are powered directly from the rectifier's DC output.

2. AC Main Failure: The DG automatically starts and provides AC power to the rectifier. The rectifier continues to charge the batteries and supply DC power to the loads.

3. Additional Components:

- Automatic Transfer Switch (ATS): Automatically transfers the load from the AC mains to the DG in case of a power outage.

- Charge Controller: Regulates the charging current to the battery bank, preventing overcharging.

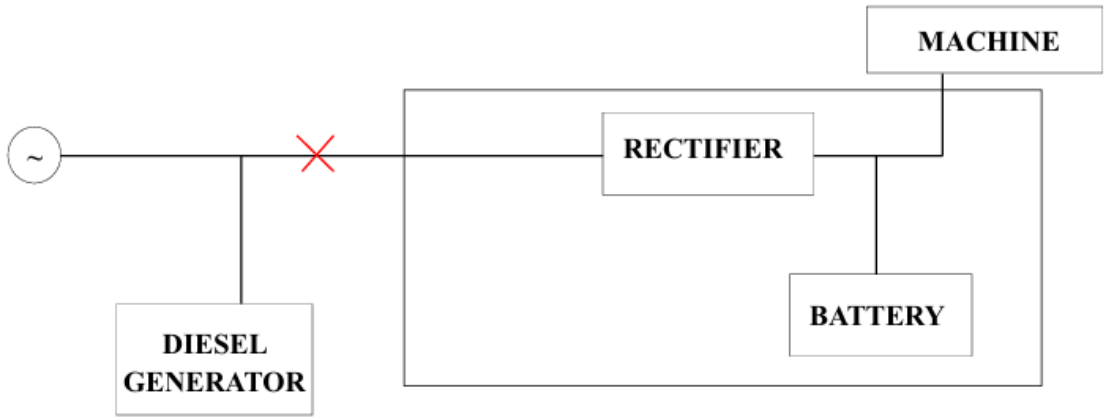


Fig: Block Diagram of Power Plant

The Red-Cross here shows the Automatic Transfer Switch (ATS).

In Communication System all the equiments are operated with a power supply of DC - 48 Volts.Normal 3-Phase Power Supply from APDCL is provided to the Machine which rectifies the AC into DC signal and also stabilizes the voltage at -48 Volts.

Why -48 Volts?

Firstly, negative voltage is provided in order to protect the system from the Lightning Strikes which usually have negative voltages in it and to ground the system efficiently as there are a lot of negative ions/charges in the atmosphere.

Secondly, 36 Volts is considered to be a safe voltage and it is unsafe to exceed too much as it may corrode and damage the wires and tranmission equipments.However, higher the voltage better the transmission efficiency. Thus 48 Volts is choosen as a standard balance between both these parameters such that we get efficient transmission as well as there is no damage done to the equipments.

->Power Plant Components:-

Power Supply + Rectifier+ Battery set

Diesel Generator

LTE Technology:
Evolution Of Mobile Broadband

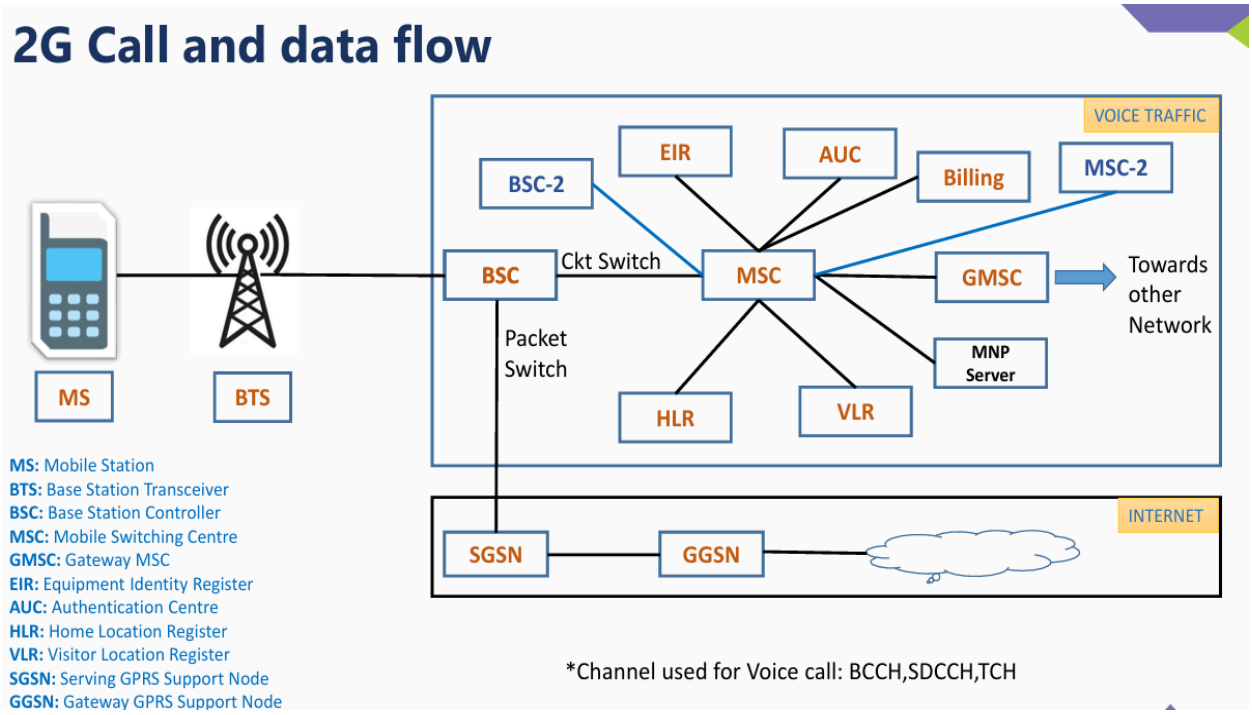
Mobile Broadband is a marketing term used for wireless access via mobile (cell) networks. Access to a network can be made through a portable modem,wireless modem or a smartphone/tablet.Some mobile services allow more than one device to be connected to the Internet using a single cellular connection using a process called “Tethering”.

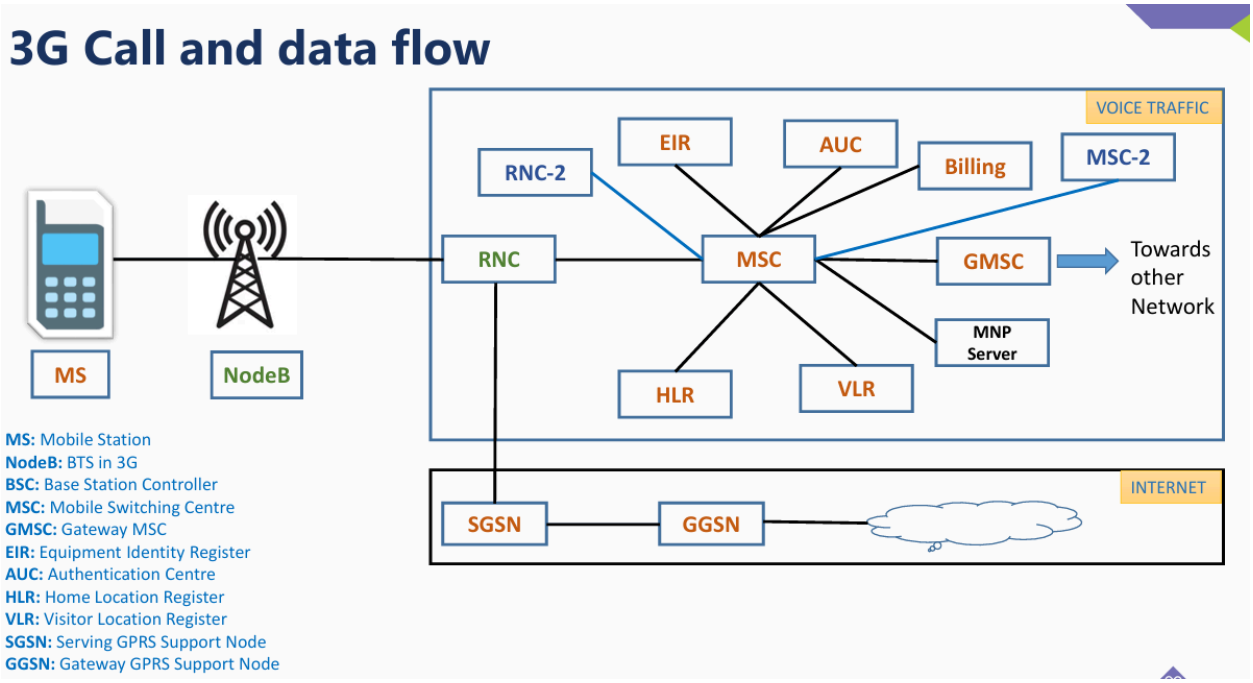
The first wireless Internet access became available in 1991 as part of second generation (2G) of mobile phone technology.Higher speeds became available in 2001 and 2006 as a part of the third generarion (3G) and fourth generation (4G) respectively.

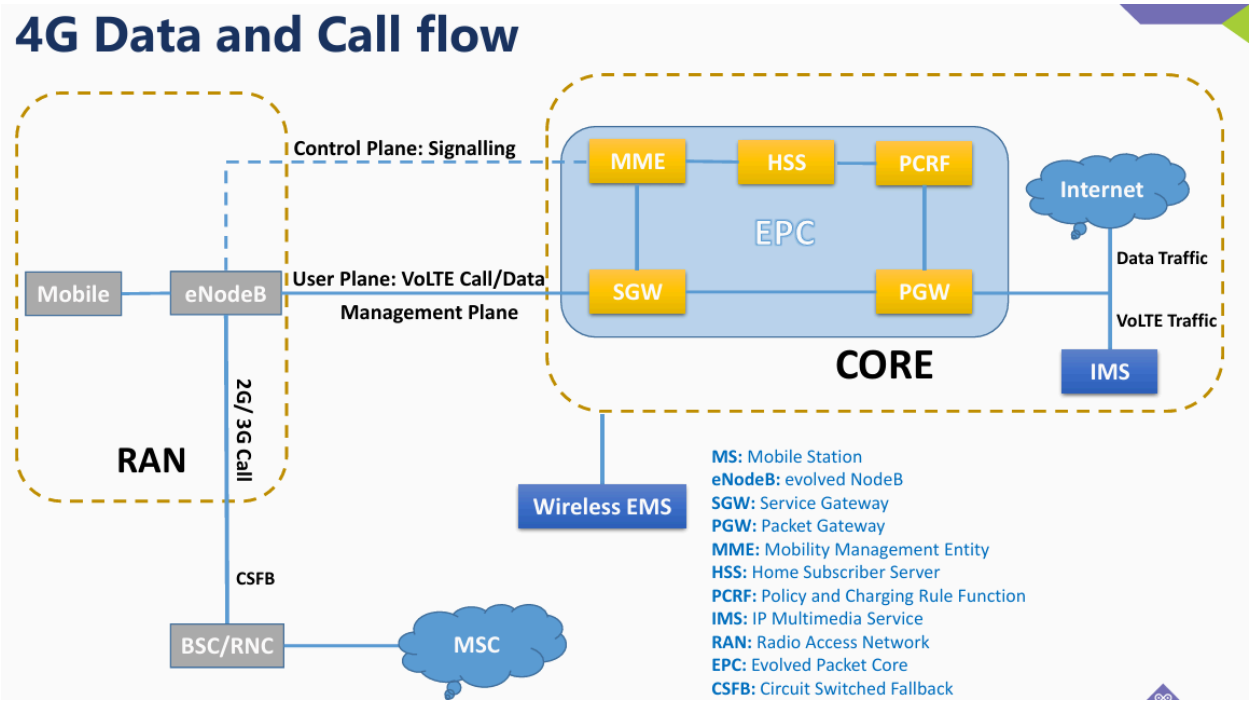
This evolution over time took place at various stages from **2G to 2.5G to 2.75G to 3G to again 3.5G to 3.75G to 4G** over a course of 20-25 years,as we have seen earlier in GSM technology too.

Thus,this technology was also named as **Lte (Long Term Evolution)**. Now,Lte has become an important part of Mobile Broadband which enables the users to access high speed Internet via a wireless medium.With time,even further advancements are continously being made with technologies like VoLte (Voice over Lte),which made voice transfer via Lte/Internet path more feasibe.

->Let us have a look how the evolutions from 2G to 3G to 4G were made!







Key Points:-

- Thus we can observe how the conventional BTS and BSC were replaced by NodeB and RNC completely,which provided the gateway for faster data exchange and thus faster internet access.

- Further the number of equipmnets also got reduced which not only made the architecture simplified but also reduced the **Latency** or delay and enabled Volte calls, Live Video streaming and other such services.

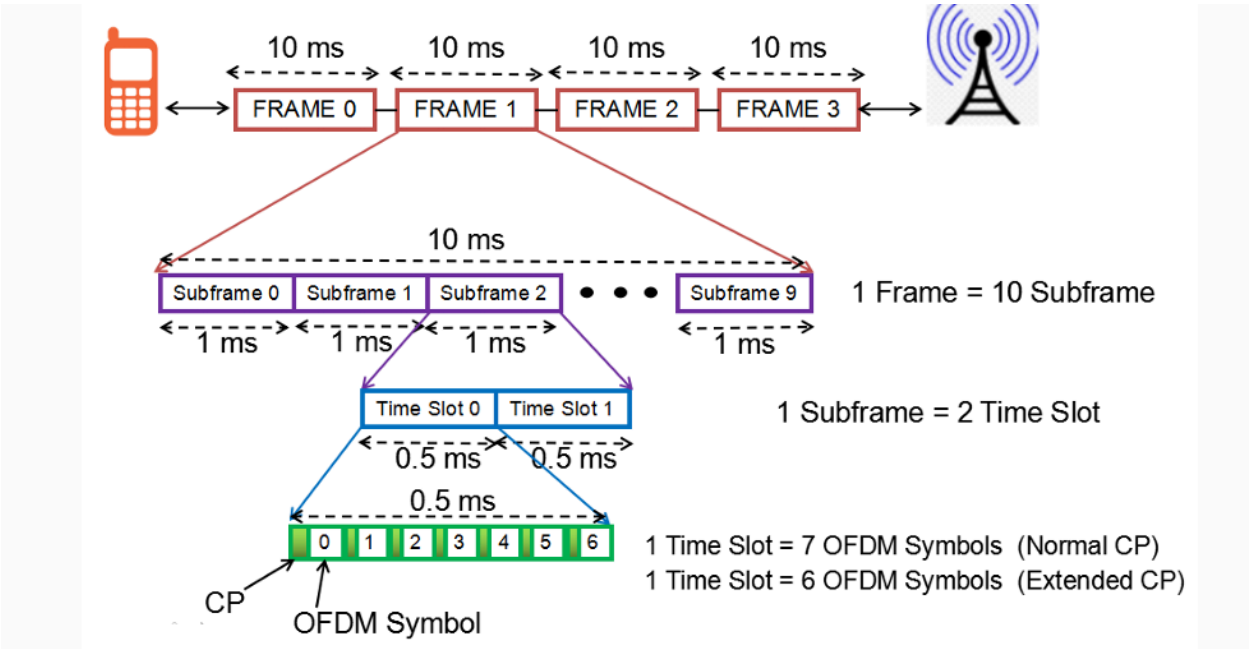
- Further the NodeB got enhanced to the eNodeB (evolved NodeB), which allowed even faster data transfer using Optical Fibres and Ethernet Cables.

Advantages of LTE:-

1.Increased Data Rates
2.Improved Mobility
3.Supports Both TDD and FDD Communication
4.Simplified Architecture
5.Packet Switched Radio Interface

LTE Frame:-

LTE uses OFDM technology to divide a wider BW into narrow band orthogonal sub-carriers (15 KHz) to decrease transfer delay.



->The eNodeB consists of -

➢ **<u>BBU (Base Band Unit)</u>**

The various components of the BBU are:-

- RAC (Radio Access Card)
- CEF Card (Carrier Ethernet Forwarding)

- WPS (Wi-fi Protected Setup)
- FTU (Fan Tray Unit)

➢ **RRH (Remote Radio Head)**

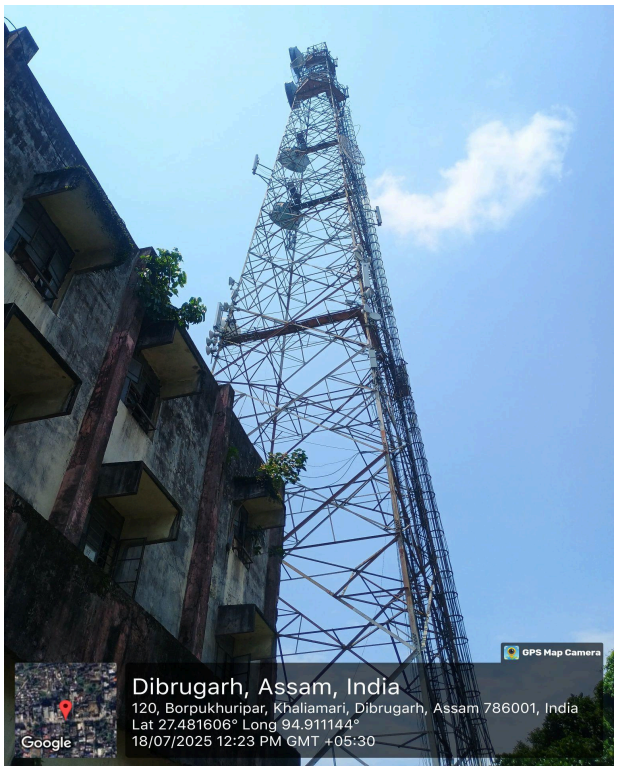
Different configuration variations of the RRH are:-

- **CategoryA-** 2T2R FDD 700 MHz
- **CategoryB-** 2T2R FDD 700 MHz & 2T2R FDD 2100 MHz/850 MHz/1800 MHz
- **CategoryC-** 2T2R FDD 700 MHz & 4T4R TDD 2500MHz
- **CategoryD-** 2T2R FDD 700MHz+2100MHz/1800MHz/850MHz & 4T4R TDD 2500MHz

➢ **ODC (Outdoor Cabinet)**

- The various components of the ODC are:-

- FTU-Alarm Unit
- Smoke Detector
- Ambient Temperature Sensor
- DCDB (Direct Current Distribution Board) (From Main Power Supply)
- Grounding or Earthing sub-system



TOWER **ODC(Base Band Unit + Remote Radio Head)**

Overview Of FTTH

The broadband internet connection technology that uses optic fibre cables (OFC) to transmit data is known as Fibre Technology.

FTTH: Fibre To The Home

->The configuration of the FTTH service looks like-

ONT -> SPLITTER -> OLT -> OCLAN -> BNG -> ROUTERS

This configuration/architechture works on the principles of PON architecture.

Passive Optical Network (PON) Architecture:

A Passive Optical Network (PON) use optical fiber and optical power splitters to connect the Optical Line Terminal (OLT) at the local exchange (CO) to the Subscriber Optical Network Unit (ONU) on the premises.
Passive Splitters are located downstream from the CO and can split the fiber signal up to 32 or more times over a maximum distance of 10-20 km. This means that the bandwidth is split, or shared, between users as well. The architecture is called passive because all splitters and intermediate equipment located between the CO and the ONT is passive; that is, it has no active electronics and therefore does not need separate power.

->The main components of PON Architecture:

1. Optical Line Terminal (OLT): The OLT resides in the Central Office (CO). The OLT system provides aggregation and switching functionality between the core network and PON interfaces. The network interface of the OLT is typically connected to the IP network and backbone of the network operator.

2. Optical Network Unit (ONU)/Optical Network Termination (ONT): This provides access to the users, i.e. External Plant/Customer Premises equipment providing user interface for many single customers. The ONU/ONT provide, user interfaces (UNI) towards the customers and uplink interfaces to uplink local traffic towards OLT. The network termination of customer premises is termed as ONT whereas the network termination of cabinet, building etc is known as ONU.

3. PON Splitters: Distributed or single staged passive optical splitters provide connectivity between OLT and multiple ONU/ONTs through one or two optical fibers. Optical splitters are capable of providing up to 1:64 optical split on end to end basis.

4. Network Management System (NMS):

Management of complete PON system from OLT are as follows:

- One OLT serves multiple ONU/ONTs through PON.
- Single Fiber/Dual Fibre to be used for upstream and downstream.
- TDM/TDMA protocol between OLT and ONT.
- Maximum split ratio is 1:64.
- Downstream transmission, i.e. from OLT to ONU/ONT is usually TDM.
- Upstream traffic, i.e. from ONU/ONT to OLT is usually TDMA.
- Typical distance between OLT and ONT can be greater than 15 km.

The types of PON Technologies are as follows:

1. Gigabits Passive Optical Network (GPON)
2. Ethernet Passive Optical Network (EPON)
3. Broadband Passive Optical Network (BPON)

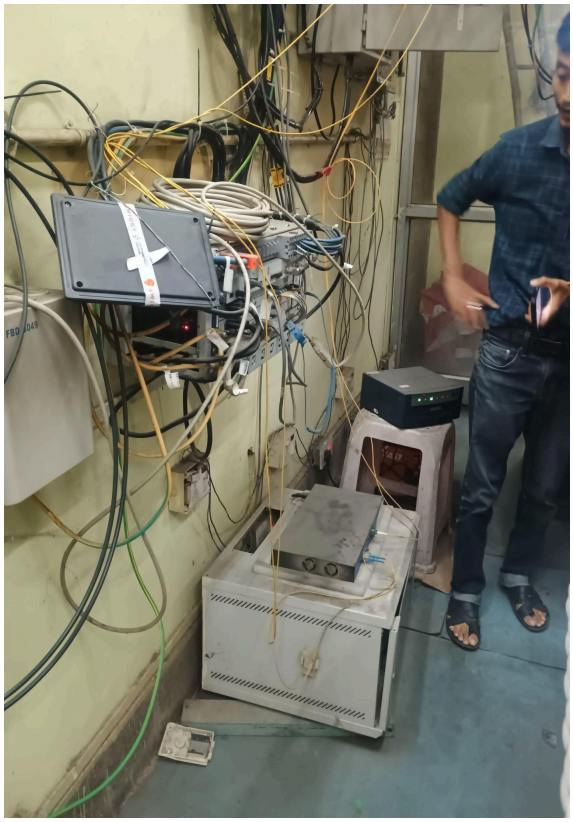
1. Gigabits Passive Optical Network (GPON): It is a high speed fiber optic network technology used to deliver broadband internet, voice and video services to homes and business.

2. Ethernet Passive Optical Network (EPON): It is a high speed fiber optic network technology that utilizes Ethernet frames for data transmission.

3. Broadband Passive Optical Network (BPON): It is a first generation fiber optic network technology used to deliver high speed internet access to homes and businesses.

Features	GPON	EPON	BPON
Responsible for Standard Body	FSAN & ITU-T SG15 (G-984 Series)	IEEE 802.3ah	FSAN & ITU-T SG15 (G-983 Series)
Bandwidth	• Downstream upto 2.5 Gbps • Upstream upto 2.5 Gbps	• Downstream upto 1.25 Gbps • Upstream upto 1.25 Gbps	• Downstream upto 622 Mbps • Upstream upto 155.52 Mbps
Downstream	1490 nm & 1550 nm	1490 nm	1490 nm & 1550 nm
Upstream	1310 nm	1310 nm	1310 nm

Layer-2 Protocols	ATM, Ethernet, TDM over GEM	Ethernet	ATM
Frame	GPON Encapsulation Method	Ethernet Frame	ATM
Max Distance (OLT to ONU)	20 km	10 and 20 km	20 km
Split Ratio	1:16, 1:32 and 1:64	1:16 and 1:32	1:16, 1:32 and 1:64



OLT Router To OCLAN

ONT/Fibre

OLT

Various Telecommunication Services Provided By BSNL

BSNL, a major telecommunication provider in India, offers a wide range of services to cater to the diverse needs of its customers.

Overviews of some of their key offerings are as follows:

1. **Landline Services**:
   - Basic Telephone Service (BTS): This is the foundation of BSNL's offerings, providing essential voice communication within local areas and long-distance calls.

     The Key Features are:
     Clear voice quality
     Caller ID
     Call waiting
     Call forwarding

   - Broadband Services: BSNL provides various broadband options to cater to different internet needs.

     ->Asymmetric Digital Subscriber Line (ADSL): Utilizes existing copper telephone lines to deliver broadband speeds.

     ->Fiber-to-the-Home (FTTH): Offers high-speed internet access through fiber optic cables directly to the customer's premises, providing significantly faster speeds and greater bandwidth.

     ->Wi-Fi: Enables wireless internet access for devices within a certain range.

2. **Mobile Services**:
   - Prepaid and Postpaid Plans: BSNL offers a wide range of plans to suit various budgets and usage patterns.

     -> Prepaid: Customers pay in advance for a certain amount of talk time, data, and SMS.

     -> Postpaid: Customers pays a bill at the end of the billing cycle for the services used.

   - Value-Added Services (VAS): These enhance the mobile experience:

     ->Caller Tunes: Customize incoming call notifications with music or sounds.

     ->Missed Call Alerts: Receive notifications when someone misses your call.

->Roaming Services: Stay connected while traveling within India and internationally.

- Mobile Broadband: Enables high-speed internet access on mobile devices, such as smartphones and tablets.

3. **Other Services**:
   - Leased Lines: Dedicated, high-bandwidth connections for businesses and organizations with specific bandwidth requirements. The various types of Leased Lines services provided are:-

     ->Internet Leased Lines: An Internet Leased Line is a dedicated data connection or internet with a fixed bandwidth; this means that the connection is not shared with others. This ensures the consistent speed and performance even during peak hours.

     ->Point-To-Point Leased Lines: A point to point leased line is one of the main ways we can connect two sides privately and securely via a dedicated line. It is like having a private, exclusive line for data transfer between those two points. Direct connection provides a more secure environment for sensitive data transmission.

     ->Multi-Protocol Level Switching (MPLS): Multiprotocol Label Switching (MPLS) is a networking technology that revolutionizes how data packets are routed across networks. Instead of relying on traditional IP routing tables, MPLS uses short "labels" to direct data along pre-determined paths, significantly speeding up network traffic. It allows for prioritization of certain types of traffic, ensuring that critical applications receive the necessary bandwidth and resources.

   - Data Centre Services: Provides secure and reliable data storage, management, and processing solutions for businesses.

NIB,Broadband Configuration

Broadband Configuration:

Broadband refers to a connection that has capacity to transmit large amounts of data at high speed. Earlier a connection having download speeds of 256 kbps or more was classified as Broadband.However with time the demand for internet and the data speeds has risen concurrently.Thus nowadays a connection having download speeds of more than 2 mbps is only classified as Broadband. When connected to the internet broadband connection, allowing surfing or downloading much faster than a dial-up or any other narrow band connections. BSNL offers 2 mbps minimum download speed for its broadband connection.

The Broadband system is nowadays being replaced by the FTTH network system. As such the configuration of a broadband system is changing with time.

->Digital Subscriber Line Access Multiplexer (DSLAM): In a broadband, it is used to combine multiple individual DSL connections from subscribers into a single high-speed uplink, effectively allowing internet service providers (ISPs) to connect many users to the internet through existing telephone lines by aggregating their data streams into one connection. It plays a crucial role in broadband internet access, particularly for DSL connections.

->Working of the DSLAM:

1. Receiving Data: Your home or office has a DSL Modem that connects to the internet via a standard copper telephone line. This Modem sends data signals to the nearest DSLAM.

2. Aggregation: The DSLAM receives data from multiple DSL modems in your local area. It then combines these individual data streams. This process is called multiplexing.

3. Transmission: The aggregated data stream is then transmitted over a high capacity link, such as fiber optic cables, to the internet service provider"s (ISP) network.

4. Routing: The ISP"s network directs the data to its final destination on the internet. While DSLAMs are still used in many areas, they are gradually being replaced by newer technologies like fiber optics.

The earlier Broadband configuration used to work on the principles of DSLAM with the connectivity being:-

MODEM -> SPLITTER -> DSLAM -> BNG -> ROUTERS

The new FTTH network which uses optical fibres has the following configuration:-

ONT -> SPLITTER -> OLT -> OCLAN -> BNG -> ROUTERS

The main characteristics of Broadband are as follows:

1. High Speed: Broadband offers significantly faster download and upload speeds compared to dialup, enabling users to quickly access and share large files, stream high-definition videos and engage in online gaming without any lag.

2. Always-on Connectivity: Unlike dial-up, which requires a dedicated phone line, broadband connections are always active, providing continuous access to the internet without the need to dial in each time.

3. Wide Bandwidth: Broadband utilizes a wide range of frequencies allowing for the simultaneous transmission of multiple signals and data types, including voice, video, and data.

The common types of Broadband Connections are:

1. Digital Subscriber Line (DSL): Uses existing copper telephone lines to deliver internet service. Offers moderate speeds, suitable for basic internet browsing, email and streaming. Limited by the distance from the central office.

2. Cable Internet: Utilizes coaxial cables, originally designed for cable television. Offers faster speed than DSL, making it ideal for streaming, gaming, and downloading large files. Shared bandwidth with other users on the same network can affect speeds during peak hours.

3. Fiber Optic: Employs thin glass fibers to transmit data using light signals. Offers the fastest speeds and highest bandwidth capacity among broadband technologies. Becoming increasingly prevalent as infrastructure expands.

4. Satellite Internet: Provides internet access via satellite, suitable for remote areas with limited access to other broadband options. Offers slower speeds and higher latency compared to terrestrial connections.

5. Fixed Wireless: Uses radio waves to transmit internet signals over long distances. Offers a flexible alternative to wired connections suitable for areas where laying cables is impractical.

NIB:

NIB stands for **National Internet Backbone**. It is BSNL's core IP infrastructure designed to deliver internet and broadband services across India. It acts as the digital highway connecting cities, towns, and rural areas to the internet.

Features of NIB:

- **High-Speed Backbone**: Built on a multi-gigabit, multi-protocol IP infrastructure using MPLS (Multiprotocol Label Switching) technology.

- **Tiered Architecture**: Divided into Type A (major cities), Type B (medium towns), and Type C (smaller towns) nodes for efficient traffic routing.

- **Services Supported**:
    - Broadband and dial-up internet
    - Leased line connectivity
    - VPNs with Quality of Service (QoS)
    - Voice over IP (VoIP), video conferencing, and messaging.

- **Data Centers**: Located in cities like Bangalore, Noida, Mumbai, and Pune for hosting and disaster recovery.

The BNG and Routers mentioned earlier form the core of the NIB.

->BNG(Broadband Network Gateway):

The **Broadband Network Gateway** is a critical network element that serves as the **access point** for subscribers to connect to the broadband network. It's often referred to as the edge router or subscriber gateway.

Functions of BNG:

- **Subscriber Session Management**: Establishes and manages sessions between customer premises equipment (CPE) and the network.
- **Authentication, Authorization, and Accounting (AAA)**: Works with RADIUS servers to verify user credentials, authorize services, and track usage for billing.
- **IP Address Allocation**: Coordinates with DHCP servers to assign IP addresses to subscribers.
- **Traffic Routing and Policy Enforcement**: Routes user traffic efficiently and enforces Quality of Service (QoS) policies.
- **Security**: Provides firewalling, NAT (Network Address Translation), and VPN termination for secure internet access.

->Routers:

A **router** is a networking device that forwards data packets between computer networks. It acts as a traffic director, ensuring that data sent from one device reaches its correct destination across the internet or a local network.

There are primarily three types of routers in the NIB and BNG configuration.

1. PE Router:-

   A **Provider Edge Router** is a router located at the boundary of a service provider's network. It connects the provider's core network to external networks, such as customer premises or other service providers. It is mostly located at the Exchange Offices and offers router service to the MPLS,Leased circuit networks in the serving area.

2. CE Router:-

   A **Customer Edge Router** is a router located at the customer's premises that interfaces with the **Provider Edge (PE) Router** of an Internet Service Provider (ISP) like BSNL. It serves as the gateway between the customer's network and the provider's MPLS or IP backbone.

3. C Router:-

A **Core Router** is a high-capacity router designed to operate at the center—or **core**—of a large network, such as the internet backbone or a telecom provider's infrastructure. It acts as a gateway to all the **PE Routers** of the regions of service under the particular Core router coverage area.The Core Routers are primarily placed at the top industrial cities like Delhi,Mumbai,Guwahati,Kolkata,Dimapur,Chennai,etc.

This connection among the C-Routers are further clustered into a cloud network across and thus BSNL successfully constitutes the **NIB**.

BNG

MNGT(PE) ROUTER

Internet Of Things (IOT)

The Internet of Things (IoT) refers to a network of physical devices, vehicles, appliances, and other physical objects that are embedded with sensors, software, and network connectivity, allowing them to collect and share data.

A device can be considered as an IoT device if it contains the following properties:

- The device should be **SMART**.
- The device should contain **MICROCONTROLLER** or **MICROPROCESSOR**.
- The device requires **SENSORS** and **ACTUATORS**.
- The device must consist of **SOFTWARE**.

Example: Google Keyboard, Google Translator,Remote-Controlled Fans,ACs etc.

IoT enables these smart devices to communicate with each other and with other internet-enabled devices. Like smartphones and gateways, creating a vast network of interconnected devices that can exchange data and perform various tasks autonomously.

This can include applications such as:-

- Smart Home: Home Automation, Energy efficiency and elderly care.
- Healthcare: Remote patient monitoring, wearable technology and precision medicine.
- Smart Cities: Traffic management, environmental monitoring and smart grids.
- Agriculture: Precision farming, livestock monitoring and food safety.
- Manufacturing: Predictive maintenance, supply chain management and quality control.
- Transportation: Connected vehicles, fleet management and smart logistic.

These applications are not fully initiated till now and are still under research and development.However many such components of IOT are in use in our day-to-day life which may be include in our communication/telecom system for efficient automation and better handling of the several equipments in the system.

->What are the advantages of IOT?

1. The main goal of IoT is efficient **economic automation**.

2. The platform of IoT can help organizations to reduce cost through improved process efficiency, asset utilization and productivity.

3. It creates opportunities for direct integration of the physical world into computer-based systems.

4. The growth and convergence of data processing in IoT makes connections more relevant and important, creating more opportunities for people, business and industries.

5. The Internet of Things has made life easy and intelligent and with the help of IoT we can assume a smart house, smart car, smart traffic signal, smart industry and smart cities too.

->Characteristics of IOT: An IOT system must include:

1. Sensors: It is a device that detects and responds to some type of input from the physical environment. IoT technology allows us to sense. It is a combination of sensors, which utilizes microcontrollers to integrate individual data collected from different sensors to obtain using any separate sensor.

2. Connecting to Real World for Real Time processing: This device receives information, manipulates operations based on the input, send the messages based on the input received.

3. Energy Efficiency: The IoT has the potential to revolutionize energy efficiency in various sectors. By connecting devices and systems, IoT and automated control, leading to significant energy savings and a reduced environmental impact.

4. Heterogeneity: It is a defining characteristic of the IoT. It refers to the wide variety of devices, protocols, data formats and communication technologies that coexist with an IoT ecosystem.

5. Safety: This includes the security of our personal data and the security of our well-being that maintain endpoints and networks to transfer data across all media to create a security model that will scale.

6. Interconnectivity: It refers to the ability of various devices, sensors and systems to communicate and exchange data with each other, forming a vast and interconnected network.

->Components of IOT:

1. Sensors and Actuators: Sensors are the devices that gather data from physical world. Actuators are the devices that perform actions based on the data received.

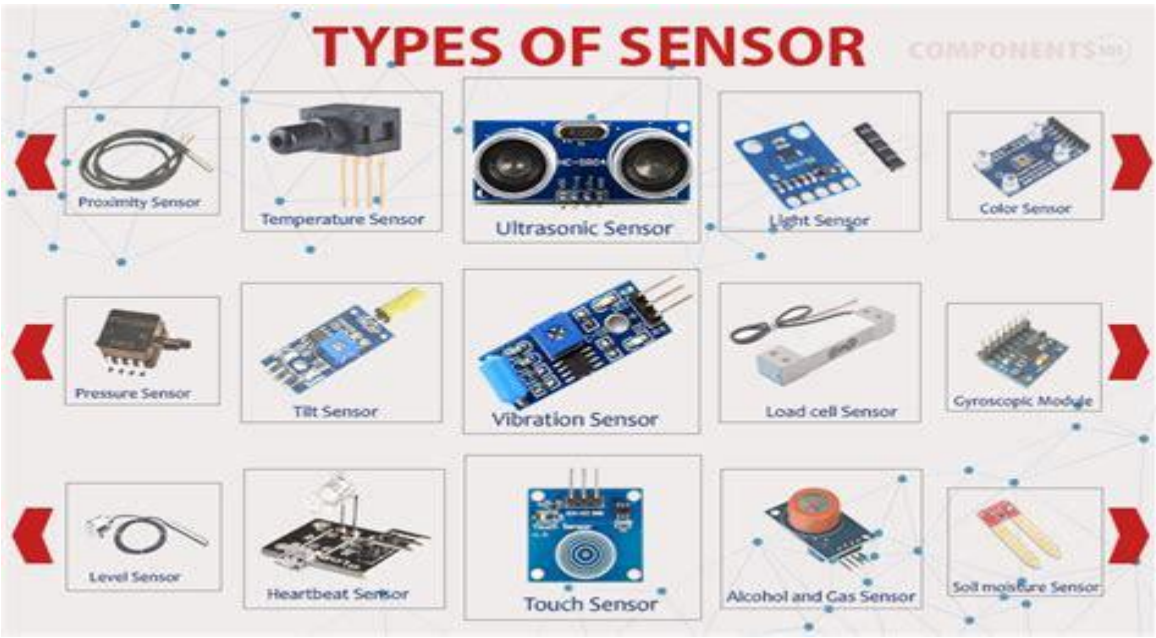
2. Connectivity: This refers to the communication networks that enable data transfer between devices.

3. People and Processes/Machines: People and processes are integrated to successful implementation and operation of any IoT system. By understanding the roles of individuals and the importance of well-defined processes, organizations can effectively leverage IoT to achieve their business objectives and improve the lives of their customers.

->Tools and Protocols used for basic IOT applications:

A)**Hardware Tools**:-

1. Sensors such as DHT(Temperature Sensor),Moisture sensor,Humidity sensor, Ultrasonic sensor,Photosensor,Piezosensor,etc.



2.Actuators such as DC motors,Relay motors,LEDs(Light Emitting Diodes), LED display screen,etc.

3. Microcontroller boards such as Arduino Mega, Arduino Uno, Arduino Nano, Raspberry Pi, Node MCU ESP8266, etc.

4.Basic Electronic Components such as Breadboards,Connecting Jumper Wires,Resistors,Capacitors,Potentiometers,etc.

B)**Software Tools**:-

1.Code Editors and Compilers such as Arduino IDE,Virtual Studio Code(with appropriate extensions and compiler installed),etc.

2.Cloud Services such as Blynk Platform(which can be facilitated by installing the Blynk Library into the Arduino IDE),etc.

C)**Device Connectivity Protocols(Wireless)**:-

1.WiFi,

2.Bluetooth,

3.Zigbee,

4.4G/5G.

D)**Communication Protocols**:-

1. UART (Universal Asynchronous Receiver Transmitter)

- Uses only two lines—TX (transmit) and RX (receive).
- Data is transmitted character by character asynchronously.
- Simple and widely supported in microcontrollers.
- Ideal for serial communication with GPS modules, Bluetooth, and debugging interfaces.

2. SPI (Serial Peripheral Interface)

- A fast synchronous protocol with 4 wires: MOSI, MISO, SCK, and SS.
- Uses a master-slave model for data exchange.
- Suitable for short-distance high-speed communication.
- Commonly used for sensors, SD cards, and display modules.

3. I^2C (Inter-Integrated Circuit)

- Two-wire protocol: SDA (data) and SCL (clock).
- Master can communicate with multiple slave devices.
- Supports relatively slower speeds but is simple and compact.
- Great for EEPROMs, temperature sensors, and RTCs.

4. CAN (Controller Area Network)

- Two-wire synchronous protocol designed for robustness.
- Used heavily in automotive and industrial systems.
- Offers high fault tolerance and error handling.
- Excellent for noisy environments and long-distance communication.

5. Ethernet

- Uses multiple wires and complex signaling for ultra-fast data transfer.
- Ideal for networked embedded systems like IoT gateways.
- Offers reliable and scalable connectivity.
- Often used where internet or LAN access is needed.

6. USB (Universal Serial Bus)

- High-speed communication with plug-and-play functionality.
- Provides both data and power through the same cable.
- Commonly used for connecting peripherals like keyboards, mice, and cameras.
- Supports host and device modes, useful in more advanced systems.

Overview Of CSC System

The BSNL **Customer Service Centre** (CSC) plays a vital role in addressing customer inquiries and resolving issues related to their services.

Some of the issues which may be faced by customers regarding telecom network are:

1.Network Issues,

2.Calling Issues,

3.SIM Card Issues,

4.Recharge Issues,

5.Data Issues,

6.Marketing or Billing Issues,

7.SIM Identification Misuse related Issues.

The above issues can be solved by the Customer Service Centre of BSNL.

Issues such as Network Problem,Calling or Data(Internet) Problems are mostly resolved by the Technicians,Engineers of BSNL.However the issues related to SIM card, Recharge, Billing, SIM misuse, etc. are dealt with by the experts of the Customer Service Centre of BSNL.

Let us know about a SIM Card!

SUBSCRIBER IDENTITY MODULE (SIM):

A SIM card (Subscriber Identity Module) is a small removable card that contains the information needed to identify and authenticate a subscriber on a mobile phone network. There are two types of SIM:

1.Prepaid SIM 2.Postpaid SIM

Feature	Prepaid	Postpaid
Payment	Pay before using services	Pay after using services
Billing	No fixed Billing Cycle	Monthly Billing Cycle
Bill Amount	Based on recharge amount	Based on usage during the Billing Cycle
Credit Limit	Limited to recharge amount	Credit limit may be available
Service Disruption	Service may be suspended if balance is insufficient	Service continues even if the bill is unpaid (may incur late fine)

SIMs can further be classified on the basis of flexibility into:-

1.Paired SIM: A SIM card specifically linked to another device or service.There is limited flexibility due to the pairing restriction. It is often used for specific services like IoT devices, M2M communication or paired with another device for security purposes.

2.Unpaired SIM:A standalone SIM card that can be used independently in any compatible device.There is high flexibility as it can be used in any compatible device. It is used in any mobile phones that supports the SIM card standard.

3.e-SIM(Embedded SIM):This type of SIM are directly embedded or integrated into the mobile or any other device and thus its service can only be used with the specific device providing no flexibility in usage and utmost security.

How to identify if a SIM is prepaid or postpaid?

There is a special SIM number provided to every SIM card by the manufacturer under the service providing company.This number contains typically 18 to 22 digits which is different from the 10 digit phone number,which one gets alongside the SIM service.

1. If the 13th digit of the SIM number is **1** then the SIM card is identified as Prepaid SIM.

2. If the 13th digit of the SIM number is **2** then the SIM card is identified as Postpaid SIM.

When it comes to SIM Card,two more terms are widely associated with it:-

1.**International Mobile Equipment Identity (IMEI)**:

The International Mobile Equipment Identity (IMEI), is a unique 15 or 17 digit number that identifies individual mobile devices, such as smartphones and tablets. It"s crucial for various aspects of telecommunication and mobile device management.

The IMEI of an individual can be found out by dialling " *#06# "in their personal smartphones. This code will display your IMEI on the screen of most devices.

2.**Porting of SIM:**

In communication, porting typically refers to the action of number portability. This is the ability to switch phone service providers while keeping the existing mobile number.

This is done with respect to the IMEI and international protocols.

ERP Overview

ERP stands for Enterprise Resource Planning. It is a type of software that integrates and manages core business processes like finance, HR, production and supply chain, all within a single system.

Let us know about SAP!

System Analysis Program (SAP) Development is a central nervous system for a business, connecting all departments and functions, allowing them to share information and work together seamlessly. It develops solution for effective data processing and streamlined information flow across the organization.

-> SAP operates while following certain modules:-

1. REM Module: In SAP, REM stands for the Real Estate Management Module. It is a comprehensive solution that helps businesses manage the entire lifecycle of their real estate assets such as Assets Management, Lease Management, Portfolio Management and Financial Management.

2. MM Module: In SAP, MM stands for Material Management. It is a core component of the SAP ERP system, designed to automate and optimize materials and inventory management processes within a company such as inventory management which consists of material master, goods movement, inventory valuation and physical inventory. It also looks after the purchasing sector which consists of processing, invoice verification and supplier evolution.

3. PS Module: In SAP, PS stands for Project System. It is a crucial component of the SAP ERP system, designed to manage and control all aspects of projects within an organization such as project definition and planning, its execution, monitoring, closing and settlement.

4. SD Module: In SAP, SD stands for Sales and Distribution. It is an important component of the SAP ERP system that manages the entire sales process, from customer inquiries to order fulfilment and invoicing. It consists of customer master data, sales order

processing, delivery processing, billing, sales forecasting and customer relationship management.

5. FICO Module: In SAP, FICO stands for Finance and Controlling. It is a corner stone of the SAP ERP system, providing a comprehensive solution for managing all aspects of a company"s financial operations such as the financial accounting and controlling which consists of general ledger, accounts receivable, accounts payable, asset accounting, bank accounting, cost accounting, profitability analysis, budgeting, planning, internal orders and product costing.

6. PM Module: In SAP, PM stands for Plant Maintenance. It is a component of SAP ERP system that is designed to manage and optimize all maintenance activities within an organization such as the equipment master, maintenance orders, work orders, maintenance planning, spare parts management, cost control, reporting and analysis.

7. HCM Module: In SAP, HCM stands for Human Capital Management. It is a comprehensive suite of software solutions designed to streamline and optimize human resources processes within an organization. It is an integral part of SAP"s ERP offerings. It consists of personnel administration, organizational management, time management, payroll, talent management, employee self-service and manager self service.

ERP system is implemented to integrate data and processes of any organization into one single system. Data is safe in electronics form and with full security. The logs are available with Time Stamps. So, the ERP system brings efficiency in the working of an organization.

A Comprehensive Overview

Of Enterprise Business

In BSNL, enterprise business encompasses a suite of telecommunication services designed to cater to the specific needs of large organizations and businesses. These services aim to enhance communication, data transfer, and overall operational efficiency for enterprises. Some of the types of Enterprise Businesses in BSNL are:

1. Internet Leased Lines: An Internet Leased Line is a dedicated data connection or internet with a fixed bandwidth; this means that the connection is not shared with others. This ensures the consistent speed and performance even during peak hours. Upload and download speeds are typically the same, which is crucial for businesses that rely heavily on data transfer, such as video conferencing or file sharing.

1:1 means that upload and download are equal.

1:2 means that upload is half of the download.

1:4 means that upload is one-fourth of the download.

2. Point-to-Point: A point-to -point leased line is one of the main ways we can connect two sides privately and securely via a dedicated line. It is like having a private, exclusive line for data transfer between those two points. Direct connection provides a more secure environment for sensitive data transmission. This link can be physical such as of fiber optic cable, or wireless, utilizing technologies microwave or satellite communication.

3. Multi-Protocol Level Switching (MPLS): Multiprotocol Label Switching (MPLS) is a networking technology that revolutionizes how data packets are routed across networks. Instead of relying on traditional IP routing tables, MPLS uses short "labels" to direct data along pre-determined paths, significantly speeding up network traffic. It allows for prioritization of certain types of traffic, ensuring that critical applications receive the necessary bandwidth and resources. MPLS enables network administrators to control traffic flow, optimize network utilization, and avoid congestion.

4. SIP Trunk: Session Initiation Protocol Trunk is the digital method of making and receiving phone calls and other digital communications over an internet connection. The term "Trunk" in SIP Trunk refers to virtual phone lines that can be used to make phone calls over the internet to anyone with a phone number. It offers a modern and flexible communication solution for businesses of all sizes, providing cost saving, enhanced features and improved mobility. It enables seamless communication for employees working from home or remote locations. It also connects offices across different locations with a single unified system.

5. Outbound Dialing (OBD) and Interactive Voice Response System (IVRS): Outbound dialing is the process of automatically placing phone calls to a list of numbers. This can include dialing individual numbers or using predictive dialers that connect callers to available agents as soon as a call is answered. An IVR system is an automated phone system that interacts with callers using voice and/or touch-tone inputs.

6. Bulk Message: Bulk Message is a service that enables businesses to send large volumes of SMS messages to customers and employees for marketing, alerts and notifications. It is a powerful tool for businesses and organizations to 65 reach a wide audience quickly and effectively.

7. Toll Free: Toll-free numbers are a special type of telephone number that allows callers to reach a business or organization without incurring any charges for the call. The cost of the call is instead borne by the recipient of the call. In essence, toll free numbers provide a convenient and cost-effective way for businesses and organizations to connect with their customers and stakeholders, fostering a positive customer experience and enhancing their brand image.

8. SI Work: In the context of telecommunications, "SI Work" typically refers to System Integration. System Integration involves the process of combining different elements of a telecommunications system into a cohesive and functional whole. This can include network design and planning, hardware and software installation, network testing and problem shooting, system maintenance and support and integration with others. This can help businesses optimize their communication infrastructure, improve operational efficiency, and achieve their business goals.

Conclusion

My internship at Bharat Sanchar Nigam Limited (BSNL) Telecom has been a transformative learning experience, bridging the gap between academic knowledge and real-world application. Over the course of the internship, I had the opportunity to work closely with experienced professionals and gain firsthand exposure to the operations of one of India's largest and most historic telecom service providers.

Technical and Operational Insights:

During my time at BSNL, I was introduced to a wide array of technologies and systems that form the backbone of modern telecommunications. These included:

- **Switching and Transmission Systems**: I observed how BSNL manages its core network infrastructure, including exchanges, routers, and transmission media.
- **Broadband and FTTH Services**: I learned about the deployment and maintenance of high-speed internet services, including fiber-optic technology and last-mile connectivity.
- **Mobile Networks**: I gained insights into GSM and CDMA technologies, BTS (Base Transceiver Stations), and the role of MSCs (Mobile Switching Centers) in call routing and subscriber management.
- **Network Monitoring ,Drive Test and Fault Management**: I observed the activities related to fault detection and drive testing and also gained insights from those.
- **NIB Functionality:** I got to understand the functioning of the National Internet Backbone and how it forms a cloud network all over the country ,thus creating the network framework.
- **IOT Application:** Today's world knows the need of efficient automation in order to make day to day life easy. In such a perspective,I also got to know the operation of IOT and how it can be inculcated into communication systems to make communication more efficient.

Organizational Understanding:

BSNL's structured approach to service delivery, its commitment to rural connectivity, and its role in national telecom infrastructure offered valuable lessons in public sector management and policy-driven operations. I also gained appreciation for the challenges faced by legacy telecom providers in adapting to rapid technological changes and market competition.

The ERP system,Finance and Accounts Department,CSC system helps the platform and allows BSNL to grow as India's largest Telecom Network Company.

Final Reflections:

This internship has significantly broadened my perspective on the telecom industry. It has reinforced my interest in pursuing a career in network engineering and telecommunications, and has equipped me with practical skills that complement my academic background. I am grateful to BSNL for providing a supportive and educational environment, and I look forward to applying these learnings in future professional endeavors.

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