







# Participant Handbook

Sector

**Telecom** 

Sub-Sector

**Passive Infrastructure** 

Occupation

**Customer Service - Passive Infrastructure** 

Reference ID: TEL/Q4302, Version 1.0

**NSQF** level 4



Telecom Grameen Udhyami

#### This book is sponsored by

#### **Telecom Sector Skill Council of India**

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If we have to move India towards development then Skill Development should be our mission.

Shri Narendra Modi Prime Minister of India







# COMPLIANCE TO QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

#### TELECOM SECTOR SKILL COUNCIL OF INDIA

for

#### SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Occupational Standards of Job Role/ Qualification Pack: <u>'Telecom Grameen Udhyami'</u> QP No. <u>'TEL/Q4302, NSQF Level 4'</u>

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The preparation of this handbook would not have been possible without the Telecom Industry's support. Industry feedback has been extremely encouraging from inception to conclusion and it is with their input that we have tried to bridge the skill gaps existing today in the industry.

This participant handbook is dedicated to the aspiring youth who desire to achieve special skills which will be a lifelong asset for their future endeavours.

#### About this book

India is currently the world's second-largest telecommunications market with a subscriber base of 1.20 billion and has registered strong growth in the last decade and a half. The Industry has grown over twenty times in just ten years. Telecommunication has supported the socioeconomic development of India and has played a significant role in narrowing down the rural-urban digital divide to some extent. The exponential growth witnessed by the telecom sector in the past decade has led to the development of telecom equipment manufacturing and other supporting industries.

Over the years, the telecom industry has created millions of jobs in India. The sector contributes around 6.5% to the country's GDP and has given employment to more than four million jobs, of which approximately 2.2 million direct and 1.8 million are indirect employees. The overall employment opportunities in the telecom sector are expected to grow by 20% in the country, implying additional jobs in the upcoming years.

This Participant handbook is designed to impart theoretical and practical skill training to students for becoming Telecom Grameen Udhyami in the Telecom Sector.

Telecom Grameen Udhyami is the person who is responsible for maintaining the networks functionality and efficiency

This Participant Handbook is based on Telecom Grameen Udhyami Qualification Pack (TEL/Q4302) and includes the following National Occupational Standards (NOSs):

- 1. CON/N0602: Handle hand and power tools relevant to construction electrical works
- 2. TEL/N4122: Wiring and installing equipment at different sites
- 3. TEL/N6400: Splice Optical Fiber
- 4. TEL/N4201: In-building FTTH/X cabling
- 5. TEL/N0112: Configure customer premises equipment and establish Broadband connectivity
- 6. TEL/N0113: Troubleshoot and rectify faults
- 7. TEL/N2213: Repair and test handsets
- 8. TEL/N4141: Provide Techpreneurial Solutions in the Village
- 9. DGT/VSQ/N0102: Employability Skills (60 Hours)

The Key Learning Outcomes and the skills gained by the participant are defined in their respective units.

Post this training, the participant will be able to manage the counter, promote and sell the products and respond to queries on products and services.

We hope this Participant Handbook will provide sound learning support to our young friends to build an attractive careers in the telecom industry.

#### **Symbols Used**



Key Learning
Outcomes



Unit Objectives



Exercise



Tips



Notes



Activity



Summary

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# S.No Modules and Units 10. Employability Skills (DGT/VSQ/N0102) (60 Hrs.) Employability Skills is available at the following location: https://www.skillindiadigital.gov.in/content/list Scan the QR code below to access the ebook 11. Annexure 343













# 1. Introduction to the role of a Telecom Grameen Udhyami

- Unit 1.1 Introduction to the Telecom Sector and the role of Telecom Grameen Udhyami
- Unit 1.2 Optical Fiber Technology and the Role of an Optical Fiber Splicer
- Unit 1.3 Wi-Fi Broadband Installation and Cable Maintenance
- Unit 1.4 Handset/Tablet Repair



#### **Key Learning Outcomes**

#### By the end of this module, the participants will be able to:

- 1. Outline the Telecom industry's size and scope, including its sub-sectors, and explain the fundamentals and concepts of telecommunication and related terminologies.
- 2. Describe the role and responsibilities of a Telecom Grameen Udhyami (rural entrepreneur) and the impact they can have on promoting connectivity in rural areas.
- 3. List and explain the daily, weekly, and monthly operations and activities that take place under the purview of a Telecom Grameen Udhyami.
- 4. Analyze the career progression opportunities within the Telecom industry and identify potential paths for advancement for a Telecom Grameen Udhyami.
- 5. Assess the role of a Telecom Grameen Udhyami in fostering an entrepreneurial mindset in rural communities and promoting economic development.
- 6. Discuss organizational policies related to workplace ethics, managing telecom sites, quality stand-ards, personnel management, and public relations within the Telecom industry.
- 7. Describe the workflow process in a telecom organization and elucidate the responsibilities of a broadband technician within this process.
- 8. Recall the fundamentals of optical fiber technology, its historical context, and the challenges faced during handling and installation.
- Evaluate the working principle of optical fiber communication systems and analyze case studies outlining the role, responsibilities, and challenges a Telecom Grameen Udhyami faces in this context.
- 10. State the safety, health and environmental policies and regulations for the workplace as well as for telecom sites in general.

# UNIT 1.1: Introduction to the Telecom Sector and the role of Telecom Grameen Udhyami

#### **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Describe the size and scope of the Telecom industry and its various sub-sectors.
- 2. Explain the fundamentals and concept of telecommunication and the terminologies used in the work process.
- 3. Explain the role and responsibilities of Telecom Grameen Udhyami.
- 4. List the various daily, weekly, and monthly operations/activities that take place under a Telecom Grameen Udhyami.
- 5. Discuss the organisational policies on workplace ethics, managing sites, quality standards, personnel management and public relations (PR).
- 6. Explain the role of Telecom Grameen Udhyami in encouraging an entrepreneurial mindset in the village.

#### 1.1.1 Telecom Sector in India -

#### **History of Telecom Sector in India**

The telecom sector in India has a long and fascinating history, with its roots stretching back to the British colonial era. In 1851, the first telegraph line was laid between Calcutta and Diamond Harbour, marking the beginning of India's journey into the world of telecommunications. Over the next century, the telegraph network expanded rapidly, connecting major cities and towns across the country.

The first major milestone in the evolution of India's telecom sector came in 1882 when the government of India established the Department of Telegraphs. The department was responsible for building and maintaining the telegraph network in India, which continued to grow steadily over the next few decades.

The advent of wireless technology in the early 20th century brought a new wave of innovation to India's telecom sector. In 1923, the first radio broadcast was made in India, followed by the establishment of the Indian Broadcasting Company in 1927. The Indian Broadcasting Service was established in 1936, which later became All India Radio in 1957.

After India gained independence in 1947, the government began to focus on expanding the telecom network to connect the entire country. The Indian Telephone Industries (ITI) was established in 1948 to manufacture telephone equipment, and the first automatic telephone exchange was installed in 1953.

#### **Growth of the Telecom Sector in India**

The growth of the telecom sector in India has been driven by several factors, including the liberalization and privatization of the industry, increasing affordability of mobile phones and data services, and government initiatives aimed at promoting the growth of the sector.

The liberalization of India's economy in the 1990s paved the way for the entry of private players in the telecom sector. The government of India opened up the sector to private investment in 1991, and in 1994, it introduced the National Telecom Policy (NTP) to promote the development of the telecom sector. The NTP set the stage for the entry of private players into the industry, which led to a significant increase in competition and innovation.

The entry of private players such as Reliance Jio, Bharti Airtel, and Vodafone Idea in the early 2000s brought significant changes to the telecom sector in India. These players invested heavily in network infrastructure and marketing, significantly increasing competition and innovation. As a result, the sector witnessed significant growth, with the number of telephone subscribers increasing from 22 million in 1999 to over 800 million in 2011, according to data from TRAI.

Another factor contributing to the growth of the telecom sector in India is the increasing affordability of mobile phones and data services. As mobile phone manufacturers have entered the Indian market, the price of smartphones has significantly reduced, making them accessible to a larger population. In addition, the price of data services has decreased significantly, making it more affordable for people to access the internet on their mobile devices.

The government of India has undertaken various initiatives to promote the growth of the telecom sector. The National Telecom Policy (NTP) of 1994 set the stage for the entry of private players into the industry, while the New Telecom Policy of 1999 focused on promoting the growth of the sector through the expansion of telecom infrastructure and the introduction of new services. In 2018, the government of India launched the National Digital Communications Policy (NDCP) to make India a digital economy and promote the growth of the telecom sector. The policy aims to provide universal broadband connectivity at 50 Mbps to every citizen by 2022, among other goals.

Overall, the growth of the telecom sector in India has been impressive, with the number of telephone subscribers increasing from 0.03 million in 1948 to 1.19 billion in 2021, according to data from TRAI. The sector has played a significant role in India's economic development, and its continued growth is essential for the country's future prosperity.

#### **Current Scenario of the Telecom Sector in India**

The current state of the telecom sector in India is marked by consolidation, increasing competition, and growth in wireless and broadband subscribers. With the merger of Vodafone India and Idea Cellular in 2018 and the merger of Bharti Infratel and Indus Towers in 2020, the sector is now dominated by three major players – Reliance Jio, Bharti Airtel, and Vodafone Idea.

Reliance Jio, which entered the market in 2016, disrupted the industry with its low-cost data plans and free voice calls, leading to a price war among telecom operators. This led to significant consolidation in the sector, with many smaller players exiting the market or merging with larger players.

According to data from the Telecom Regulatory Authority of India (TRAI), as of January 2022, India's total wireless subscriber base stood at 1.16 billion, while the total broadband subscriber base stood at 830 million. The average wireless data usage per monthly subscriber in the country was 14.7 GB in December 2021, up from 11.8 GB in December 2020.

Reliance Jio is currently the market leader with a wireless subscriber base of 442 million as of January 2022, followed by Bharti Airtel with a subscriber base of 364 million and Vodafone Idea with a subscriber base of 269 million. However, Vodafone Idea has been facing financial difficulties due to high debt and intense competition, and its future remains uncertain.

The sector has witnessed significant growth in recent years, driven by the increasing adoption of smartphones and the internet. According to a report by the Internet and Mobile Association of India (IAMAI) and Nielsen, the number of smartphone users in India is expected to reach 820 million by 2022. The report also stated that the time spent on smartphones in India has increased from 138 minutes per day in 2019 to 162 minutes per day in 2020.

The government of India has also been taking various initiatives to promote the growth of the telecom sector, such as the National Digital Communications Policy (NDCP) launched in 2018, which aims to provide universal broadband connectivity at 50 Mbps to every citizen by 2022. In addition, the government has recently announced the production-linked incentive (PLI) scheme for the telecom sector, aimed at promoting domestic manufacturing of telecom equipment and components.

Over the last seven years, the Telecom Tower industry in India has grown significantly by 65%. The number of mobile towers increased from 400,000 in 2014 to 660,000 in 2021. This has resulted in the rapid growth of Mobile Base Transceiver Stations by 187% and increased from 800,000 in 2014 to 2.3 mn in 2021.

The Department of Telecom (DoT), GOI targets a combination of 100% broadband connectivity in the villages, 55% fibreization of mobile towers, average broadband speeds of 25 Mbps and 30 lakh km of optic fibre rollouts by December 2022. By December 2024, it looks at 70% fibreisation of towers, average broadband speeds of 50 Mbps and 50 lakh km of optic fibre rollouts at a pan-India level. It is also projected that 5G technology will contribute approximately \$450 bn to the Indian Economy in the period 2023-2040.

Source: https://www.investindia.gov.in/sector/telecom

However, the sector also faces challenges such as high debt, intense competition, and regulatory issues. The sector is heavily regulated, with the government setting prices for spectrum and imposing high taxes and fees on operators. The government has also been pushing for increased localization of data, which could lead to higher costs for operators.

#### 1.1.2 Sub Sectors of the Telecom Industry

The telecommunications sector has three basic sub-sectors: Telecom equipment, Telecom services, Wireless communication.



Fig. 1.1.1: Telecom Sub-Sectors

- **Telecom Infrastructure** is a physical medium through which all the data flows. This includes telephone wires, cables, microwaves, satellites, and mobile technology such as fifth-generation (5G) mobile networks.
- **Telecom Equipment** includes a wide range of communication technologies, from transmission lines and communication satellites to radios and answering machines. Examples of telecommunications equipment include switches, routers, voice-over-internet protocols (VoIP), and smartphones.
- Telecom Services: A service provided by a telecommunications provider or a specified set of userinformation transfer capabilities provided to a group of users by a telecommunications system. It includes voice, data and other hosts of services.

The major segments within these sub-sectors include the following:

- Wireless communications
- Communications equipment
- Processing systems and products
- Long-distance carriers
- Domestic telecom services
- Foreign telecom services
- Diversified communication services

#### 1.1.3 Telecom Basics -

Any telecommunication system has three basic units:

- Transmitter: It takes information and converts it to a signal
- Transmission medium: Also called the "physical channel" that carries the signal
- Receiver: It takes the signal from the channel and converts it back into usable information



Fig. 1.1.2: Signal Transmission

#### **Important Telecom Terminologies**

- **FTTH:** Fiber to the Home A technology that directly delivers high-speed internet and other services to residences using fiber optic cables.
- Fiber Optics: Transmission of data through thin, flexible glass or plastic fibers using light signals.
- **FTTX:** A general term referring to various fiber-to-the-X technologies, including FTTH (Home), FTTB (Building), and FTTC (Curb).
- DSL: Digital Subscriber Line A broadband technology that uses telephone lines to transmit data.
- **Wireless Broadband:** High-speed internet access is provided via wireless technology, often cellular or Wi-Fi networks.
- **WiFi Backhaul:** The use of Wi-Fi connections to provide backhaul connectivity for data transfer in wireless networks.
- **Handset Repair:** The process of diagnosing and fixing issues in mobile phones or handsets, including hardware and software problems.
- Tablet Repair: Similar to handset repair but focusing on tablets or portable computing devices.
- Antenna: A device that transmits and receives radio waves in wireless communication systems.
- **Signal Propagation:** The way radio waves travel through the air or other mediums, affected by factors like frequency, distance, and obstacles.
- Spectrum: The range of electromagnetic radio frequencies used for wireless communication.
- LTE: Long-Term Evolution A standard for wireless broadband communication, often referred to as 4G.
- **5G:** The fifth generation of wireless technology, offering significantly faster speeds and reduced latency.

- **Network Infrastructure:** The physical components, such as routers, switches, and cables, that form the backbone of telecom networks.
- Latency: The delay in data transmission between the sender and receiver in a network, is crucial for real-time applications.
- VoIP: Voice over Internet Protocol Technology that allows voice calls to be made over the internet.
- **Router:** A device that directs data packets between different computer networks, facilitating data transmission.
- **Modem:** A device that modulates and demodulates digital data to enable it to be transmitted over analogue networks.
- Ethernet: A common wired networking technology used for local area networks (LANs).
- IP Address: A unique numerical label assigned to each device connected to a computer network.
- Packet Loss: The failure of data packets to reach their destination in a network.
- **Frequency Band:** A range of frequencies within the electromagnetic spectrum allocated for specific communication purposes.
- **Firewall:** A security system that controls incoming and outgoing network traffic, protecting against unauthorized access.
- **Router Configuration:** The settings and parameters that determine how a router functions within a network.
- **DNS:** Domain Name System A system that translates domain names (e.g., www.example.com) into IP addresses.
- Latency Testing: Measuring the time data travels from source to destination in a network.
- Mbps: Megabits per second A unit of data transfer rate often used to quantify network speeds.
- QoS: Quality of Service A set of network management techniques to ensure a consistent level of performance.
- **Subscriber Identity Module (SIM):** A smart card used in mobile devices to authenticate and connect to a cellular network.
- Broadband Speed: The rate at which data can be transmitted over a broadband connection.
- **Transceiver:** A device that combines transmission and reception capabilities, common in wireless communication.
- Propagation Delay: The time it takes for a signal to travel from the sender to the receiver.
- MAC Address: Media Access Control Address A unique hardware identifier assigned to network devices.
- Access Point: A hardware device that allows Wi-Fi devices to connect to a wired network.
- **Bandwidth:** The maximum data transfer rate of a network or internet connection, often measured in bits per second.

#### 1.1.4 Role and Responsibilities of Telecom Grameen Udhyami

The roles and responsibilities of Telecom Grameen Udhyami include, but are not limited to:

- **Broadband Infrastructure Installation:** Install cable, system wiring, and related equipment at customer premises, ensuring the efficient setup of broadband connectivity in rural areas.
- **Component Installation and Troubleshooting:** Apply knowledge and skills to install and troubleshoot various components of broadband infrastructure, including routers, modems, and access points.
- Coordination for Cable Laying: Coordinate and oversee cable laying and pulling activities, ensuring that the network infrastructure is properly installed and connected.

- Maintenance Procedures: Perform protective and corrective maintenance procedures to maintain
  the reliability and performance of the telecom network infrastructure, promptly addressing any
  issues that may arise.
- WiFi Access Point Configuration: Demonstrate proficiency in installing, configuring, and maintaining WiFi Access Point equipment to provide wireless connectivity in rural areas.
- Outside Plant Cable Installation: Follow established procedures for outside plant cable installation, ensuring cables are securely and safely laid outdoors.
- **FTTH/X Installation:** Prepare cables for splicing and installing passive FTTH/X components, enabling high-speed internet access within buildings and homes in rural communities.
- Handset/Tablet Repair: Repair and restore functionality to handsets and tablets.

#### Additionally, Telecom Grameen Udhyamis may engage in the following entrepreneurial activities in rural villages:

- **Techpreneurial Solutions:** Provide innovative technology-based solutions to address the specific needs of rural communities, such as offering digital services, training, or tech support.
- **Community Engagement:** Act as a liaison between the telecom industry and the local community, fostering awareness and promoting the benefits of connectivity in rural areas.
- **Business Development:** Identify and explore opportunities for expanding telecom-related services or products to create sustainable businesses within the village.
- **Customer Support:** Offer technical support and assistance to end-users, helping them navigate and troubleshoot connectivity issues.
- **Network Expansion:** Collaborate with telecom service providers to advocate for and facilitate network expansion into underserved rural regions.
- **Entrepreneurial Training:** Provide training and mentorship to local individuals interested in entering the telecom sector, thus encouraging entrepreneurship in the village.
- Quality Assurance: Ensure the quality and reliability of telecom services by conducting regular inspections and maintenance checks.
- Marketing and Promotion: Promote telecom services and packages to the local population, helping to increase adoption and usage.

# 1.1.5 Various Activities Performed under a Telecom Grameen Udhyami

#### **Daily Operations:**

- **Customer Support:** Provide customer support and promptly address inquiries, issues, and service requests.
- **Equipment Installation:** Install broadband equipment, cables, and networking components at customer premises as needed.
- Maintenance Checks: Conduct daily checks and routine maintenance of installed telecom equipment and infrastructure to ensure functionality.
- **Troubleshooting:** Diagnose and resolve connectivity and equipment issues that arise during the day.
- Sales and Marketing: Promote telecom services and products, actively engage with potential customers, and generate sales leads.

- **Inventory Management:** Maintain an inventory of telecom equipment, spare parts, and cables to ensure availability for installations and repairs.
- Billing and Payments: Manage customer billing and payment collection processes accurately.

#### **Weekly Operations:**

- **Network Monitoring:** Perform weekly network health checks, monitoring for potential issues and taking proactive measures.
- **Equipment Upkeep:** Clean, maintain, and update equipment and devices to ensure optimal performance.
- Quality Assurance: Conduct quality checks on installations and services to meet established standards.
- **Training:** Participate in ongoing training programs to stay updated on industry trends, technologies, and best practices.

#### **Monthly Operations:**

- **Performance Analysis:** Analyze monthly performance data, including customer satisfaction, network uptime, and service usage.
- **Billing and Accounting:** Prepare monthly invoices for customers, track accounts receivable, and manage financial records.
- **Inventory Replenishment:** Replenish inventory by ordering necessary equipment and supplies for future installations and repairs.
- **Report Generation:** Generate monthly reports on key performance indicators (KPIs), such as revenue, customer acquisition, and maintenance activities.
- **Community Engagement:** Engage with the local community to understand their needs and gather feedback on telecom services.
- **Planning and Expansion:** Plan for network expansion or upgrades based on the growth of the customer base and changing demands.
- Marketing Campaigns: Plan and execute monthly marketing campaigns to attract new customers and retain existing ones.

# **1.1.6 Organizational Policies and Best Practices for Telecom Grameen Udhyami**

#### **Workplace Ethics**

Workplace ethics are essential to maintain trust and professionalism. Organizational policies in this area may include:

- **Customer Confidentiality:** Ensuring that customer information and data are kept confidential and not shared without proper authorization.
- **Honesty and Integrity:** Encouraging honesty in all dealings, including transparent pricing and accurate representation of services.
- **Conflict of Interest:** Defining guidelines to prevent conflicts of interest, especially when dealing with multiple service providers or suppliers.
- Fair Competition: Promoting fair competition and adherence to legal and ethical business practices.

#### **Managing Sites**

Proper site management is crucial for the installation and maintenance of telecom equipment. Policies may include:

- Safety Protocols: Enforcing safety measures to protect personnel and customers during site visits and installations.
- **Site Documentation:** Maintaining accurate records of site locations, equipment installations, and maintenance schedules.
- **Environmental Compliance:** Ensuring adherence to environmental regulations when installing equipment, such as tower installations.

#### **Quality Standards**

Quality standards are vital to ensure the reliability and performance of telecom services. Policies may

- **Installation Standards:** Establishing guidelines for the proper installation of equipment and infrastructure.
- Maintenance Procedures: Outlining step-by-step maintenance procedures to maintain service quality.
- Quality Assurance Checks: Conducting regular quality checks and audits to monitor compliance with established standards.

#### **Personnel Management**

Managing personnel effectively contributes to the efficiency of operations. Policies may include:

- **Training and Development:** Providing ongoing training and development opportunities to enhance skills and knowledge.
- Code of Conduct: Defining expected behaviour and professionalism for employees and contractors.
- **Performance Evaluation:** Establishing mechanisms for performance evaluations, feedback, and recognition.

#### Public Relations (PR)

Positive public relations are essential for building trust and a good reputation in the community. Policies may encompass:

- **Community Engagement:** Encouraging employees to engage with the local community and address their telecom needs.
- **Crisis Communication:** Developing a strategy for handling and communicating during crises or service disruptions.
- **Brand Image:** Maintaining a positive brand image through ethical and responsible business practices.

#### 1.1.7 Role of Telecom Grameen Udhyami in Encouraging Entrepreneurial Mindset in the Village

The role of Telecom Grameen Udhyami (rural entrepreneurs in the telecom industry) in encouraging an entrepreneurial mindset in the village is multifaceted and significant. Here's an explanation of how they contribute to fostering entrepreneurship within their communities:

- **Demonstrating Entrepreneurial Success:** Telecom Grameen Udhyamis serve as living examples of successful entrepreneurship within the village. By establishing and running their telecom businesses effectively, they showcase the possibilities of self-employment and small-scale entrepreneurship.
- **Providing Opportunities:** These entrepreneurs offer employment and business opportunities to local individuals, thereby stimulating economic growth. They contribute to job creation and impart essential skills by hiring and training local talent.
- **Inspiring Innovation:** Telecom entrepreneurs often need to adapt to changing technologies and market demands. Their efforts to provide innovative telecom solutions can inspire others in the community to explore new ideas and opportunities.
- Facilitating Digital Literacy: Telecom Grameen Udhyamis plays a vital role in bridging the digital divide. They provide digital literacy training to community members, teaching them how to use smartphones, access the internet, and utilize digital resources for personal and business development.
- **Encouraging Networking:** These entrepreneurs frequently collaborate with local businesses, educational institutions, and government agencies to expand their services. This network-building fosters an entrepreneurial ecosystem, creating opportunities for partnerships and collaborations.
- **Supporting Micro-Enterprises:** Telecom services are often essential for thriving micro-enterprises and small businesses. Telecom Grameen Udhyamis empower these businesses with the connectivity they need to reach customers, manage operations, and explore growth avenues.
- **Promoting Financial Inclusion:** They facilitate mobile banking and financial services, encouraging villagers to engage in digital financial transactions. This promotes financial inclusion and entrepreneurial opportunities, such as savings and microloans.
- Community Engagement: Telecom entrepreneurs actively engage with the local community, seeking feedback and understanding the unique needs and challenges of the village. They then tailor their services to address these specific requirements, thus contributing to the growth of local businesses.
- Mentorship and Guidance: These entrepreneurs often become mentors and advisors to aspiring local entrepreneurs. They share their experiences, offer guidance, and help others navigate the complexities of starting and running a business.
- **Promoting Self-Reliance:** By providing essential services within the village, Telecom Grameen Udhyami reduce the dependency on external service providers. This instils a sense of self-reliance and autonomy within the community.

#### **UNIT 1.2: Optical Fiber Technology and the Role of an Optical Fiber Splicer**

## Unit Objectives 6



#### By the end of this unit, the participants will be able to:

- 1. Summarize the history of optical fiber.
- 2. Infer the importance of cable jackets, strength members, and moisture/water-blocking compounds.
- 3. Explain the various fiber geometric parameters (core, clad, and buffer).
- 4. Compare optical fiber performance parameters like attenuation, bending, dispersion, cut-off wavelength, and modified diameter.
- 5. Illustrate the working principle of an optical fiber communication system.
- 6. Identify the roles and responsibilities of an Optical Fiber Splicer.
- 7. Prepare for the role of an Optical fiber splicer by visiting a work site and interacting with others.
- 8. Per the route plan, perform coordinating activities for installation and commissioning of Optical Fibre Cable (OFC).
- 9. Identify the challenges faced during the handling of fiber optics.

#### 1.2.1 Introduction to Optical Fibre Technology

Fiber optics is a technology that employs the transmission of light signals using glass or plastic fibers. These fibers are widely utilized in various applications, including communications, lighting, and sensors. The concept of optical fibers was first developed around 40 years ago, originating in research labs in Chicago, USA.

In the early days of its development, optical fibers replaced traditional copper cables and microwave systems as a means of transmitting signals due to their advantages in terms of speed, capacity, and data integrity. This transition took place during the late 1980s and marked a significant shift in the telecommunications industry.

In the 2000s, optical fibers found widespread use in providing high-speed internet connections to homes, commonly known as Fiber to the Home (FTTH) or Fiber to the Premises (FTTP) services. Fiber optic technology revolutionized home internet connectivity by delivering faster and more reliable data transmission.

In the past, optical fibers were primarily employed in telephone communications to transmit signals from senders to receivers. However, with the advent of mobile and wireless internet systems, digital communication methods have largely replaced traditional phone lines.

While wireless technologies dominate the current market for mobile communications, optical fibers are still widely used in local area networks (LANs) and long-distance communication networks to transmit data and signals with exceptional speed and efficiency. The capacity and reliability of optical fiber make it an indispensable component in modern telecommunications and data transmission systems.

#### **1.2.2 Structure of Optical Fibers**

The structure of optical fiber cables is designed to protect the delicate optical fibers within and ensure reliable transmission of light signals over long distances. These cables are engineered with multiple layers to shield the fibers from environmental factors and physical damage.

Here is an elaboration of the structure of optical fiber cables:

**Core:** The core is the central region of the optical fiber cable where light travels. It is typically made of highly transparent glass or plastic with a higher refractive index than the cladding. The core's refractive index is carefully chosen to facilitate total internal reflection, which keeps the light signals within the core.

**Cladding:** Surrounding the core is the cladding, a layer of glass or plastic with a slightly lower refractive index than the core. The refractive index difference

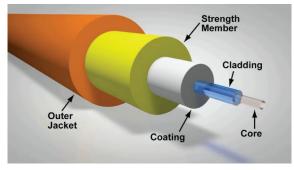


Fig. 1.2.1: Generic Structure of an Optical Fiber Cable

between the core and cladding is crucial for the total internal reflection of light within the core. The cladding serves to guide the light and prevents it from escaping.

**Buffer/Coating:** A buffer or coating further protects the optical fibers. This layer is made of a soft and protective material, often a UV-cured acrylate that covers the cladding. It safeguards the fragile core and cladding from physical damage, moisture, and other environmental factors.

**Strength Members:** To provide structural integrity and tensile strength to the optical fiber cable, strength members are integrated. Aramid fibers, fiberglass, or steel wires are typically used as strength members. These materials help the cable withstand the forces exerted during installation and under tension.

Central Tube or Filling Compound (in loose-tube cables): In some cable designs, especially loose-tube cables, a central tube or a filling compound surrounds the optical fibers. This structure prevents water ingress and provides extra protection, ensuring that the fibers maintain their integrity in harsh conditions.

Water-Blocking Elements: Optical fibre cables often incorporate water-blocking elements to further



Fig. 1.2.2: Water Blocking and Filling Yarn

protect against moisture and water infiltration. These can be in the form of gel-filled tubes, water-swellable tapes, or moisture-blocking yarns. These elements are crucial for maintaining the cable's performance, especially in outdoor and underground installations.

**Armor or Outer Sheath:** The outermost layer of the optical fiber cable is the armor or outer sheath. This protective covering shields the cable from physical stress, weather conditions, and external damage. The outer sheath can be made of materials such as polyethylene (PE), polyvinyl chloride (PVC), or thermoplastic materials.

**Ripcord (Optional):** Some cables may feature a ripcord under the outer sheath, which aids in removing the outer sheath during cable termination or splicing.

**Marker Tape (Optional):** In certain applications, a marker tape with identification information may be included just beneath the outer sheath to label the cable for identification and management purposes.

**Strength Elements (Optional):** For aerial installations, optical fiber cables can include additional strength elements, such as steel wires or messenger wires, to support the cable's weight and maintain tension.

#### 1.2.3 How Fiber Optics Works?

Fiber optics is a sophisticated technology that involves the transmission of light signals through thin, flexible strands of glass or plastic known as optical fibers. These fibers are designed to carry data over long distances, making them a fundamental component of modern telecommunications and data transmission systems.

Here's a detailed explanation of how fiber optics works:

- **Light as the Information Carrier:** At the heart of fiber optics is the use of light as the carrier of information. Light is an electromagnetic wave that travels in straight lines and can carry vast amounts of data in the form of digital or analog signals.
- Optical Fiber Structure: The core of the optical has a higher refractive index than the cladding, which is the outer layer surrounding the core. This difference in refractive indices is essential for the functioning of optical fibers.
- **Total Internal Reflection:** The core of the optical fiber is designed to facilitate total internal reflection. Light entering the core from one end strikes the core-cladding interface at a shallow angle. Due to the refractive index difference, the light reflects off the interface, staying within the core.

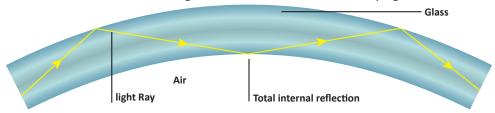


Fig. 1.2.3: Total Internal Reflection in Optical Fibre

- Multiple Reflections: As the light progresses along the fiber, it continues to undergo multiple
  internal reflections, bouncing off the core-cladding interface. This process is what keeps the light
  signal confined within the core, preventing signal loss.
- Modal Dispersion: Light can follow multiple paths or modes in multimode fibres, resulting in modal dispersion. However, with a narrower core, single-mode fibres limit the number of modes, allowing for faster and more precise data transmission.
- **Signal Encoding:** Data is encoded onto the light signal by using various modulation techniques, such as amplitude modulation or frequency modulation. This encoding transforms the information into variations in the light signal.
- **Transmission:** The modulated light signal enters one end of the optical fiber. As it travels through the core, it retains its integrity due to total internal reflection. The signal can travel for long distances without significant degradation.
- **Signal Amplification:** Periodic signal amplification may be necessary for very long-distance transmission. Optical amplifiers, like erbium-doped fiber amplifiers (EDFAs), are used to boost the light signal without converting it back to electrical form.
- **Signal Reception:** At the receiving end of the optical fiber, a photodetector is employed to convert the light signal back into an electrical signal. The photodetector detects the light's intensity variations and decodes it to retrieve the transmitted data.
- **Data Processing:** Once the electrical signal is obtained, it undergoes further processing, error correction, and data interpretation to extract the original information.
- **Signal Regeneration:** For very long-distance transmissions, signal regeneration may be needed. Regeneration equipment detects and amplifies the optical signal to maintain its quality over extended distances.

#### **1.2.4 Types of Optical Fibres**

There are two main types of optical fibers:

#### Single-Mode Fiber (SMF):

Single-mode fiber features an extremely narrow core diameter, typically around 8.3 micrometers. This small core allows only a single mode (path of light) to propagate through the fiber. SMF is favored for long-distance transmission due to its minimal signal loss. It offers exceptional bandwidth and is widely used in telecommunications and high-speed data networks.

#### Multimode Fiber (MMF):

Multimode fiber has a larger core diameter, typically 50 or 62.5 micrometers, enabling multiple modes of light to travel through it simultaneously. MMF is a cost-effective solution for shorter-distance transmissions, such as within data centers and LANs. However, it is limited by modal dispersion, which can affect signal quality over extended distances.

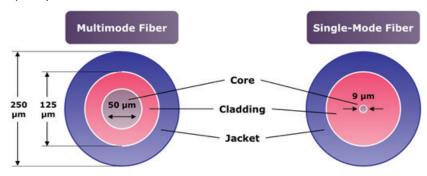


Fig. 1.2.4: Different Types of Optical Fibers

Within each of these two main optical fibre types, there are several different subtypes. Some of the most common subtypes include:

- **Step-Index Fiber:** Step-index multimode fiber features a core with a uniform refractive index and a cladding with a lower refractive index. This difference causes total internal reflection at the corecladding boundary, guiding light signals.
- **Graded-Index Fiber:** In graded-index multimode fiber, the core's refractive index gradually decreases from the center to the edges, reducing modal dispersion and signal distortion.

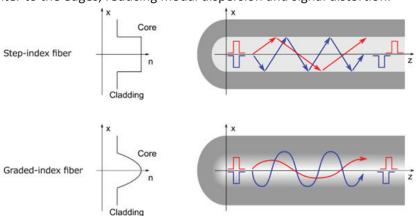


Fig. 1.2.5: Step-Index multimode fiber and Graded-index multimode fiber

- **Dispersion-Shifted Fiber:** This subtype is a type of single-mode fiber designed to minimize chromatic dispersion, making it suitable for high-speed data transmission applications.
- **Non-Zero Dispersion Shifted Fiber:** This single-mode fiber has a specific amount of chromatic dispersion and is used for certain optical amplifier applications.
- Bending-Insensitive Fiber: Bending-insensitive optical fiber is engineered to withstand bending
  without signal loss, making it ideal for applications where cables may be routed through tight
  spaces or bent during installation.

Optical fibers can be classified by the material they are made of. The most common type is silica glass, known for its excellent optical properties and widespread use. However, other materials, such as plastic or fluoride glass, can also be used in specialized applications.

These variations in core diameter, refractive index profiles, and materials allow optical fibers to be tailored to specific requirements, making them versatile in a wide range of applications, from long-distance telecommunications to high-speed data transmission and even in scenarios where bending or tight routing is a concern. Each type and subtype serves a distinct purpose in optical communications.

#### **1.2.5 Optical Fiber Performance Parameters**

#### **Attenuation**

Attenuation refers to the loss of optical power as light travels through the optical fiber. It is typically measured in decibels per kilometre (dB/km). Attenuation is critical because it determines how far a light signal can travel before it becomes too weak to be detected or decoded at the receiving end. Low attenuation is essential for long-distance transmission and high-quality data transfer.

Single-mode fibers have lower attenuation, often less than 0.2 dB/km, making them suitable for long-distance transmission. Multimode fibers typically have a higher attenuation, around 3 dB/km for 850 nm wavelength and 1 dB/km for 1300 nm wavelength.

#### **Bending Loss**

Bending loss, also known as macro-bending loss, is the optical power loss that occurs when an optical fiber is bent beyond a certain radius. It's a critical parameter for applications where fibers may need to bend around corners, such as in cable routing. Minimizing bending loss is essential to maintain signal quality.

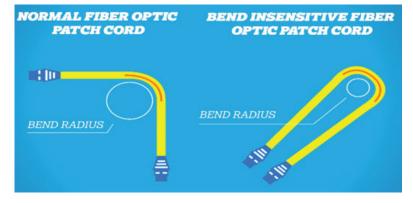


Fig. 1.2.6: Bend Radius of Normal and Bend Insensitive Fiber Optical Cable

The bending radius should not fall below the specified minimum bend radius for the given fiber, typically in the range of a few millimetres for tight-buffered fibers to a few centimetres for loose-tube cables.

#### Dispersion

Dispersion is the spreading of optical signals as they propagate through the fiber, leading to signal distortion. Two main types of dispersion are:

- **Chromatic Dispersion:** It results from the dependence of the refractive index on wavelength. For single-mode fibers, chromatic dispersion is typically in the range of 17-20 ps/nm·km.
- Modal Dispersion: Multimode fibers are more susceptible to modal dispersion, ranging from 500 to 1000 ps/km·nm.

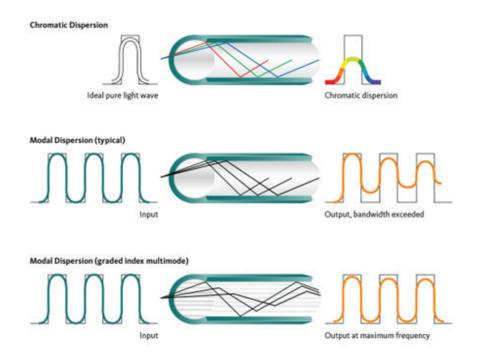


Fig. 1.2.7: Dispersion in Optical Fiber

#### **Cut-off Wavelength**

The cut-off wavelength is the specific wavelength at which a single-mode optical fiber transitions to multimode behaviour. Below the cut-off wavelength, the fiber only supports a single mode, and above it, it allows multiple modes to propagate. Knowledge of the cut-off wavelength is important for selecting the right fiber for the intended application.

For standard single-mode fibers, the cut-off wavelength is typically around 1260 nm.

#### **Modified Diameter**

The modified diameter, also known as the mode field diameter (MFD), measures the optical mode size within the fiber core. It affects the coupling efficiency between optical components and the fiber.

The mode field diameter is typically around 9.2  $\mu m$  for standard single-mode fibers operating at 1310 nm.

# 1.2.6 Working Principle of an Optical Fiber Communication System

An optical fiber communication system utilises optical fibres, slender, flexible strands made of glass or plastic, to transmit light signals over long distances at high speeds. This system is composed of fundamental components that ensure the successful transmission and reception of data:

- **Transmitter:** The transmitter serves as the starting point of the communication process. It transforms an electrical signal into an optical signal, typically employing a laser or light-emitting diode (LED) to achieve this conversion.
- Optical Fiber Cable: The optical fiber cable acts as the conduit for the optical signal. It facilitates
  the transmission of the optical signal from the transmitter to the receiver, maintaining the integrity
  and quality of the signal.
- **Receiver:** The receiver, located at the other end of the optical fiber, performs the reverse process of the transmitter. It converts the optical signal back into an electrical signal, a task typically executed by a photodetector.

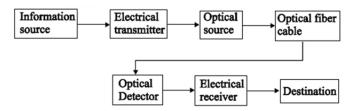


Fig. 1.2.8: Block Diagram of Optical Fiber Communication System

The functioning of an optical fiber communication system can be summarized in the following sequence:

- **Step 1:** The transmitter receives an electrical signal and transforms it into an optical signal using a laser or LED.
- **Step 2:** The optical signal is conveyed through the optical fiber cable, where it travels over long distances while preserving its quality and integrity due to the principles of total internal reflection within the fiber.
- **Step 3:** Upon reaching the destination, the receiver receives the optical signal and reverts it into an electrical signal through a photodetector.
- **Step 4:** The resulting electrical signal is then processed by electronic devices and systems at the receiver's end, enabling data interpretation, further transmission, or any other relevant actions.

#### 1.2.7 Optical Fiber Splicing

Optical Fiber Splicing is a meticulous process involving permanently joining two optical fiber cables, creating a continuous optical path. This precision connection enables the transmission of light signals from one fiber to another with minimal or no signal loss, making it a fundamental technique in the realm of telecommunications and data transmission. Optical Fiber Splicing is instrumental in maintaining the integrity of optical communication networks, ensuring seamless and high-quality connectivity.

#### **Types of Optical Fiber Splicing**

There are two primary techniques for Optical Fiber Splicing, each with its specific applications and significance:

- **Fusion Splicing:** Fusion Splicing involves the precise melting of the ends of two optical fibers, followed by their fusion into a single, continuous fiber. This meticulous process results in a low-loss, permanent connection, virtually eliminating signal attenuation.
  - Fusion Splicing is the preferred method for long-distance telecommunications and high-speed data transmission applications where signal quality is paramount.
- Mechanical Splicing: Mechanical Splicing employs alignment fixtures and gel to connect optical
  fibers. While it may exhibit slightly higher insertion losses compared to fusion splicing, it offers a
  more expedient and cost-effective solution.

It finds application in scenarios where rapid, temporary connections are needed or extremely high precision is not a primary concern, such as testing and troubleshooting activities.

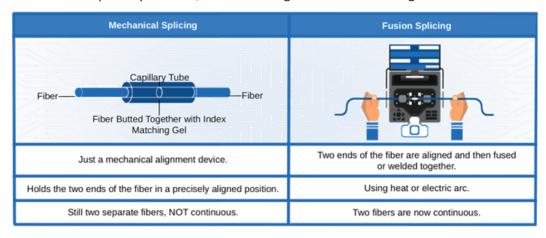


Fig. 1.2.9: Mechanical Splicing Vs. Fusion Splicing

#### Why is Optical Fiber Splicing Done?

Several compelling reasons drive the execution of Optical Fiber Splicing:

- Extending Optical Networks: Optical Fiber Splicing empowers network operators to extend their
  optical networks by seamlessly connecting fiber cables across extensive distances. This capability
  is indispensable for telecommunications and internet services to reach remote and underserved
  areas, bridging connectivity gaps.
- Repair and Maintenance: In situations where optical fiber cables sustain damage or experience signal loss due to external factors like cuts, bends, or environmental influences, Optical Fiber Splicing is deployed for effective repairs. This restorative measure is pivotal in returning the damaged sections to operational status, and restoring the network's functionality.
- **Signal Quality:** Signal quality is paramount in the realm of telecommunications and data networks. Optical Fiber Splicing is essential for minimizing signal loss, ensuring the high-quality transmission of data over considerable distances. This is fundamental for sustaining reliable communication services
- Network Expansion: As data and communication services demand escalates, network expansions
  become imperative. Optical Fiber Splicing plays a pivotal role in accommodating this growth by
  facilitating the seamless integration of new fiber optic cables into existing networks. It ensures
  the scalability and flexibility required to meet the evolving needs of modern communication
  infrastructure.

#### 1.2.8 Introduction to the Role of Optical Fiber Splicer

An Optical Fiber Splicer plays a pivotal role in modern telecommunications by expertly splicing together fiber optic cables. This process involves combining scientific knowledge and cutting-edge telecom technology to seamlessly connect thin strands of flexible glass that enable the transmission of light from one location to another.

The responsibilities of a Fiber Splicer Technician are both specialized and essential. They specialize in the intricate process of terminating fiber optic cables, a critical task for extending telecom networks into new areas, enhancing existing ones, or resolving issues with signal transmission. Fiber Splicer Technicians are responsible for installing, troubleshooting, and maintaining fiber optic cables used for high-speed communications. They employ a variety of specialized tools and techniques to cut, connect, and test these wires to ensure optimal performance. These professionals are also known as telecommunications line installers and repairers, with a specific focus on the aspects of fiber optic cables utilized in phone, television, and data networks.

The roles and responsibilities of an Optical Fiber Splicer encompass the following key tasks:

- Cable Installation, Maintenance, and Repair: Optical Fiber Splicers are involved in the installation, maintenance, and repair of fiber optic cables, which form the backbone of modern telecommunications.
- **Splicing Activity:** They expertly perform splicing activities, ensuring the seamless connection of fiber optic cables.
- Cable Fault Detection and Repair: These professionals are adept at locating cable faults and promptly repairing them to maintain the existing cable network's integrity without causing signal interruptions.
- **End-to-End Testing:** Optical Fiber Splicers conduct thorough end-to-end testing to ensure seamless service provisioning across the cable network.
- **Cable Termination Verification:** They confirm the accuracy of cable terminations on cross-connects, hubs, patch panels, and routers to guarantee smooth signal transmission.
- Site Surveys and Documentation: Optical Fiber Splicers also conduct site surveys to assess
  conditions and prepare detailed reports, design drawings, and technical manuals necessary for
  cable installation feasibility.
- **Project Management:** They maintain project tracking information, including production sheets, time sheets, and required paperwork, to ensure efficient project management.
- **Safety and Compliance:** An Optical Fiber Splicer prioritizes safety and a secure work environment by adhering to legal regulations and government standards.

#### 1.2.9 Installation Coordination and Handling Challenges

Performing coordinating activities for installing and commissioning Optical Fiber Cable (OFC) is a crucial task in optical fiber splicing. Here's a professional guide on how to execute these activities while addressing the challenges faced during the handling of fiber optics:

Coordinating Activities for OFC Installation and Commissioning:

- **Route Plan Analysis:** Begin by thoroughly reviewing the route plan provided. Understand the layout, distances, and the specific locations where the OFC needs to be installed.
- Resource Allocation: Determine the required resources, including cables, splice closures, connectors, and splicing equipment. Ensure that you have the necessary tools and materials at your disposal.

- Safety Precautions: Before commencing any work, conduct a safety assessment. Identify potential hazards and take appropriate measures to mitigate them. This includes personal protective equipment (PPE) and adherence to safety protocols.
- **Site Preparation:** Inspect the installation sites for any obstacles or obstructions that may hinder the installation process. Ensure that the work environment is conducive to safe and efficient installation.
- **Cable Preparation:** Prepare the optical fiber cables according to the required specifications, including cable lengths, splice points, and connector terminations.
- **Splicing and Testing:** Carry out the splicing of optical fibers with precision. Perform rigorous testing to verify signal integrity and detect any issues that may arise during the installation.
- **Documentation:** Maintain comprehensive documentation of the installation process, including cable routing, splice points, test results, and any deviations from the original plan.
- Quality Assurance: Implement quality checks at every stage to ensure that the installation meets industry standards and performance requirements.

#### **Challenges Faced During Handling of Fiber Optics:**

- **Fragility:** Optical fibers are extremely delicate and can break or bend easily. Special care is required when handling, as improper treatment can lead to signal loss.
- **Microbending and Macrobending:** Bending of fibers can cause signal attenuation. Avoid sharp bends and ensure that cable routing follows a gentle curve.

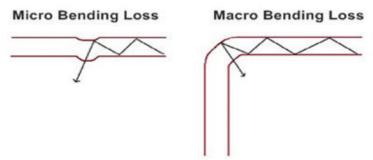


Fig. 1.2.10: Microbending and Macrobending

• **Contamination:** Dust, dirt, and oil can contaminate optical connectors and degrade signal quality. Proper cleaning and inspection are essential.

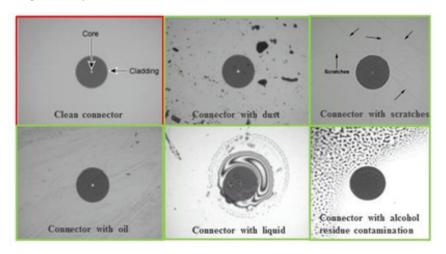


Fig. 1.2.11: Contamination in Optical Fiber Connector

- **Connector Mismatches:** Using connectors from different manufacturers or with different specifications can lead to signal loss. Ensure compatibility and use high-quality connectors.
- **Cable Strain:** Excessive tension during installation can damage fibers. Careful handling and proper strain relief techniques are essential.
- **Environmental Factors:** Harsh environmental conditions like extreme temperatures and moisture can impact fiber performance. Protective measures should be taken in challenging environments.
- **Splice Quality:** Poor splicing techniques, misalignment, or dirty connectors can result in signal loss. Regular training and quality control are essential to maintain splice quality.
- Accurate Documentation: Incomplete or inaccurate documentation can lead to difficulties in troubleshooting and maintenance. Ensure detailed and accurate records are kept.

#### **UNIT 1.3: Wi-Fi Broadband Installation and Cable** Maintenance

## Unit Objectives 6



#### By the end of this unit, the participants will be able to:

- 1. Identify various electrical and electronic components and their specifications.
- 2. Discuss the scope/future and industry of Wi-Fi broadband.
- 3. Explain the processes and technologies used in the installation of Wi-Fi broadband.
- 4. Demonstrate how to install cables inside homes and businesses or service outdoor lines at a communications company.
- 5. Demonstrate how to utilize all varieties of cable construction equipment, cables, and safety test equipment.
- 6. Conduct preventive maintenance activities and ensure effective fault management in case of fault occurrence.
- 7. State the safety, health, and environmental policies and regulations for the workplace and telecom sites in general.

#### 1.3.1 Electrical and Electronic Components used for Wireless Installations

Wireless technicians use a variety of electrical and electronic components to install, configure, maintain, and troubleshoot wireless networks.

#### Antennas

An antenna is an electrical device designed to transmit or receive electromagnetic waves. It is usually a metallic structure or arrangement of conductors that converts electrical signals into electromagnetic waves (transmitting) or electromagnetic waves into electrical signals (receiving).

Antennas are commonly used in communication systems such as radio, television, cellular telephony, and satellite communication. An antenna's shape, size, and design depend on the frequency of the signal it is intended to send or receive and the specific application for which it is used.



Fig. 1.3.1: Directional Antenna

Antennas are also used in scientific research, military applications, and other fields where the transmission

and reception of electromagnetic waves are important. Antennas are used to transmit and receive wireless signals. Wireless technicians use different types of antennas, including omnidirectional antennas, directional antennas, and Yagi antennas, depending on the network requirements.

#### **Transmitters and Receivers**

Transmitters and receivers are fundamental components in wireless communication systems, facilitating the transmission and reception of wireless signals.

- Transmitters: These devices are responsible for converting information, such as voice, data, or video, into electromagnetic signals suitable for wireless transmission. They utilize modulation techniques to encode data onto carrier waves, and their power output is measured in watts (W). Higher power transmitters can cover longer distances. Transmitters typically operate within specific frequency bands, such as those allocated for Wi-Fi, cellular networks, or broadcasting. Depending on the application, they vary in terms of modulation schemes, bandwidth, and output power.
- Receivers: On the receiving end, receivers capture wireless signals, demodulate them to extract
  the original information, and deliver it for further processing. Receivers operate within the same
  frequency bands as transmitters and are designed to be sensitive to weak signals. Sensitivity is a
  crucial receiver specification, typically measured in dBm (decibels referenced to one milliwatt). A
  more sensitive receiver can detect signals from greater distances. Advanced receivers incorporate
  features like error correction, automatic gain control, and filtering to enhance signal quality and
  mitigate interference.

#### **Amplifiers**

Amplifiers are devices used to increase the strength of wireless signals. They can be instrumental in extending the range of wireless networks or improving signal quality. Amplifiers boost the power of wireless signals, measured in decibels (dB). They are particularly useful in scenarios where the signal strength is insufficient for reliable communication. Common types of amplifiers include power amplifiers and low-noise amplifiers, each serving distinct purposes.



Fig. 1.3.2: Low Noise Amplifier

In wireless networks, amplifiers can be used in various applications. For example, in cellular networks, power amplifiers are employed to increase the reach of base stations, allowing mobile devices to connect from farther distances. Low-noise amplifiers are utilized in the receiver front-end to enhance the sensitivity of the system and capture weaker incoming signals. Amplifiers can be essential in satellite communication, Wi-Fi extenders, and radio broadcasting.

It's critical to balance signal improvement with potential drawbacks like increased noise and interference when using amplifiers. Over-amplification can lead to signal distortion, reducing signal quality.

#### Repeaters

Repeaters are crucial for extending the coverage of wireless networks. They receive signals and retransmit them to improve wireless coverage. Repeaters serve as intermediaries in wireless communication. They receive signals from a source, such as a base station, and retransmit them to reach areas with weak or no signal. By doing so, they effectively "repeat" the signal, hence their name. Repeaters are invaluable in scenarios like large buildings, tunnels, remote areas, and outdoor spaces where physical obstacles or long distances hinder signal propagation.

Repeaters can be categorized based on their application and frequency range. For instance, cellular signal boosters are a



Fig. 1.3.3: Dual Band Fiber Optic Repeater

common type of repeater used to improve mobile phone coverage. They operate in specific frequency bands, such as those designated for 3G, 4G, or 5G. Other repeaters are designed for Wi-Fi networks and extend coverage within the 2.4 GHz and 5 GHz bands.

They are strategically placed between the source of the signal and the area with poor coverage. They capture the signal, amplify it, and retransmit it. The quality of repeater installation, including antenna placement and signal strength optimization, is critical to achieving the desired coverage extension.

#### Power over Ethernet (PoE) Injectors

PoE injectors are used to power network devices such as wireless access points, IP cameras, and VoIP phones. They eliminate the need for separate power cables, making installation easier.



Fig. 1.3.4: PoE Injectors

#### **Routers and Switches**

Routers and switches are network devices that are used to manage and direct data traffic on the wireless network. Routers connect multiple networks together and help to direct data packets to their intended destination. Switches are used to connect multiple devices together and to manage the flow of data between them.





Fig. 1.3.4: Router

Fig. 1.3.5: Network Switch

#### **Surge Protectors**

Surge protectors are used to protect network equipment from power surges and lightning strikes. They can help prevent damage to network equipment and ensure that wireless networks remain operational.



Fig. 1.3.6: Ethernet Surge Protector

#### **Cables**

Coaxial and fibre-optic cables are used to transmit data and power to network devices. Coaxial cables are commonly used for short-distance connections, while fibre-optic cables are used for long-distance connections.

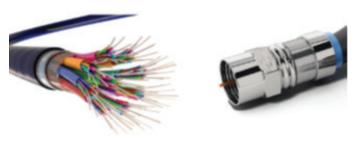


Fig. 1.3.7: Fiber Optics Cable and Coaxial Cable

#### **Ethernet Cables**

Ethernet cables are used to connect network devices such as wireless access points, routers, and switches. They are available in different lengths and categories, such as Cat5e, Cat6, and Cat7.

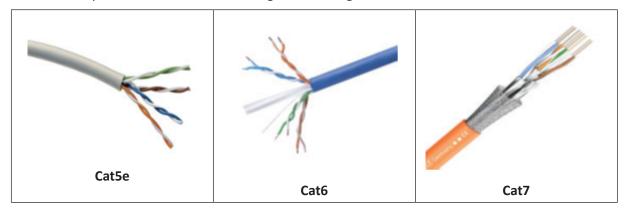


Table 1.3.1: Categories of Ethernet cables

#### **Power Supplies**

Power supplies are used to provide power to network equipment. They can be integrated into devices or be standalone components.

#### **Wireless Network Adapters**

Wireless network adapters are used to connect devices to wireless networks. These adapters can be built-in or external and can connect to wireless networks using various standards, such as 802.11a/b/g/n/ac.



Fig. 1.3.8: Wireless Network Adaptor (PCI)

### 1.3.2 Wi-Fi Broadband Industry in India

Wi-Fi broadband services in India have become increasingly popular in recent years as more and more people rely on the internet for work, education, entertainment, and communication. Wi-Fi broadband services provide high-speed internet connectivity over a wireless network, allowing users to access the internet from multiple devices simultaneously without the need for wired connections.

Wi-Fi broadband services are offered by a range of service providers in India, including private telecom companies such as Bharti Airtel, Reliance Jio, and Vodafone Idea, as well as internet service providers (ISPs) such as Hathway, Spectra, and ACT Fibernet. These companies offer various plans with different speeds, data limits, and prices, catering to the needs of different users.

One of the advantages of Wi-Fi broadband services is that they offer faster and more reliable internet connectivity than mobile networks. Wi-Fi networks can deliver speeds of up to 1 Gbps, which is significantly higher than the speeds offered by mobile networks. This makes Wi-Fi broadband services ideal for applications that require high-speed internet connectivity, such as video streaming, online gaming, and video conferencing.

Another advantage of Wi-Fi broadband services is that they offer more flexibility in terms of usage. Unlike mobile networks, which have data caps and can be expensive to use for heavy data consumption, Wi-Fi broadband services offer unlimited data plans, allowing users to consume as much data as they need without worrying about extra charges.

However, some challenges are associated with Wi-Fi broadband services in India. One of the biggest challenges is the lack of infrastructure in many areas, especially in rural areas, where access to high-speed internet connectivity is limited. Another challenge is the high installation and maintenance cost of Wi-Fi networks, which can make it difficult for smaller service providers to compete with larger players in the market.

The market share of Wi-Fi broadband players in India constantly evolves and is subject to change. However, based on recent reports and surveys, some of the leading players in the Wi-Fi broadband market in India and their respective market shares are:

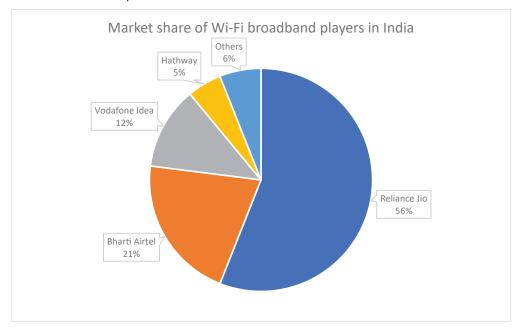


Fig. 1.3.9: Market share of Wi-Fi broadband players in India (Source: https://pib.gov.in/)

Reliance Jio is India's largest player in the Wi-Fi broadband market, with a market share of around 56%. The company offers high-speed internet connectivity through its JioFiber service, which offers various plans with different speeds, data limits, and prices.

Reliance Jio is followed by Bharti Airtel as the second major player in the Wi-Fi broadband market in India, with a market share of around 21%. The company offers its broadband services under the brand name Airtel Xstream Fiber, with plans ranging from 100 Mbps to 1 Gbps speeds.

Vodafone Idea is India's third largest telecom operator and offers Wi-Fi broadband services through its Vodafone Fiber service. The company has a market share of around 12% in the Wi-Fi broadband market in India.

It is important to note that the market share of Wi-Fi broadband players in India is constantly changing due to the intense competition in the market, the entry of new players, and changes in customer preferences and behaviour.

The scope and future of Wi-Fi broadband in India are significant as the demand for high-speed internet connectivity continues to grow in the country. With the continued growth of the internet economy in India, more and more people are relying on the internet for work, education, entertainment, and communication. This has led to a significant increase in demand for high-speed internet connectivity, especially in urban areas.

The Wi-Fi broadband industry in India is expected to grow significantly in the coming years. According to a report by the India Brand Equity Foundation, the Wi-Fi hotspot market in India is projected to grow at a compound annual growth rate (CAGR) of around 28% from 2021 to 2026, reaching a value of around \$3.3 billion by 2026.

Some of the key factors that are likely to shape the future of Wi-Fi broadband in India are:

- Increasing penetration: The penetration of Wi-Fi broadband services in India is expected to increase in the coming years as more and more people become aware of the benefits of high-speed internet connectivity. The increasing availability of Wi-Fi hotspots in public places, such as airports, cafes, and malls, is also expected to contribute to the growth of Wi-Fi broadband in India.
- Government policies: The Indian government's initiatives, such as the National Broadband Mission,
  National Digital Communications Policy, Digital India, BharatNet and Wi-Fi Access Network Interface
  (WANI), are expected to play a key role in driving the growth of the Wi-Fi broadband industry in
  India. These initiatives aim to provide high-speed internet connectivity to all citizens across the
  country, especially in rural areas.
- Infrastructure development: The development of infrastructure for Wi-Fi broadband, including the installation of fibre optic cables and the deployment of Wi-Fi hotspots, is likely to improve the quality and reliability of internet connectivity in India. The government's initiatives, such as the National Broadband Mission, are expected to play a significant role in the development of infrastructure for Wi-Fi broadband in India.
- Advancements in technology: Advancements in technology, such as 5G and Wi-Fi 6, are likely
  to further enhance the capabilities of Wi-Fi broadband services in India. These technologies
  are expected to deliver higher speeds, lower latency, and improved connectivity, making Wi-Fi
  broadband even more attractive to consumers.
- **Increased competition:** The Wi-Fi broadband market in India is highly competitive, with a large number of players vying for market share. This is likely to drive innovation and improvements in service quality as companies compete to offer better plans, speeds, and customer service.

### 1.3.3 Wi-Fi Broadband Technology

Wi-Fi broadband is a wireless networking technology that uses radio waves to provide high-speed internet connectivity to devices such as laptops, smartphones, and tablets. Wi-Fi broadband uses a set of technologies to ensure reliable and fast data transmission over wireless networks.

One example of Wi-Fi Broadband Technology is 802.11ac, also known as Wi-Fi 5. This wireless networking standard operates in the 5 GHz frequency band and supports data transfer rates of up to 1.3 Gbps. It uses multiple antennas and advanced modulation techniques to provide faster and more reliable wireless connections than previous Wi-Fi standards.

An example of the installation process of Wi-Fi 5 is stated below:

- Pre-installation preparation: The technician will contact you to arrange a suitable installation date
  and time. They will also check the location and installation requirements, including the router type,
  modem, and any additional hardware needed.
- **Installing the modem:** The technician will install the modem in a suitable location near the telephone or cable outlet. They will then connect the modem to your internet service provider's network.
- **Installing the router:** The technician will install the Wi-Fi 5 router in a central location within your home or office, ensuring that it is located away from any sources of interference, such as microwaves or other electronic devices.
- **Connecting devices:** The technician will then connect any devices that you want to use with the Wi-Fi network, such as smartphones, laptops, or tablets, to the network.
- **Configuring the router:** The technician will configure the router's settings, such as the Wi-Fi network name (SSID) and password, and ensure that the router is using the latest firmware version.
- **Testing the connection:** Once the installation is complete, the technician will test the Wi-Fi network to ensure that it is working correctly and that all devices are able to connect to it.
- **Providing aftersales support:** After the installation, the technician will provide you with any necessary information or documentation, such as the Wi-Fi network name and password, and provide you with contact information for after-sales support in case of any issues or concerns.

Some of the key technologies used in Wi-Fi broadband are:

### • IEEE 802.11 standards

Wi-Fi broadband networks use IEEE 802.11 standards to ensure compatibility and interoperability between devices from different manufacturers. These standards define the specifications for wireless local area networks (WLANs) and include various protocols for data transmission, network security, and network management.

### Multiple Input Multiple Output (MIMO)

MIMO is a technology that uses multiple antennas at both the transmitter and receiver ends to improve wireless signal quality and increase data transmission rates. MIMO allows more efficient use of available radio frequency (RF) spectrum by transmitting and receiving multiple data streams simultaneously.

### Carrier Aggregation

Carrier aggregation is a technology that enables wireless networks to combine multiple frequency bands to increase data transmission rates. It allows for the use of wider bandwidths, which can provide faster data speeds and improved network capacity.

### Beamforming

Beamforming is a technique used to improve wireless signal quality and coverage by directing the radio signal towards the receiver. It uses multiple antennas to transmit and receive signals in a specific direction, which can help to reduce interference and improve signal strength.

### Quality of Service (QoS)

QoS is a set of technologies used to prioritize network traffic and ensure that critical data, such as voice and video, are given higher priority over less important data. This helps to ensure that the network can provide a consistent and reliable performance for different types of applications.

### Wi-Fi Protected Access (WPA) and Wi-Fi

Protected Access II (WPA2) WPA and WPA2 are security protocols used to protect Wi-Fi networks from unauthorized access and cyber-attacks. They use encryption to secure wireless network traffic and prevent dropping, data theft, and other security threats.

# **1.3.4** Installing Cables in Homes and Businesses or Servicing Outdoor Lines

Telecom technicians play a pivotal role in ensuring the seamless installation of cables inside homes and businesses and servicing outdoor lines for a communications company. This compre-hensive guide outlines the essential steps and best practices for performing these critical tasks.

#### **Indoor Cable Installation:**

- Site Assessment: Commence the process with a thorough site assessment, whether it's a residential or commercial setting. Identify the entry point for the cable, map out the routing path, and pinpoint the locations of endpoint devices, such as modems or routers.
- Cable Selection: Carefully select the appropriate type of cable tailored to the application's specific needs. Consider critical factors such as data transfer rates, transmission distance, and potential interference. Common cable types include Ethernet, coaxial, and fiber optic cables.



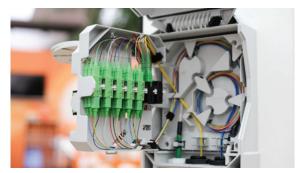
Fig. 1.3.10: Cable Routing

- **Routing:** Skilfully route the cable from the designated entry point to the endpoint device. This may involve the intricate task of running cables through walls, ceilings, or conduits. Employ cable clips, anchors, or conduits as necessary to secure and safeguard the cables, ensuring a clean and professional installation.
- Termination: Execute the termination process with precision and diligence. Properly connect the
  cable to the endpoint device using connectors or jacks, paying meticulous attention to detail. Ensure
  that all connections are tight and secure to avert signal loss or interference, thereby upholding
  optimal signal quality.
- **Testing:** Following installation, subject the cable connection to comprehensive testing to validate its flawless functionality. Scrutinize signal integrity, connectivity, and data transfer speeds to guarantee peak performance.

### **Outdoor Line Servicing:**

- Safety Precautions: Safety remains paramount when servicing outdoor lines. Prioritize personal protective equipment (PPE) such as gloves, helmets, and safety harnesses to ensure the well-being of yourself and your team.
- Access Points: Begin by identifying access points to the outdoor lines. These entry points may encompass distribution boxes, utility poles, or ground-level access locations. Mark and document these access points for future reference.

- Line Inspection: Conduct a meticulous visual inspection of the outdoor lines to identify any signs of damage, wear and tear, or loose connections. Promptly address any immediate issues to prevent signal degradation and service disruption.
- **Equipment Preparation:** Thoroughly prepare all necessary tools and replacement components, including connectors, splicing equipment, and test instruments. Ensure that you are Fig. 1.3.11: A FTTH Cabinet wellequipped to handle a spectrum of potential scenarios effectively.



- Splicing: If outdoor lines necessitate splicing, adhere to precise splicing procedures to establish secure connections. Choose the method suited to the context, whether employing fusion or mechanical splicing. Apply weatherproof enclosures or splice trays to shield the connections from environmental elements and guarantee long-term reliability.
- Testing and Verification: Conduct comprehensive testing and verification following the servicing. Conduct tests like the optical time-domain reflectometer (OTDR) testing for fiber optic lines or signal to test for copper lines. Ensure that all components meet operational specifications.
- **Documentation:** Methodically maintain detailed records of the outdoor line servicing. Document cable routes, splicing details, and test results. This comprehensive documentation is invaluable for future maintenance, troubleshooting, and network management.
- Weatherproofing: Safeguard outdoor connections and splices against the rigors of Splicing Terminal weather and environmental elements. Employ



Fig. 1.3.12: Outdoor Aerial Fiber Optical Cross Connect

- weatherproof enclosures and sealing materials to ensure the durability and resilience of your installations.
- Final Inspection: Conduct a meticulous final inspection to confirm that all components are securely fastened and adequately weatherproofed. Ensure that access points are securely sealed and properly marked for future reference.
- Cleanup: Conclude the process by leaving the work area in pristine condition. Dispose of waste materials and packaging in an environmentally responsible manner. Maintain a clean and organized workspace to uphold professionalism and safety.

# 1.3.5 Utilizing Cable Construction Equipment, Cable, and Safety Test Equipment

A Telecom Grameen Udhyami's proficiency in harnessing cable construction equipment, diverse cable types, and safety test equipment is indispensable for the efficiency and reliability of telecommunications infrastructure.

### **Cable Construction Equipment**

### **Cable Reel Stands:**

Cable reel stands are essential for supporting and dispensing large cable spools smoothly. They prevent cable entanglement and ensure organized spooling during installation.

Secure the reel stand firmly on a stable surface. Place the cable spool on the stand's spindle. Adjust the spindle's height to align with the desired pulling angle. As the cable unwinds, ensure it feeds smoothly without excessive tension or slack.



Fig. 1.3.13: Cable Reel Stand

### **Cable Pullers:**

Cable pullers are employed to apply controlled tension while laying cables, preventing kinks and ensuring even distribution.

Attach the cable to the puller's winch or drum. Place the puller at the starting point of the cable route. Slowly engage the winch to pull the cable, ensuring consistent tension and alignment as it's routed.



Fig. 1.3.14: Cable Puller

### **Cable Trenchers:**

Cable trenchers are indispensable for burying cables underground, combining trench excavation and cable laying in one operation.

Set the trencher's depth according to the cable's burial requirements. Start the trencher and guide it along the intended cable route. As the trencher excavates, the cable is simultaneously laid within the trench. Exercise caution to avoid damaging the cable during the process.



Fig. 1.3.15: Micro-Trenching

### **Cable Rollers:**

Cable rollers guide cables during installation, minimizing friction and protecting the cable's outer sheath.

Position cable rollers strategically along the cable route, ensuring they form a smooth and straight path. Gently feed the cable through the rollers, avoiding sharp bends or excessive tension.

# **1.3.6 Preventive Maintenance and Effective Fault Management in Telecom Cables**

Telecom technicians play a pivotal role in ensuring the reliability of telecommunications infrastructure by conducting preventive maintenance and efficiently managing faults in telecom cables. This comprehensive guide outlines the steps and best practices for these critical tasks.

### **Preventive Maintenance Activities:**

- **Regular Inspections:** Conduct routine visual inspections of all telecom cables, both indoor and outdoor. Look for signs of wear and tear, damage, loose connections, or environmental factors that could impact cable integrity.
- **Cleanliness:** Ensure that cable connectors and endpoints are kept clean and free from dust, debris, and moisture. Use appropriate cleaning materials and techniques to prevent signal degradation.
- Cable Routing: Regularly inspect cable routing to ensure that there are no sharp bends, kinks, or cable stress points. Correct any routing issues to prevent cable damage.
- Weatherproofing: Check and maintain weatherproof enclosures and seals for outdoor cables.
   Ensure that all cables are adequately protected from environmental elements like rain, snow, and extreme temperatures.



Fig. 1.3.16: Duct Sealing

Signal Testing: Periodically perform signal testing to assess the quality of the transmission. This includes using cable testers and network analyzers to identify any performance issues.

### **Effective Fault Management:**

- Fault Identification: In the event of a fault or signal disruption, quickly identify the location and the type of fault. This could include cable damage, connector issues, or environmental factors.
- **Isolation:** Isolate the affected section of the cable network to prevent the fault from affecting the entire system. This may involve disconnecting and rerouting cables as necessary.
- Visual Inspection: Conduct a thorough visual inspection of the affected area. Check for physical damage, loose connectors, or signs of tampering. Address any visible issues.
- **Testing:** Use specialized test equipment, such as optical time-domain reflectometers (OTDRs) for fiber optic cables or cable testers for copper cables, to pinpoint the exact location and nature of the fault.
- **Repair or Replacement:** Based on the nature of the fault, repair or replace the affected cables or connectors. Ensure that all replacements are of the same quality and type as the original components.
- Testing and Verification: After the fault is resolved, conduct rigorous Domain Reflectometers testing and verification to ensure the cable network functions correctly. This includes signal testing, connectivity checks, and data transfer rate tests.



Fig.. 1.3.17: Optical Time-

# 1.3.7 Safety, Health and Environmental Regulations for Workplace

sites to ensure the well-being of employees, customers, and the environment. Here are some examples of such policies and regulations:

Workplace Safety and Health: Employers are required to provide a safe working environment for their employees. This includes ensuring that the workplace is free from hazards, providing appropriate safety equipment and training, and complying with local safety regulations. Employers are also required to have an emergency response plan in place in case of accidents or natural disasters.

- **Electrical Safety:** Telecom sites use high-voltage electrical equipment, and there are specific regulations in place to ensure the safety of employees who work with or near these devices. These regulations include requirements for electrical safety training, the use of personal protective equipment, and compliance with local and national electrical codes.
- **Environmental Regulations:** Telecom sites can have an impact on the environment, and there are regulations in place to ensure that these impacts are minimized.
  - Environmental Impact Assessment (EIA): Telecom sites must undergo an EIA to assess the
    potential environmental impact of their operations. The EIA report includes information on the
    site's location, the potential impact on local ecosystems, and measures to mitigate any adverse
    effects.
  - o **Air Pollution Control:** Telecom sites must comply with local air pollution control regulations. This includes minimizing the release of pollutants such as dust, emissions from backup generators, and other sources that may contribute to air pollution.
  - Noise Pollution Control: Telecom sites must comply with local noise pollution control regulations.
     This includes minimizing the noise generated by backup generators, cooling systems, and other equipment.
  - o **Hazardous Waste Management:** Telecom sites generate hazardous waste, such as batteries and electronic waste, and must comply with local regulations for their disposal. This includes the safe storage, transportation, and disposal of hazardous waste.
  - Green Energy: Telecom sites are encouraged to use renewable energy sources such as solar, wind, or hydropower to reduce their carbon footprint. The Indian government has introduced several schemes to promote the use of green energy in telecom sites.
  - o **Biodiversity Conservation:** Telecom sites must take measures to protect local biodiversity, such as planting trees and maintaining green cover. They must also avoid disturbing local ecosystems, including wildlife and water bodies.
- Radiofrequency (RF) Radiation: Telecom sites use RF radiation to transmit wireless signals, and
  there are regulations in place to ensure that this radiation does not exceed safe limits. Employers
  are required to provide appropriate safety training and protective equipment to employees who
  work with RF radiation, and there are limits on the amount of RF radiation that can be emitted by
  telecom equipment.
- Occupational Health: Employers are required to provide a healthy working environment for their employees. This includes providing appropriate medical and first aid facilities, access to health and wellness programs, and compliance with local health regulations.

# **UNIT 1.4: Handset/Tablet Repair**

# **Unit Objectives**



### By the end of this unit, the participants will be able to:

- 1. List the roles and responsibilities of handset and tablet technician.
- 2. Explain complex technical issues to customers in a non-technical, simple-to-understand manner.
- 3. Determine components required based on fault diagnosis.
- 4. Provide repair and replacement estimates to customers.
- 5. Perform testing on handsets for adequacy.
- 6. Perform handset repair, including hardware and software components.
- 7. Manage post-repair activities and maintain inventory levels of hardware components.

# 1.4.1 List the Role and Responsibilities of Handset and Tablet Technician

Mobile and tablet repair technicians specializing in handset and tablet repair play a crucial role in ensuring the functionality and longevity of these devices. Their responsibilities encompass a wide range of technical tasks and customer interactions.

### Diagnosis and Troubleshooting:

- o Perform comprehensive diagnostics to identify hardware and software issues in handsets and tablets.
- Analyze customer complaints and conduct thorough testing to pinpoint the root causes of problems.

### • Repairs and Replacements:

- o Execute skilled repairs on mobile devices, including replacing damaged components like screens, batteries, and charging ports.
- o Utilize precision tools and techniques to conduct micro-soldering and component-level repairs.
- o Safely disassemble and reassemble devices, ensuring proper alignment and functionality.

### Software Solutions:

- o Resolve software-related problems, such as operating system issues, firmware updates, and application errors.
- o Perform software flashing and data recovery to restore devices to working condition.

### • Quality Control:

o Ensure the quality of repairs by conducting rigorous testing after each repair, including functionality checks, signal testing, and data connectivity assessments.

### • Customer Service:

- o Interact with customers to understand their device issues, provide repair estimates, and offer guidance on device maintenance.
- o Explain repair options, pricing, and repair timelines clearly to customers.

### • Inventory Management:

- o Manage inventory of spare parts, components, and tools to ensure availability for timely repairs.
- o Monitor stock levels and reorder supplies as needed.

#### Documentation:

- o Maintain accurate and detailed records of repairs, including customer information, repair procedures, and parts used.
- o Create service reports and invoices for customers.

### • Safety Compliance:

o Adhere to safety protocols and use personal protective equipment (PPE) to prevent accidents and maintain a safe working environment.

#### Data Security:

- o Safeguard customer data and privacy during repair and maintenance activities.
- o Follow data protection regulations and guidelines.

### Business Operations:

o Manage administrative tasks, including handling payments, scheduling appointments, and providing excellent customer service.

# 1.4.2 Explaining Complex Technical Issues to Customers in a Simple Manner

Explaining complex technical issues to customers simply and understandably is a crucial skill for mobile and tablet repair technicians. Here's a step-by-step guide to effectively communicate with customers:

- Active Listening: Begin by listening carefully to the customer's description of the issue. Allow them
  to explain the problem without interruption. This shows respect and helps you fully understand the
  situation.
- Ask Clarifying Questions: After the customer has described the problem, ask clarifying questions to gather more details. This can help you pinpoint the issue and ensure you're addressing their specific concerns.
- Avoid Jargon: Steer clear of technical jargon and acronyms. Instead of using terms like "firmware" or "RAM," use plain language. For example, you can explain "firmware" as the device's software and "RAM" as the device's memory.
- **Use Analogies:** Analogies can be highly effective in simplifying complex technical concepts. Compare the issue to something familiar in daily life. For instance, if explaining a software update, you can liken it to updating apps on a smartphone for better performance.
- **Visual Aids:** Use visual aids like simple diagrams or illustrations to visually represent the problem and solution. Visuals can make it easier for customers to grasp the issue.
- **Step-by-Step Breakdown:** Break down the problem and the repair process into easy-to-follow steps. Present each step clearly and explain its importance in resolving the issue.
- **Real-Life Examples:** Share real-life examples or scenarios that are relatable to the customer. For instance, if discussing device storage, you can compare it to space in a closet or a bookshelf.
- **Emphasize the Benefits:** Explain how resolving the issue will benefit the customer. Highlight the positive outcomes, such as improved performance, longer device lifespan, or enhanced functionality.
- **Provide Options:** Present different solutions or repair options, if applicable. Explain the advantages and disadvantages of each option, and let the customer choose the one that best suits their needs.
- **Empathetic Language:** Show empathy by acknowledging the inconvenience the issue has caused. Use phrases like, "I understand how frustrating this can be," to connect with the customer's emotions.

- **Use Common Terms:** Use everyday language instead of technical terms whenever possible. For example, use "device memory" instead of "RAM" or "temporary files" instead of "cache."
- **Follow-up:** After explaining the issue and the solution, ask the customer if they have any questions or need further clarification. Encourage them to seek additional information.
- **Summarize:** At the end of your explanation, summarize the key points and next steps. This reinforces the information and ensures the customer leaves with a clear understanding of the situation and the repair process.

# **1.4.3 Determining Components Required Based on Fault Diagnosis**

Determining the required components based on fault diagnosis is critical in mobile and tablet repair. To ensure an efficient and successful repair process, follow these steps:

- **Thorough Fault Diagnosis:** Begin by thoroughly diagnosing the device to identify the specific fault or issue. This may involve running diagnostic tests, examining the physical components, and listening to the customer's description of the problem.
- **Identify Faulty Components:** Once you've identified the fault, determine which components are causing the issue. It could be a faulty screen, battery, motherboard, charging port, camera, or any other part of the device.
- **Check for Visible Damage:** Inspect the components for any visible damage or defects. This includes checking for cracks, dents, water damage, loose connections, or burnt-out components.
- **Utilize Diagnostic Tools:** Use diagnostic tools and software to help pinpoint the fault. These tools can provide detailed information about the device's internal components, such as sensors, chips, and connectors.
- **Test Functionality:** If possible, test the functionality of individual components to confirm the fault. For example, test the battery's capacity, the screen's responsiveness, or the camera's image quality.
- Consult Schematics and Service Manuals: Refer to the device's schematics and service manuals to understand the internal structure and connections. These documents can provide insights into which components are linked to specific issues.
- Cross-Check with Known Issues: Cross-reference the diagnosed fault with known issues associated with the device model. Manufacturers often release service bulletins or common fault lists that can help you identify common problems and their associated components.
- **Prioritize Component Replacement:** Determine the priority of component replacement based on the severity of the fault. For instance, if the device doesn't power on, focus on the power-related components. If it's a cracked screen, prioritize screen replacement.
- Consider Compatibility: Ensure that the replacement components are compatible with the specific
  device model. Check for part numbers, compatibility lists, and physical fit to avoid compatibility
  issues.
- **Estimate Costs:** Calculate the cost of the required components and provide an estimate to the customer before proceeding with the repair. This helps manage expectations and allows the customer to make an informed decision.

# **1.4.4 Provide Repair and Replacement Estimates** to Customers

Providing customers with accurate repair and replacement estimates is crucial for transparent and trustworthy communication. Here's a step-by-step guide on how to do it effectively:

- **Initial Assessment:** Begin by initially assessing the customer's device. This may involve listening to the customer's description of the problem and performing a visual inspection to identify any visible damage or issues.
- Thorough Diagnosis: Perform a thorough diagnosis of the device to identify the specific fault or
  issue. This may include running diagnostic tests, using specialized tools, and examining the device's
  components.
- **Identify Required Components:** Determine which components need repair or replacement. This could include the screen, battery, motherboard, charging port, camera, or other internal or external components.
- **Consider Labour and Service Fees:** Calculate the labour and service fees associated with the repair. This should account for the time and expertise required to repair or replace.
- **Estimate Component Costs:** Calculate the cost of the required replacement components, such as a new screen, battery, or other parts. Ensure you use accurate pricing from reliable suppliers.
- **Provide a Detailed Quote:** Present the customer with a detailed estimate that includes the following:
  - A clear description of the issue or fault.
  - o The specific components that need repair or replacement.
  - Labour and service fees for the repair work.
  - o The cost of replacement components (parts).
  - o Any additional fees, such as taxes or disposal charges.
  - The estimated total cost of the repair or replacement.
- **Explain the Estimate:** Explain the estimate to the customer clearly and understandably. Describe the scope of work, the benefits of the repair, and the expected outcome.
- Offer Options: Provide the customer with options, if available. For example, you can offer original manufacturer parts and third-party components at different prices. Explain the advantages and disadvantages of each option.
- Address Questions and Concerns: Be prepared to answer any questions or concerns the customer
  may have. Address their inquiries about the repair process, warranty, and the estimated timeline
  for completion.

### 1.4.5 Basics of Handset Repair – Hardware and Software

Performing handset repair, which includes both hardware and software components, requires a systematic approach and expertise in mobile device troubleshooting and repair. Here's a step-by-step guide:

### **Step 1: Initial Assessment**

Begin with an initial assessment of the device. Listen to the customer's description of the issue and inspect the device for any visible damage or defects.

### Step 2: Backup Data

Before conducting any repair, ensure that the customer's data is backed up, as the repair process may involve data loss. This is particularly crucial when working on software-related issues.

#### **Step 3: Hardware Repair**

For hardware issues (e.g., broken screen, malfunctioning buttons, damaged components), follow these steps:

- Disassemble the device carefully, following manufacturer guidelines.
- Identify the faulty hardware component. This may require diagnostic tools or a visual inspection.
- Replace the faulty hardware component with a compatible replacement.
- Reassemble the device, ensuring all connections are secure and components correctly aligned.

### **Step 4: Software Repair**

For software issues (e.g., software crashes, unresponsive operating system), follow these steps:

- Attempt a soft reset or reboot to resolve minor software glitches.
- If the issue persists, perform a factory reset, which erases all user data, to restore the device to its default settings.
- For more complex software problems, you may need to reflash the device's firmware or install a software update.
- Use specialized diagnostic software and tools to identify and repair software issues.

### **Step 5: Testing and Verification**

After the repair, thoroughly test the device to ensure that the issue has been resolved. Check the functionality of both the repaired hardware components and the software.

### **Step 6: Data Restoration**

If data was backed up before the repair, restore the customer's data onto the device.

### **Step 7: Final Inspection**

Conduct a final visual inspection to ensure that all components are properly secured and aligned. Check for any cosmetic issues that may need attention.

### **Step 8: Functional Testing**

Test all device functions, including calls, messages, internet connectivity, and app performance, to ensure that the device is fully operational.

## 1.4.6 Performing Testing on Handsets for Adequacy

Performing testing on handsets for adequacy is a crucial step to ensure that the device functions properly and meets quality standards. Here's a systematic guide on how to perform handset testing:

### **Step 1: Functional Testing**

Begin with a series of functional tests to evaluate the device's basic operations. Test the following:

- Power on/off functionality
- Screen responsiveness and touch sensitivity
- Call and audio quality (microphone and speaker)
- Volume control
- Vibration and haptic feedback
- Camera functionality (front and rear)
- Network connectivity (Wi-Fi, mobile data, Bluetooth, GPS)
- Battery performance and charging
- Sensor functionality (e.g., accelerometer, gyroscope, proximity sensor)

### Step 2: Display and Touchscreen Testing

Evaluate the screen display for issues like dead pixels, discolouration, or touch responsiveness problems. Use test patterns or diagnostic software to identify display irregularities.

### **Step 3: Audio Testing**

Test the audio output quality by playing various types of media, such as music, videos, and phone calls. Listen for distortion, crackling, or other audio issues.

### **Step 4: Camera Testing**

Inspect the camera functionality by taking photos and videos in different modes and lighting conditions. Ensure that both the front and rear cameras are working correctly.

### **Step 5: Connectivity Testing**

Verify the device's connectivity by:

- Testing Wi-Fi connectivity by connecting to a network and browsing the web.
- Checking Bluetooth connectivity by pairing with other devices.
- Testing mobile data connectivity by using apps or browsing the web.
- Evaluating GPS functionality by using location-based apps and navigation.

### **Step 6: Battery and Charging Testing**

Assess the device's battery performance by monitoring its power consumption over time. Test charging by using different chargers and cables to ensure compatibility and proper charging speed.

### **Step 7: Software and Operating System Testing**

Check the device's software and operating system for issues like freezes, crashes, or slow performance. Ensure that apps and features operate smoothly.

### **Step 8: Stress Testing**

Subject the handset to stress tests, such as running multiple apps simultaneously or running resource-intensive apps, to evaluate its performance under heavy usage.

### **Step 9: Diagnostic Software**

Utilize diagnostic software or apps specifically designed for testing mobile devices. These tools can provide an in-depth analysis of the device's components and functions.

### **Step 10: Environmental Testing**

Test the device's performance under different environmental conditions, including extreme temperatures, humidity, and exposure to elements.



Fig. 1.4.1: A Grameen Udhyami Engaged in Handset Repairing

### **Step 11: User Experience Testing**

Consider the overall user experience, including ease of use, responsiveness, and user interface. Ensure that the device meets user expectations in terms of usability and intuitiveness.

### **1.4.7 Post-Repair Activities**

Managing post-repair activities and maintaining inventory levels of hardware components is crucial for the efficient operation of a mobile and tablet repair service. After completing a repair, quality assurance is the first step, ensuring that the device functions properly and that the issue has been successfully resolved. This includes software configuration and data restoration, ensuring that any backed-up data is correctly restored onto the device. A thorough functional and cosmetic inspection should follow, addressing any issues that may have occurred during the repair process. Involve the customer in the post-repair inspection to ensure their satisfaction and maintain meticulous documentation of the entire process for reference and quality control. Additionally, provide information to the customer regarding any warranties or guarantees on the repair.

Effective management of hardware component inventory is essential for maintaining a smooth repair operation. Implement an inventory management system that tracks stock levels in real time, allowing you to monitor inventory status regularly. Set up alerts for low stock levels to prevent running out of critical components and establish a reorder point for each component to initiate timely replenishment orders. Maintaining strong relationships with suppliers and distributors ensures a consistent supply of quality components and may lead to favourable terms for bulk purchases. Implement quality checks for incoming components, rejecting or returning those that don't meet industry standards.

Proper storage conditions, including controlled environments, are vital to prevent damage or degradation. Implement the FIFO (First-In-First-Out) inventory method to minimize the risk of expired or outdated components. Regular inventory audits verify the accuracy of inventory records and identify discrepancies. Keep a watchful eye on costs related to inventory management, such as storage, insurance, and carrying costs, to maintain efficient inventory levels. Identify backup suppliers or alternative sources for critical components to avoid disruptions in case of supplier issues. Lastly, use historical data and sales trends to forecast the demand for hardware components, allowing for more accurate inventory management.

# Summary



- The telecom industry encompasses a wide range of sub-sectors and plays a critical role in connectivity and communication.
- Telecom Grameen Udhyamis, or rural entrepreneurs, are essential in expanding connectivity in rural areas.
- Daily, weekly, and monthly operations of Telecom Grameen Udhyamis involve network maintenance, customer support, and business development.
- Career progression in the telecom industry offers various paths for advancement, including management roles and technical expertise.
- Telecom Grameen Udhyamis foster entrepreneurial mindsets and drive economic development in rural communities.
- Organizational policies cover workplace ethics, site management, quality standards, personnel management, and public relations.
- The workflow in a telecom organization involves broadband technicians responsible for installation, maintenance, and troubleshooting.
- Optical fiber technology is a fundamental component in telecom, it faces challenges during handling and installation.
- Optical fiber communication systems rely on principles of light transmission and pose challenges for Grameen Udhyamis in maintenance.
- Safety, health, and environmental regulations are crucial for telecom workplaces and sites.

# Exercise 🔀

### **Multiple Choice Questions:**

- 1. What is the fundamental concept of telecommunication?
  - a. Communication using telegraphs
  - b. Communication using technology over distances
  - c. Communication using printed materials
  - d. Communication using face-to-face conversations
- 2. What is the role of a Telecom Grameen Udhyami?
  - a. Urban infrastructure development
- b. Promoting connectivity in rural areas
- c. Managing urban telecom networks
- d. Regulatory oversight of telecom operations
- 3. What is a key responsibility of a Telecom Grameen Udhyami?
  - a. Strategic planning for a telecom organization
  - b. Daily maintenance of telecom networks
  - c. Long-term financial forecasting
  - d. Marketing of telecom services in urban areas

- 4. What is a potential career progression for a Telecom Grameen Udhyami?
  - a. Senior Executive in a multinational corporation
  - b. Entrepreneurial consultant for urban startups
  - c. Telecom regulator in a government agency
  - d. Chief Executive Officer (CEO) of a telecom firm
- 5. How does a Telecom Grameen Udhyami contribute to economic development?
  - a. By implementing urban telecom projects
  - b. By creating employment opportunities in rural areas
  - c. By investing in urban infrastructure
  - d. By providing high-speed internet in urban centers

### **Descriptive Questions:**

- 1. What are the core components of a telecom organization and its sub-sectors?
- 2. Explain the role of a Telecom Grameen Udhyami in promoting connectivity in rural areas.
- 3. What are the daily, weekly, and monthly operations managed by a Telecom Grameen Udhyami?
- 4. Describe potential career advancement paths for a Telecom Grameen Udhyami within the Telecom industry.
- 5. How can a Telecom Grameen Udhyami contribute to fostering an entrepreneurial mindset and economic development in rural communities?

Notes 🗐	 		

Scan the QR codes or click on the link to watch the related videos



https://youtu.be/G-UyeFDsXII?si=iF4gaeTx4HmqHhb5

Telecommunication Sector Of India

https://youtu.be/PirV-IZn9yI?si=cubgR3BhPntGyDPX

Optical fiber in hindi









# 2. Handle Hand and Power Tools Relevant to Construction Electrical Works



Unit 2.1 - Electrical Fundamentals and Circuits

Unit 2.2 - Electrical Installation and Maintenance Operations



# **Key Learning Outcomes**

### By the end of this module, the participants will be able to:

- 1. Explain basic principle of electrical current flow and fundamental concept of alternate and direct current, voltage, resistance, temperature, cross section of conductors, etc.
- 2. Explain the application of tester, mustimeter, digital ammeter etc.
- 3. Interpret wiring symbols, SLDs, manufacturer's guidelines and electrical specifications
- 4. Discuss use of various electrical hand and power tools such as pliers, crimping tools, electrical drill machines, cutting machines etc. during electrical wiring of house/ building.
- 5. Demonstrate how to check proper and safe working of hand and power tools.
- 6. Perform fitting of conduits, cables wiring, fixing of electrical fixtures, electrical connection termination at power outlets, etc. using hand and power tools.
- 7. Perform maintenance of electrical tools, devices post use as per manufacturer's guidelines.

### **UNIT 2.1: Electrical Fundamentals and Circuits**

# **Unit Objectives**



### By the end of this unit, the participants will be able to:

- 1. Explain basic principle of electrical current flow and fundamental concept of alternate and direct current, voltage, resistance, temperature, cross section of conductors, etc.
- 2. Explain Ampere's law, Ohm's law, and electromagnetic field.
- 3. Explain the application of tester, mustimeter, digital ammeter etc.
- 4. Interpret wiring symbols, SLDs, manufacturer's guidelines and electrical specifications
- 5. Discuss use of various electrical hand and power tools such as pliers, crimping tools, electrical drill machines, cutting machines etc. during electrical wiring of house/ building.
- 6. Explain type of electrical devices like starters, relays and circuit breakers, their power ratings, working principles and use in circuits.
- 7. Describe features of switches, fuses, resistors and various circuit protecting devices and their use in electrical circuits and connections.

# 2.1.1 Basic principle of electrical current flow and fundamental concept

### Foundations of Electrical Principles and Their Significance in the ICT and Telecom Context

Understanding the core principles of electricity is pivotal for ICT and telecom engineers as these principles underpin the operation of modern information and communication technologies. Here, we delve into these principles and their relevance in the specialized field of ICT and telecom engineering.

### **Basic Principle of Electrical Current Flow:**

At the heart of electrical systems lies the concept of electrical current, the flow of charged particles like electrons or ions through conductors. This flow is instigated by the movement of electrons from regions of higher electrical potential to lower ones.

- **Voltage and Its Role:** Voltage, quantified in volts (V), represents the potential difference between two points. Voltage is instrumental in driving the current through a conductor—the higher the voltage, the more force propelling the current.
- The Law of Resistance: Resistance, gauged in ohms  $(\Omega)$ , measures a conductor's opposition to current flow. Resistance arises from electron collisions with conductor atoms. It governs the amount of current flowing through a conductor at a given voltage—a higher resistance means less current.
- **Temperature's Impact:** Temperature alters a conductor's resistance. As temperature rises, resistance increases due to accelerated electron movement and increased collisions with atoms.
- **Cross-Sectional Area:** The cross-sectional area of a conductor, perpendicular to the current's direction, affects resistance. A larger cross section leads to lower resistance.

### **Fundamental Concept of Alternating and Direct Current:**

In the realm of electrical currents, two distinct types prevail:

- Alternate Current (AC): AC oscillates direction periodically. It is the current supplied to homes
  and businesses, generated by power plants, and employed in various electronic devices, including
  computers and televisions.
- **Direct Current (DC):** DC flows in a single direction without oscillation. It's produced by batteries, solar cells, and utilized in devices like flashlights and portable radios.

In the specialized domain of ICT and telecom engineering, these fundamental electrical principles are pivotal:

- **Voltage and Signal Transmission:** Voltage plays a critical role in the transmission of signals, ensuring that data and communication signals traverse networks efficiently.
- **Resistance and Signal Integrity:** Engineers must manage resistance to maintain signal integrity and prevent data loss or degradation in high-speed data transmission.
- **Temperature Control:** Temperature control is essential in data centers and telecom facilities to maintain equipment performance and prevent overheating.
- **Cross-Sectional Considerations:** Understanding the cross-sectional area of conductors is crucial for designing and maintaining efficient cabling systems for data transmission.
- AC and DC Compatibility: In ICT and telecom networks, engineers must consider the compatibility of AC and DC systems for various applications, including power distribution and equipment operation.
- **Energy Efficiency:** Knowledge of these principles helps engineers design energy-efficient systems, reducing power consumption and environmental impact.

In an ever-evolving ICT and telecom landscape, these electrical principles serve as the foundation upon which reliable and efficient networks are built. Engineers in this field must master these principles to ensure the optimal performance of modern communication technologies.

# 2.1.2 Ampere's law, Ohm's law, and electromagnetic field

### **Fundamental Electromagnetic Laws and Their Significance in Electrical Systems**

Understanding the foundational principles of electricity and magnetism is essential for anyone involved in electrical systems. Here, we delve into Ampere's Law, Ohm's Law, and the Electromagnetic Field, exploring their importance and relevance in electrical engineering.

### Ampere's Law:

Ampere's Law, named after the French physicist André-Marie Ampère, is a fundamental principle in electromagnetism that describes the relationship between the magnetic field (B) produced by a current-carrying conductor and the current passing through it. Mathematically, Ampere's Law is expressed as:

 $\oint B \cdot dI = \mu 0I_{enclosed}$ 

### Where:

- ∮B·dl represents the line integral of the magnetic field (B) around a closed path (dl) surrounding the current-carrying conductor.
- $\mu$ 0 is the permeability of free space ( $\mu$ 0 $\approx$  4 $\pi$  ×10-7 T·m/A).
- Ienclosed is the total current passing through the surface enclosed by the closed path.

This equation signifies that the magnetic field integrated over a closed loop (the left-hand side) is equal to the product of the permeability of free space and the total current passing through the enclosed surface (the right-hand side).

### **Significance and Applications:**

Ampere's Law is of immense importance, especially in practical applications related to electrical equipment design and analysis:

- Magnetic Field Calculation: Ampere's Law allows for the precise calculation of the magnetic field
   (B) generated by a given current distribution. This is particularly crucial when designing devices
   such as transformers, motors, solenoids, and inductors.
- **Design of Electrical Equipment:** Engineers use Ampere's Law to design and optimize the magnetic components of electrical equipment. For instance, it helps determine the number of turns in a coil, the required magnetic material, and the geometry of the core.
- Magnetic Circuits: In the analysis of magnetic circuits, Ampere's Law is utilized to understand the behavior of magnetic fields within various materials and configurations.
- **Inductance Calculations:** For calculating inductance in a circuit, Ampere's Law is indispensable. It aids in determining the inductance of coils and helps in designing circuits with specific inductance requirements.

#### Ohm's Law:

Ohm's Law, a foundational concept in electrical theory, establishes a vital relationship between current (I), voltage (V), and resistance (R) within an electrical circuit. This relationship is mathematically defined and widely used in electrical engineering to analyze and design circuits effectively.

### **Ohm's Law Formula:**

Ohm's Law is succinctly expressed by the formula:

V=IR

### Where:

- V is the voltage across the component in volts (V),
- I is the current flowing through the component in amperes (A),
- R is the resistance of the component in ohms  $(\Omega)$ .

### **Elaboration:**

- **Voltage (V):** It represents the electrical potential difference between two points in the circuit and is measured in volts (V). In simpler terms, it's the 'push' that drives the current through the circuit.
- **Current (I):** This denotes the flow of electric charge in the circuit and is measured in amperes (A). It's akin to the rate at which electrons move through the conductor under the given voltage.
- Resistance (R): Resistance is the opposition offered by the material to the flow of electric current. It's measured in ohms  $(\Omega)$  and quantifies how effectively the component restricts the current flow for a given voltage.

### **Applications and Significance:**

- Calculating Voltage (V): By rearranging the Ohm's Law formula, we can solve for V as: V=IR This is crucial in determining the voltage across a component based on the current flowing through it and its resistance.
- Calculating Current (I): Rearranging the formula for I gives: I=V/R This helps calculate the current flowing through a component given the voltage applied and the resistance.
- Calculating Resistance (R): By isolating R in the formula, we get: R=V/I This allows us to compute the resistance of a component based on the voltage across it and the current flowing through it.

### **Practical Application:**

- **Design of Circuits:** Ohm's Law aids engineers in selecting suitable components for a circuit by understanding how voltage, current, and resistance interrelate.
- **Troubleshooting Circuits:** When a circuit malfunctions, Ohm's Law assists in identifying issues—calculations based on measured values can reveal discrepancies and point to problematic areas.
- **Efficient Power Usage:** Understanding Ohm's Law helps in optimizing power usage by ensuring components are appropriately sized to handle the expected currents at specified voltages.

### **Electromagnetic Field:**

The Electromagnetic Field (EMF) is a fundamental concept in physics and engineering, describing the interplay of electric and magnetic forces within the space surrounding electrically charged particles and moving currents. To comprehend its significance fully, let's delve into its constituents, properties, and delve into the mathematical formulations that underpin its understanding.

### **Components of Electromagnetic Field:**

- Electric Field (E):
  - **Definition:** The electric field (E) represents the force experienced by a charged particle at a given point in space.
  - Mathematical Formulation: The electric field (E) at a particular point is given by the equation: E=qF
- Magnetic Field (B):
  - o **Definition:** The magnetic field (B) is a field of force around a magnetic object or a moving electric charge.
  - O Mathematical Formulation: The magnetic field (B) at a given point is described by the equation:  $B=F/q \cdot v$ . where F is the magnetic force experienced by a charge q moving with velocity v.
- Significance of Electromagnetic Fields:
  - o **Forces on Charged Particles:** Electromagnetic fields are critical as they determine the forces acting on charged particles. This understanding is fundamental in designing electrical systems and devices.
  - Magnetic Induction and Transmission: EMF is crucial for electrical induction and transmission, ensuring the efficient and reliable transfer of electrical energy from power plants to homes and industries.
- Relevance in the Electrical Market:
  - o **Global Market Growth:** The electrical and electronics market is experiencing exponential growth on a global scale, expected to reach \$2 trillion by 2025. This is propelled by the increasing demand for electricity and the widespread adoption of electronic devices.

- Indian Electrical Market: India's electrical and electronics market is a rapidly growing sector, projected to expand from \$250 billion in 2021 to \$400 billion by 2025. Factors driving this growth include governmental focus on power and electronics sectors and the rising adoption of electronic devices by Indian consumers.
- Practical Application for Local Businessmen and Electricians:
  - o **Transformers and Efficient Designs:** Businessmen can apply Ampere's Law to design transformers capable of handling high currents effectively, ensuring efficient operations without overheating.
  - o **Troubleshooting and Circuit Maintenance:** Electricians can utilize Ohm's Law to troubleshoot malfunctioning circuits, ensuring they operate at optimal efficiency.
  - **Energy Efficiency Advice:** Businessmen and electricians can use knowledge of electromagnetic fields to guide consumers on energy-saving practices and reduce electrical hazards.

Ampere's Law, Ohm's Law, and the Electromagnetic Field are fundamental pillars of electrical and electronics understanding. Local businessmen and electricians must grasp these principles to safely install, maintain, and troubleshoot electrical systems, ultimately contributing to the safety and reliability of electrical systems in India's burgeoning market.

## 2.1.3 Application of tester, mustimeter, digital ammeter

In the realm of electrical engineering and maintenance, possessing a profound understanding and effective utilization of measuring instruments is indispensable. Testers, multimeters, and digital ammeters are pivotal tools that empower electricians, technicians, and engineers to diagnose, troubleshoot, and ensure the optimal performance of electrical circuits and systems.

### **Tester: Detecting Voltage Presence**

**Definition and Use:** A tester is a straightforward electrical instrument utilized to confirm the presence of voltage within a circuit. Variants like voltage testers, continuity testers, and circuit breakers serve various purposes, from checking power outlet functionality to diagnosing faulty electrical devices.

### **Multimeter: Versatile Measurement Tool**

**Definition and Use:** The multimeter, a highly versatile measuring instrument, enables the measurement of voltage, current, and resistance. Its flexibility makes it a go-to choice for professionals as a single tool suffices for a wide array of measurements. Available in both analog and digital formats, multimeters provide accuracy and ease of reading.

### **Digital Ammeter: Precision in Current Measurement**

**Definition and Use:** A digital ammeter specializes in displaying current measurements with digital precision. Its advantage lies in accuracy and readability compared to traditional analog ammeters. Often used in conjunction with multimeters, digital ammeters play a crucial role in measuring current flow.

### to Applications in Practical Scenarios

• **Troubleshooting Electrical Circuits:** Identifying faulty components and measuring critical electrical parameters for efficient troubleshooting.

- **Installing and Maintaining Electrical Systems:** Verifying proper functioning and compliance with safety standards during installation and maintenance.
- **Testing Electrical Products:** Ensuring electrical products adhere to requisite safety and performance standards.

### Harnessing Knowledge for Local Business and Electricians

Having a comprehensive understanding of how to utilize testers, multimeters, and digital ammeters is paramount for local businessmen and electricians. This knowledge aids in:

- **Safety Assurance:** Utilizing testers to verify power outlets, promoting safe connections for electrical devices.
- **Efficient Electrical Work:** Employing multimeters to measure voltage accurately before initiating any electrical tasks.
- **Component Identification:** Utilizing digital ammeters to identify faulty components by measuring current flow within circuits.

In India, the electrical and electronics market is experiencing substantial growth. Government initiatives like the National Electricity Plan (NEP) and the Production Linked Incentive (PLI) scheme for electronics manufacturing are propelling the sector forward. This growth underscores the importance of adeptly using measuring instruments to keep pace with advancements.

# 2.1.4 Wiring symbols, SLDs, manufacturer's guidelines and electrical specifications

In the realm of electrical systems and circuits, the ability to interpret wiring symbols, Schematic Logic Diagrams (SLDs), and manufacturer's guidelines is paramount. These skills empower local business personnel and electricians to efficiently and safely navigate the complex world of electrical installations, maintenance, and troubleshooting.

### Wiring Symbols: The Universal Language

Wiring symbols are standardized representations of electrical components and connections, serving as a universal language for electricians and technicians globally. Some commonly encountered wiring symbols include:

- **Conductors:** Represented by solid or dashed lines, solid lines indicate solid conductors, while dashed lines indicate stranded conductors.
- **Insulators:** Illustrated as a series of short, parallel lines.
- **Ground:** Depicted as a horizontal line with a vertical line at one end.
- **Switches:** Varied symbols, depending on the switch type (e.g., a single-pole, single-throw switch represented by a circle with a line through it).
- Receptacles: Shown as squares or rectangles with two or more prongs.
- **Fixtures:** Diverse symbols based on the fixture type (e.g., a light fixture represented by a triangle with a circle inside).

### Schematic Logic Diagrams (SLDs): Unveiling Current Flow

SLDs are invaluable tools for electricians and engineers, unveiling the intricate flow of current within electrical circuits. They serve multiple purposes, including troubleshooting, circuit design, and maintenance. SLDs employ symbols such as:

- **Components:** Each component is symbolically represented to signify its function (e.g., a resistor symbolized by a zigzag line).
- Connections: Lines establish connections between components, delineating electrical paths.
- **Signal Flow:** Arrows indicate the direction of current flow, aiding in comprehending the circuit's operation.

### Manufacturer's Guidelines and Electrical Specifications: Ensuring Safety and Efficiency

Manufacturer's guidelines and electrical specifications are indispensable resources, providing essential information for the safe and correct installation and operation of electrical instruments. These documents typically encompass:

- Wiring Diagrams: Detailed diagrams illustrating how to connect the instrument to power sources and other devices.
- **Voltage and Current Requirements:** Specifications regarding the instrument's voltage and current prerequisites.
- **Environmental Conditions:** Guidelines outlining the environmental conditions conducive to the safe operation of the instrument.

India's electrical and electronics market is on an upward trajectory, set to escalate from \$250 billion in 2021 to an estimated \$400 billion by 2025, driven by government initiatives like the National Electricity Plan (NEP) and the Production Linked Incentive (PLI) scheme for electronics manufacturing. This growth underscores the significance of adeptly interpreting electrical documentation and ensuring compliance with evolving standards.

### **Empowering Local Business and Electricians**

Proficiency in interpreting wiring symbols, SLDs, and manufacturer's guidelines equips local businessmen and electricians with the knowledge to:

- **Enhance Safety:** Safely install and maintain electrical systems by adhering to established standards and safety protocols.
- **Efficient Troubleshooting:** Swiftly identify and resolve electrical issues by decoding SLDs and wiring symbols.
- **Optimal Instrument Usage:** Ensure instruments are correctly installed and operated in line with manufacturer's guidelines and electrical specifications.

## 2.1.5 Electrical hand and power tools

In the intricate world of electrical wiring for homes and buildings, the adept use of electrical hand and power tools is a cornerstone for local businesses and electricians. These tools are not just instruments; they are the enablers of safe, efficient, and reliable electrical systems. Let's explore the significance of these tools, delve into their applications, and emphasize their pivotal role in India's dynamic electrical landscape.

### **Pliers: The Multifaceted Workhorses**

Pliers, a versatile tool in the electrician's arsenal, serve multiple purposes:

- Stripping insulation from wires
- Cutting wires with precision
- Bending wires to desired angles
- Gripping wires securely
- Holding wires in place during installation

This multifaceted tool is indispensable for electricians, ensuring meticulous wire handling and connections.

### **Crimping Tools: Crafting Secure Connections**

Crimping tools play a crucial role in the creation of robust electrical connections. By crimping wire connectors onto wires, these tools guarantee secure and enduring connections, vital for preventing electrical faults and ensuring the longevity of installations.

#### **Electrical Drill Machines: The Precision Drillers**

Electrical drill machines, available in both corded and cordless variants, are the backbone of creating holes in diverse materials like walls and ceilings. Electricians employ them for the installation of electrical boxes, wires, and various components. These machines also facilitate the removal of old wiring and components, streamlining renovation and maintenance tasks.

### **Cutting Machines: Precision in Every Cut**

Cutting machines, including wire strippers, cable cutters, and conduit cutters, offer precision when preparing electrical wires and cables. Electricians depend on these tools for accurate and safe wire terminations and connections, adhering to safety and quality standards.

### **Other Electrical Hand and Power Tools**

A comprehensive toolkit for local businesses and electricians also includes:

- Screwdrivers
- Nut drivers
- Voltage testers
- Continuity testers
- Circuit breakers
- Fish tape for routing wires
- Cable pullers for efficient wire installations

India's electrical and electronics market is poised for substantial growth, with the industry expected to reach \$400 billion by 2025, according to the Indian Electrical and Electronics Manufacturers' Association (IEEMA). This growth is propelled by the government's emphasis on power and electronics sectors and the increasing adoption of electronic devices.

The Indian government, cognizant of the pivotal role of electricity in the nation's development, is investing significantly in the power and electronics sectors. The National Electricity Plan (NEP), launched in 2021, outlines a visionary roadmap to expand India's power generation capacity to 800 GW by 2030.

Simultaneously, the government is actively promoting the adoption of electronic devices among Indian consumers through initiatives like the Production Linked Incentive (PLI) scheme for electronics manufacturing. This scheme is not only expected to bolster electronic device production but also generate employment opportunities on a massive scale.

To harness these electrical hand and power tools effectively, local businessmen and electricians should:

- Master the safe and efficient use of these tools.
- Comprehend their role in ensuring the safety and reliability of electrical systems.
- Align with evolving electrical standards to meet the nation's burgeoning electrical needs.

By integrating this knowledge into their skill set, local businesses and electricians become indispensable contributors to India's electrification drive, enhancing safety and efficiency in homes and buildings.

### Safety Tips: A Non-Negotiable

In the pursuit of efficient electrical work, safety is paramount. Local businessmen and electricians should adhere to these safety precautions:

- Wear safety glasses to protect eyes from debris.
- Use appropriate gloves to prevent electrical shocks.
- Select the right tool for each task.
- Inspect tools meticulously before use.
- Follow manufacturer's instructions rigorously.

In adhering to these safety tips, local businesses and electricians not only prevent accidents and injuries but also ensure the safety and reliability of electrical systems in India.

### 2.1.6 Electrical devices

In the realm of electrical systems, understanding the intricacies of devices like starters, relays, and circuit breakers is imperative for local businessmen and electricians. These devices play pivotal roles in ensuring safety, control, and efficient operation of electrical circuits. Let's embark on an enlightening journey to comprehend their types, power ratings, working principles, and applications within the context of India's dynamic electrical landscape.

### **Starters: Igniting Electrical Systems**

### **Types of Starters:**

- **Direct On-Line (DOL) Starters:** These starters provide full voltage to the motor, suitable for small motors with low starting torque requirements.
- **Star-Delta Starters:** Primarily employed for larger motors, these starters reduce the voltage during startup, minimizing the initial current surge.
- **Auto-transformer Starters:** Ideal for motors requiring a moderate starting current reduction, these starters utilize an auto-transformer to achieve the desired voltage reduction.

### **Power Ratings:**

Starters are rated based on the motor's power (in horsepower or kilowatts) and the voltage rating of the system. For instance, a starter might be rated for a 5 HP, 415V motor.

### **Working Principle:**

Starters ensure controlled motor starting. When the start button is pressed, they connect the motor to the power supply. DOL starters provide full voltage to the motor, while others, like star-delta and auto-transformer starters, use transformers to reduce voltage during startup. This controlled startup prevents excessive current surges and mechanical stress on the motor.

### **Applications:**

Starters are essential in scenarios where motors need controlled starting, like industrial machines, conveyor belts, pumps, and fans. In India, industries such as manufacturing, agriculture, and infrastructure rely heavily on these devices.

### **Relays: The Control Hub**

### **Types of Relays:**

- **Electromagnetic Relays:** These relays use electromagnetic coils to control the switching of contacts.
- **Solid-State Relays (SSRs):** SSRs use semiconductor devices to achieve switching, offering advantages like noiseless operation and longer lifespan.

### **Power Ratings:**

Relays are available in various voltage and current ratings, suitable for a wide range of applications.

### **Working Principle:**

Relays act as remote-controlled switches. When a control signal (typically a low-voltage input) is applied to the coil, it generates a magnetic field, causing the contacts to close or open, thereby controlling the high-voltage circuit.

### **Applications:**

Relays are ubiquitous in electrical control systems, serving as the interface between low-voltage control circuits and high-voltage loads. In India, they find extensive use in applications such as home automation, industrial automation, and motor control.

### **Circuit Breakers: Guardians of Electrical Safety**

### **Types of Circuit Breakers:**

- **Miniature Circuit Breakers (MCBs):** Commonly used in homes, MCBs protect circuits from overcurrents and short circuits.
- **Molded Case Circuit Breakers (MCCBs):** Suitable for higher current applications, MCCBs provide thermal and magnetic protection.

• Residual Current Circuit Breakers (RCCBs): These devices protect against ground faults and are essential for ensuring safety in electrical installations.

### **Power Ratings:**

Circuit breakers are rated based on their current-carrying capacity and the fault current they can interrupt safely. In India, common ratings include 6A, 16A, and 32A for MCBs.

### **Working Principle:**

Circuit breakers automatically open the circuit when excessive current flows through them. Thermal and magnetic mechanisms within the breaker are responsible for detecting and interrupting overcurrents and short circuits.

### **Applications:**

Circuit breakers are vital components of electrical distribution systems. They safeguard homes, offices, and industries from electrical faults, preventing fires and electrical accidents. In India, the demand for circuit breakers is driven by rapid urbanization and infrastructure development.

The electrical devices market in India is on an upward trajectory, driven by increased infrastructure projects and the expansion of the manufacturing sector. According to data from the Indian Electrical and Electronics Manufacturers' Association (IEEMA), the Indian electrical and electronics market is expected to grow from \$250 billion in 2021 to \$400 billion by 2025.

#### In-Depth Understanding for Local Businessmen and Electricians

Local businessmen and electricians should grasp the significance of starters, relays, and circuit breakers in electrical systems:

- **Efficient Utilization:** Understanding the right device for a specific application ensures optimal system performance and energy efficiency.
- Safety: Mastery of these devices aids in creating safe electrical systems, reducing the risk of electrical accidents and equipment damage.
- **Compliance:** Adhering to relevant standards and regulations is paramount, and a profound understanding of these devices helps local businessmen and electricians meet compliance requirements.

In India, where the power sector is undergoing significant expansion, local businesses and electricians are crucial stakeholders in ensuring the reliability and safety of electrical installations.

Starters, relays, and circuit breakers are the unsung heroes of electrical systems, contributing to safety, control, and efficiency. For local businessmen and electricians in India, an indepth understanding of these devices translates into enhanced safety, compliance, and competitiveness in the vibrant electrical landscape of the nation.

### 2.1.7 Features of switches, fuses, resistors and various circuit

Features of Switches, Fuses, Resistors, and Various Circuit Protecting Devices

#### **Switches**

Switches are electrical devices that are used to turn on and off the flow of current in a circuit. They are available in a variety of different types, including:

**Single-pole, single-throw (SPST) switches:** SPST switches have two terminals and one position. They can be used to turn on and off a single device.





Fig. 2.1.1: SPST Switch

**Double-pole, single-throw (DPST) switches:** DPST switches have four terminals and two positions. They can be used to turn on and off two separate devices or to control the polarity of a device.



Fig. 2.1.2: DPST Switch

**Single-pole, double-throw (SPDT) switches:** SPDT switches have three terminals and two positions. They can be used to switch between two different devices or to change the direction of current flow in a circuit.



Fig. 2.1.3: SPDT Switch

**Double-pole, double-throw (DPDT) switches:** DPDT switches have six terminals and four positions. They can be used to switch between two different pairs of devices or to change the polarity of two separate devices.



Fig. 2.1.4: DPDT switch

#### **Fuses**

Fuses are electrical devices that are used to protect circuits from overload and short circuit currents. They work by melting when the current through them exceeds their rated current. This interrupts the flow of current and prevents damage to the circuit.

### Fuses are available in a variety of different types, including:

**Glass fuses:** Glass fuses are the most common type of fuse. They are made of a glass tube with a metal element inside. When the current through the fuse exceeds its rated current, the metal element melts and the fuse blows.



Fig. 2.1.5: Glass fuse

**Cartridge fuses:** Cartridge fuses are similar to glass fuses, but they are enclosed in a plastic or ceramic cartridge. Cartridge fuses are more durable than glass fuses and they are less likely to break if they are dropped or bumped.



Fig. 2.1.6: Cartridge fuse

**Resettable fuses:** Resettable fuses also known as Polyfuses or PTC fuses, are thermal fuses that automatically reset once they have cooled down. They are often used in electronic circuits to protect components from overload currents.

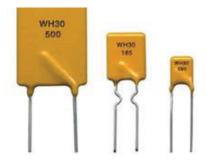


Fig. 2.1.7: Resettable fuse

### **Resistors**

Resistors are electrical devices that are used to oppose the flow of current in a circuit. They are available in a variety of different values, which are measured in ohms ( $\Omega$ ).

Resistors are used in a variety of different applications, including:

- Limiting current: Resistors can be used to limit the current that flows through a circuit. This is useful for protecting components from overload currents.
- **Dropping voltage:** Resistors can be used to drop the voltage in a circuit. This is useful for powering devices that require a lower voltage than the available voltage.
- Creating voltage dividers: Resistors can be used to create Fig. 2.1.8: Resistor voltage dividers, which are circuits that divide the voltage of a signal into two or more smaller voltages.



### **Various Circuit Protecting Devices**

In addition to fuses, there are a number of other circuits protecting devices that are commonly used in electrical circuits. These devices include:

- Circuit breakers: Circuit breakers are similar to fuses, but they can be reset after they have tripped. This makes them more convenient to use than fuses.
- Residual current circuit breakers (RCCBs): RCCBs protect circuits from earth leakage currents. This is important for preventing electrocution.
- Miniature circuit breakers (MCBs): MCBs protect circuits from overload and short circuit currents. They are more accurate and reliable than fuses.



Fig. 2.1.9: Circuit breaker

### **Use in Electrical Circuits and Connections**

Switches, fuses, resistors, and various circuit protecting devices are used in a variety of different electrical circuits and connections. For example:

- Switches are used to turn on and off lights, fans, and other electrical devices.
- Fuses are used to protect electrical circuits from overload and short circuit currents.
- Resistors are used to limit current, drop voltage, and create voltage dividers.
- Circuit breakers and RCCBs are used to protect electrical circuits from overload, short circuit, and earth leakage currents.

According to the Indian Electrical and Electronics Manufacturers' Association (IEEMA), the Indian electrical and electronics market is expected to grow from \$250 billion in 2021 to \$400 billion by 2025. This growth is being driven by factors such as the government's focus on developing the power and electronics sectors and the increasing adoption of electronic devices by Indian consumers.

#### **UNIT 2.2: Electrical Installation and Maintenance Operations**

#### - Unit Objectives



#### By the end of this unit, the participants will be able to:

- 1. Discuss about the electrical measuring/ testing tools and devices such as voltage tester, earth tester, mustimeter, digital ammeter, meggers, tong tester, etc.
- 2. Demonstrate how to check proper and safe working of hand and power tools.
- 3. Perform fitting of conduits, cables wiring, fixing of electrical fixtures, electrical connection termination at power outlets, etc. using hand and power tools.
- 4. Measure size and dimension of wires, conduits as per electrical installation/ maintenance work requirement using measuring instruments
- 5. Perform basic inspections of electrical circuits/ wiring using electrical devices like ammeter, voltmeter, meggers, multi-meter, tong tester, earth tester, etc.
- 6. Install electrical components like starter, circuit breakers, relays, etc.
- 7. Perform maintenance of electrical tools, devices post use as per manufacturer's guidelines.

#### 2.2.1 Electrical measuring/ testing tools and devices

Electrical measuring/testing tools and devices are used to measure and test various electrical parameters, such as voltage, current, resistance, and insulation. These tools and devices are essential for electricians, technicians, and engineers to troubleshoot and repair electrical circuits.

#### **Voltage Tester**

A voltage tester is a simple tool that is used to detect the presence of voltage in a circuit. It is typically used to check if a power outlet is working or to troubleshoot a faulty electrical device. Voltage testers are available in a variety of different types, including:

- **Non-contact voltage testers:** Non-contact voltage testers can detect the presence of voltage without making contact with the circuit. This makes them safer to use than contact voltage testers.
- **Contact voltage testers:** Contact voltage testers require contact with the circuit to detect the presence of voltage. They are typically more accurate than non-contact voltage testers.

#### **Earth Tester**

An earth tester is used to measure the resistance of an electrical ground connection. It is important to have a good electrical ground connection to prevent electrocution and to protect electrical equipment from damage.

#### Multimeter

A multimeter is a versatile tool that can be used to measure voltage, current, and resistance. It is a popular choice for electricians and technicians because it is a single instrument that can be used to perform a variety of measurements. Multimeters are available in both analog and digital formats.

#### **Digital Ammeter**

A digital ammeter is a specific type of ammeter that uses a digital display to show the current measurement. Digital ammeters are more accurate and easier to read than analog ammeters.

#### Megger

A megger is used to measure the insulation resistance of an electrical circuit. Insulation resistance is the resistance between the conductor of the circuit and the ground. It is important to have good insulation resistance to prevent electrical leakage and to protect electrical equipment from damage.

#### **Tong Tester**

A tong tester is used to measure the current flowing through a conductor without making contact with the conductor. This makes them ideal for measuring current in high-voltage circuits.

#### Other Electrical Measuring/Testing Tools and Devices

Other electrical measuring/testing tools and devices include:

- **Power factor meters:** Power factor meters measure the power factor of a circuit. Power factor is a measure of how efficiently the power is being used in a circuit.
- **Frequency counters:** Frequency counters measure the frequency of a signal. Frequency is the number of cycles per second of a signal.
- Oscilloscopes: Oscilloscopes display the waveform of a signal. Waveform is the shape of the signal over time.

#### **Applications**

Electrical measuring/testing tools and devices are used in a variety of applications, including:

- Troubleshooting electrical circuits: Electrical measuring/testing tools and devices can be used to troubleshoot electrical circuits by identifying faulty components and measuring electrical parameters.
- Installing and maintaining electrical systems: Electrical measuring/testing tools and devices can be used to install and maintain electrical systems by verifying that the systems are working properly and that they are meeting safety standards.
- **Testing electrical equipment:** Electrical measuring/testing tools and devices can be used to test electrical equipment to ensure that it is meeting safety and performance standards.

Electrical measuring/testing tools and devices are essential tools for electricians, technicians, and engineers to troubleshoot and repair electrical circuits. These tools and devices are also used to install and maintain electrical systems and to test electrical equipment.

#### 2.2.2 Proper and safe working of hand and power tools

To check the proper and safe working of hand and power tools that are used by an electrician, you should follow these steps:

#### **Hand Tools**

- Inspect the handles and bodies of the tools for cracks or other damage.
- Make sure that all blades are sharp and free of rust.
- · Check that all screws and bolts are tight.
- Test the insulation on insulated tools to make sure it is intact.



Fig. 2.2.1: hand Tools

#### **Power Tools**

- Inspect the cords and plugs for cracks or other damage.
- Make sure that all guards and safety switches are in place and working properly.
- Test the tool to make sure it is running smoothly and without any unusual noises or vibrations.



Fig. 2.2.2: Power tool

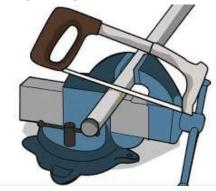
#### **Safety Precautions**

- When using hand and power tools, it is important to follow all safety precautions. This includes:
- Wearing safety glasses and gloves.
- Using the right tool for the job.
- Disconnecting the tool from the power source before servicing or cleaning it.
- · Keeping the work area clean and well-lit.

# 2.2.3 Fitting of conduits, cables wiring, fixing of electrical fixtures, electrical connection termination at power outlets, etc. using hand and power tools

#### **Fitting of Conduits**

• Cut the conduit to the desired length using a hacksaw.



• Deburr the cut ends of the conduit using a file or deburring tool.



• Thread the ends of the conduit using a conduit threading machine.



- Apply a sealant to the threads of the conduit to prevent moisture from entering the conduit.
- Connect the conduit to fittings using locknuts and bushings.



Secure the conduit to the wall or ceiling using conduit straps or hangers.



#### **Cabling Wiring**

• Pull the cables through the conduit using a fish tape.



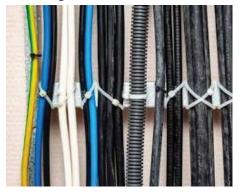
• Strip the insulation from the ends of the cables using a wire stripper.



• Connect the cables to terminals using wire connectors.



Secure the cables to the conduit using cable ties.



#### **Fixing of Electrical Fixtures**

- Mark the location of the electrical fixture on the wall or ceiling.
- Drill a hole at the marked location using a drill machine.



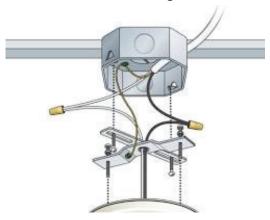
• Install an electrical box in the hole and secure it using screws.



• Connect the electrical fixture to the electrical box using wire connectors.



Secure the electrical fixture to the electrical box using screws.



#### **Electrical Connection Termination at Power Outlets**

• Strip the insulation from the ends of the power cable using a wire stripper.



• Connect the wires to the terminals of the power outlet using wire connectors.



• Secure the power cable to the power outlet using cable ties.



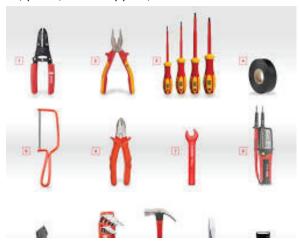
Attach the power outlet to the wall or ceiling using screws.



#### Hand and Power Tools Used by Electricians

Some of the hand and power tools that are commonly used by electricians include:

• Hand tools: Screwdrivers, pliers, wire strippers, and knives.



• Power tools: Drill machines, saws, and grinders.



#### **Safety Precautions**

When working with electrical circuits, it is important to follow all safety precautions. This includes:

- Wearing safety glasses and gloves.
- Turning off the power to the circuit before working on it.

- Using insulated tools.
- Being aware of the hazards of electrical shock.

By following these safety precautions, electricians can help to prevent accidents and injuries.

# 2.2.4 Size and dimension of wires, conduits as per electrical installation/ maintenance work requirement using measuring instruments

To measure the size and dimension of wires, conduits, and other electrical components, electricians use a variety of measuring instruments. The most common measuring instruments used by electricians include:

• **Tape measures:** Tape measures are used to measure the length of wires, conduits, and other electrical components.



• Calipers: Calipers are used to measure the diameter, thickness, and depth of wires, conduits, and other electrical components.



• **Micrometers:** Micrometers are used to measure the precise dimensions of wires, conduits, and other electrical components.



 Wire gauges: Wire gauges are used to measure the American Wire Gauge (AWG) of wires.



 Conduit gauges: Conduit gauges are used to measure the trade size of conduits.



#### Measuring the Size and Dimension of Wires

To measure the size and dimension of wires, electricians use the following steps:

- Select the appropriate measuring instrument. For most wire measurements, a wire gauge will be sufficient. However, for more precise measurements, a caliper or micrometer may be used.
- Identify the type of wire. There are two main types of wires: solid and stranded. Solid wires are made up of a single conductor, while stranded wires are made up of multiple conductors.
- Measure the wire gauge. The wire gauge is a measure of the diameter of the wire. The larger the wire gauge, the smaller the diameter of the wire.
- Record the measurement.

#### **Measuring the Size and Dimension of Conduits**

To measure the size and dimension of conduits, electricians use the following steps:

- Select the appropriate measuring instrument. For most conduit measurements, a conduit gauge will be sufficient. However, for more precise measurements, a caliper or micrometer may be used.
- Identify the type of conduit. There are two main types of conduits: rigid and flexible. Rigid conduits are made of metal or PVC, while flexible conduits are made of metal or plastic.
- Measure the trade size of the conduit. The trade size of a conduit is a measure of its internal diameter. The larger the trade size, the larger the internal diameter of the conduit.
- Record the measurement.

#### **Using Hand and Power Tools**

In addition to measuring instruments, electricians also use a variety of hand and power tools to measure the size and dimension of wires, conduits, and other electrical components. Some common hand and power tools used by electricians for measuring include:

• **Strippers:** Strippers are used to strip the insulation from wires.



• **Cutters:** Cutters are used to cut wires, conduits, and other electrical components.



• Benders: Benders are used to bend conduits



• Fish tapes: Fish tapes are used to pull wires through conduits.



• Cable pullers: Cable pullers are used to pull large bundles of wires through conduits.



By using the appropriate measuring instruments, hand tools, and power tools, electricians can accurately measure the size and dimension of wires, conduits, and other electrical components. This ensures that the electrical components are properly installed and maintained, and that the electrical system is safe and reliable.

## 2.2.5 Inspections of electrical circuits/ wiring using electrical devices like ammeter, voltmeter, meggers, multi-meter, tong tester, earth tester, etc.

To perform basic inspections of electrical circuits/wiring using electrical devices, follow these steps:

- Disconnect the power supply to the circuit. This is important to prevent electrical shock.
- Inspect the wires for any signs of damage. This includes looking for cuts, nicks, and fraying. If you find any damaged wires, they should be replaced immediately.
- Inspect the connections for any signs of corrosion or loose connections. Tighten any loose connections and clean any corroded connections.
- Use a voltmeter to measure the voltage at various points in the circuit. The voltage should be within the specified range for the circuit.
- Use an ammeter to measure the current flowing through the circuit. The current should be within the specified range for the circuit.
- Use a megger to measure the insulation resistance of the circuit. The insulation resistance should be above a certain minimum value, which is typically specified in the circuit diagram.
- Use a tong tester to measure the current flowing through a conductor without making contact with the conductor. This is useful for measuring current in high-voltage circuits.
- Use an earth tester to measure the resistance of the electrical ground connection. It is important
  to have a good electrical ground connection to prevent electrocution and to protect electrical
  equipment from damage.

To inspect a simple light switch circuit, you would:

- Disconnect the power supply to the circuit by turning off the circuit breaker or fuse.
- Inspect the wires and connections for any signs of damage or corrosion.
- Use a voltmeter to measure the voltage at the input and output of the circuit. The voltage should be within the specified range for the circuit.
- Use an ammeter to measure the current flowing through the circuit when the switch is turned on. The current should be within the specified range for the circuit.
- Use a megger to measure the insulation resistance of the circuit. The insulation resistance should be above a certain minimum value, which is typically specified in the circuit diagram.

If the inspection reveals any problems, such as damaged wires, loose connections, or low insulation resistance, the problems should be corrected before the power supply is reconnected.

## 2.2.6 Electrical components like starter, circuit breakers, relays, etc.

A starter is a device that is used to start a motor. It typically consists of three contactors and a thermal overload relay. The contactors connect the motor to the power supply, and the thermal overload relay protects the motor from overload currents.

To install a starter, follow these steps:

- Disconnect the power supply to the circuit.
- Mount the starter in a suitable location.

- Connect the motor leads to the starter terminals.
- Connect the power supply leads to the starter terminals.
- Connect the thermal overload relay to the starter terminals.
- Reconnect the power supply to the circuit.



#### **Circuit Breaker**

A circuit breaker is a device that is used to protect a circuit from overload and short circuit currents. It works by tripping when the current through it exceeds its rated current. This interrupts the flow of current and prevents damage to the circuit.

To install a circuit breaker, follow these steps:

- Disconnect the power supply to the circuit.
- Mount the circuit breaker in a suitable location.
- Connect the load wires to the circuit breaker terminals.
- Connect the power supply wires to the circuit breaker terminals.
- Reconnect the power supply to the circuit.

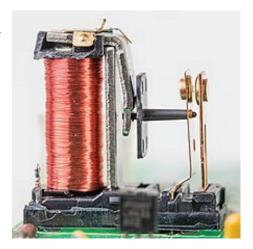


#### Relay

A relay is a device that is used to control one circuit using another circuit. It typically consists of a coil and a set of contacts. When the coil is energized, the contacts close. This allows current to flow through the controlled circuit.

To install a relay, follow these steps:

- Disconnect the power supply to the circuit.
- Mount the relay in a suitable location.
- Connect the coil of the relay to the control circuit.
- Connect the contacts of the relay to the controlled circuit.
- Reconnect the power supply to the circuit.



#### **Safety Precautions**

When installing electrical components, it is important to follow all safety precautions. This includes:

- Disconnecting the power supply to the circuit before working on it.
- Wearing safety glasses and gloves.
- Using the correct tools and equipment.
- Following the manufacturer's instructions.

By following these safety precautions, one can help to prevent accidents and injuries.

## 2.2.7 Maintenance of electrical tools, devices post use as per manufacturer's guidelines

#### **Clean and Inspect Tools**

After each use, be sure to clean and inspect your electrical tools and devices. This will help to remove any dirt, dust, or debris that may have accumulated and could potentially cause problems. Use a soft cloth or brush to clean the exterior of the tools and devices. Avoid using harsh chemicals or solvents, as these can damage the finish.



Pay attention to the following areas:

- Vents: Be sure to clean any vents on the tools and devices to prevent overheating.
- **Cord:** Inspect the cord for any signs of damage, such as cuts, nicks, or frayed wires. If there is any damage, replace the cord immediately.
- **Blades:** Inspect any blades on the tools for signs of wear or damage. If a blade is dull or damaged, sharpen or replace it immediately.

#### **Store Tools and Devices Properly**

When you are not using your electrical tools and devices, be sure to store them properly. This will help to protect them from damage and extend their lifespan.

- Store tools and devices in a dry, clean place. Avoid storing them in damp or humid environments, as this can lead to corrosion.
- Store tools and devices out of reach of children.

 Store tools and devices in a case or cabinet when not in use. This will help to protect them from dust and dirt.



#### **Lubricate Tools and Devices**

Some electrical tools and devices require regular lubrication. Be sure to consult the manufacturer's guidelines to determine if your tools and devices require lubrication and how often to lubricate them.

- Use a lubricant that is specifically designed for electrical tools and devices.
- Apply a thin coat of lubricant to the moving parts of the tools and devices.
- Avoid over-lubricating, as this can attract dirt and grime.

#### **Replace Worn or Damaged Parts**

If any parts of your electrical tools and devices are worn or damaged, be sure to replace them immediately. This will help to prevent accidents and ensure that the tools and devices are operating safely and efficiently.

- Use only genuine replacement parts from the manufacturer.
- Follow the manufacturer's instructions to replace the worn or damaged parts.

Have Your Tools and Devices Professionally Serviced

Even if you follow all of the above maintenance tips, it is still important to have your electrical tools and devices professionally serviced on a regular basis. A professional technician can inspect the tools and devices for any potential problems and make any necessary repairs.

- Have your tools and devices serviced at least once a year.
- Have your tools and devices serviced more often if you use them heavily.

By following these simple maintenance tips, you can help to ensure that your electrical tools and devices last for many years to come.

#### **Summary**



- Electrical current flows through conductors based on voltage and resistance, either as alternating current (AC) or direct current (DC).
- Ampere's law describes the magnetic field produced by a current, Ohm's law relates voltage, current, and resistance, and electromagnetic fields result from moving charges.
- Testers, multimeters, and digital ammeters are used to measure and test electrical parameters for circuit evaluation and troubleshooting.
- Understanding wiring symbols, single-line diagrams (SLDs), manufacturer's guidelines, and electrical specifications is crucial for accurate electrical installations.
- Various electrical hand and power tools, including pliers, crimping tools, drills, and cutting machines, are essential for safe and efficient electrical wiring in buildings.
- Starters, relays, and circuit breakers are key electrical devices with specific power ratings and operational principles, crucial for controlling electrical circuits.
- Switches, fuses, resistors, and circuit protection devices play a vital role in managing electrical circuits and ensuring safety during operations.
- Electrical measuring and testing tools like voltage testers, earth testers, multimeters, and tong testers are essential for evaluating electrical parameters and ensuring safe electrical operations.
- Proper and safe usage of electrical hand and power tools is assessed through thorough checks for functionality and safety features.
- Installing conduits, wiring cables, fixing electrical fixtures, and terminating connections using appropriate hand and power tools are fundamental aspects of electrical installation and maintenance.

#### **Exercise**

#### **Multiple Choice Questions**

- 1. What is the fundamental concept of electrical current flow?
  - a. Movement of electrons through a conductor
  - b. Movement of protons through a conductor
  - c. Movement of neutrons through a conductor
  - d. Movement of photons through a conductor
- 2. According to Ohm's law, what is the relationship between voltage, current, and resistance?
  - a. Voltage = Current x Resistance

b. Voltage = Resistance / Current

c. Current = Voltage x Resistance

d. Resistance = Voltage / Current

- 3. Which electrical testing tool is primarily used to measure voltage?
  - a. Multimeter

b. Ammeter

c. Mustimeter

d. Tong tester

- 4. What does Ampere's law describe?
  - a. The relationship between current and magnetic fields
  - b. The relationship between voltage and current
  - c. The relationship between resistance and temperature
  - d. The relationship between voltage and magnetic fields
- 5. Which electrical device protects a circuit from overcurrent?

a. Circuit breaker

b. Relay

c. Starter

d. Fuse

#### **Descriptive Questions:**

- 1. Explain the fundamental difference between alternating current (AC) and direct current (DC).
- 2. Describe Ampere's law and its significance in the context of electromagnetism.
- 3. What are the primary applications of a multimeter and a digital ammeter in electrical circuits?
- 4. Interpret a common wiring symbol used in electrical diagrams and its significance.
- 5. Discuss the essential uses of electrical hand tools like pliers and cutting machines during house/building electrical wiring.

otes			

Scan the QR codes or click on the link to watch the related videos



https://youtu.be/nzmoGca5rXc?si=zHhMMrD5VQbBJ\_qH

Flow of Electricity through a Circuit











# 3. Pre-requisites of Wiring and Wi-Fi Backhaul Equipment

Unit 3.1 - Installation of Wi-Fi System

Unit 3.2 - Complete Documentation



### **Key Learning Outcomes**

#### By the end of this module, the participants will be able to:

- 1. Define work-orders and job sheets, their significance and parameters.
- 2. Discuss overall organisational policies, standards, values and processes.
- 3. Discuss necessary documentation required for installation and different payment modes.
- 4. State the safety norms to be followed and emergency contacts.
- 5. Explain escalation matrix for reporting identified incidents, trouble sand/emergencies, e.g., system failures, fire and power failures.
- 6. Match connectors to the correct type of cable for installation.
- 7. Demonstrate the installation and usage of cable termination between equipment and antenna.
- 8. Test the cable and joints for transmission loss and strength.
- 9. Demonstrate how to write and record appropriate technical forms, activity logs.

#### **UNIT 3.1: Installation of Wi-Fi System**

#### **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Analyse work-orders and job sheets, their significance and parameters
- 2. List the different types of cables, connectors, tools and equipment required for installation
- 3. Distinguish between different processes for cable laying and feeder cable laying
- 4. Explain different electrical principles and safety measures to be considered while turning on the Wi-Fi system
- 5. Walk through the steps of Wi-Fi system installation
- 6. Demonstrate the installation and usage of cable termination between equipment and antenna
- 7. Test the cable and joints for transmission loss and strength

#### **3.1.1** Analysing Work Orders and Job Sheets

A job-sheet provides detailed instructions on what needs to be done, including the type of equipment that needs to be installed, the cabling and wiring required, and any other specifications that need to be followed.

Technicians and other workers typically use the job sheet to complete the job correctly and efficiently. It may also include information about the materials and tools needed to complete the job and any safety precautions that need to be taken. Once the job is completed, the job sheet is usually used to document the work done and any issues that were encountered.

As a Wireless Technician, my primary responsibility is to support the installation and maintenance of wireless communication equipment. Analyzing work orders and job sheets is important because it provides the necessary information to complete the assigned tasks correctly and efficiently.

Here are the steps a Wireless Technician may take to analyze work orders and job sheets:

- **Review the Work Order:** The first step is to review the work order to understand the scope of work, the location of the site, and the type of equipment that needs to be installed or serviced. This helps the technician to plan the work and gather the necessary equipment and tools.
- Identify the Job Requirements: Once the technician has reviewed the work order, they will then analyze the job sheet to identify the job's specific requirements. This includes the type of equipment that must be installed, the cabling and wiring required, and any other specifications that must be followed.
- **Plan the Work:** Based on the information gathered from the work order and job sheet, the technician will then plan the work to be done. This includes identifying the required tools and equipment, scheduling the work, and estimating the time required to complete the job.
- **Prepare the Site:** Before beginning any work, the technician will prepare the site by ensuring that it is safe to work on. This includes checking for any potential hazards, such as electrical wiring, and ensuring that the area is clear of debris.
- **Perform the Work:** With the site prepared, the technician will then begin the work, following the instructions provided in the job sheet. This may include installing or repairing equipment, testing the system, and ensuring that everything is working correctly.
- Document the Work: Finally, the technician will document the work done by completing the job sheet with all the necessary information, including any problems encountered, any additional work required, and any parts used.

#### 3.1.2 Wi-Fi Backhaul

Wi-Fi backhaul is a term used to describe the process of using wireless networking technology to connect one or more access points to a wired network, usually the internet. Backhaul refers to the connection that carries data between the access points and the network infrastructure in a Wi-Fi network.

For example, in a Wi-Fi network that provides internet access in a public space, such as a park or shopping center, multiple access points may be deployed to provide coverage across the entire area. These access points are connected to the internet via a wired connection, usually provided by an internet service provider (ISP).

The connection between the access points and the ISP is the backhaul connection, and it can be achieved using various wireless technologies, such as Wi-Fi, microwave, or satellite. The backhaul connection must be fast and reliable to ensure that the network can handle high volumes of data traffic and provide a seamless user experience.

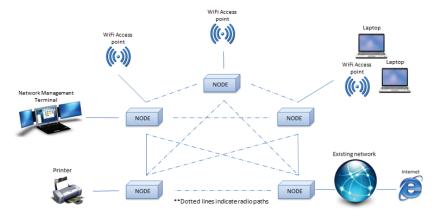


Fig. 3.1.1: Wi-Fi Backhaul

In summary, Wi-Fi backhaul refers to the process of using wireless networking technology to connect Wi-Fi access points to a wired network, such as the internet. It is an essential component of modern Wi-Fi networks, allowing users to access the internet from any location within range of the network.

## 3.1.3 Cables, Connectors, Tools and Equipment Required for Installation

Several types of cables, connectors, tools, and equipment are required to install, configure, and test Wi-Fi backhaul equipment (5 GHz) and Wi-Fi access points (3.4 GHz) for broadband access. Here are some of the most commonly used items:

#### **Cables**

Coaxial Cable: Coaxial cables are used to connect the Wi-Fi backhaul equipment, such as the access point and wireless router, to the broadband modem. These cables are designed to transfer high-frequency signals with minimal interference.



Fig. 3.1.2: Coaxial Cable

• **Ethernet Cable:** Ethernet cables are used to connect the Wi-Fi access points to the wired network. These cables come in different categories, such as Cat5, Cat6, and Cat7, and are capable of transferring data at different speeds.



Fig. 3.1.3: Ethernet Cable

#### **Connectors**

SMA Connector: SMA connectors are commonly used to connect the antennas to the Wi-Fi backhaul equipment. These connectors are designed to maintain a constant impedance across the connection, which is essential for transferring high-frequency signals.



Fig. 3.1.4: SMA Connector

• **RJ45 Connector:** RJ45 connectors are used to terminate Ethernet cables. These connectors are designed to maintain a secure and reliable connection between the cable and the network device.



Fig. 3.1.5: RJ45 Connector

#### **Tools**

• **Cable Crimper:** A cable crimper is used to attach the connectors to the cables. This tool helps ensure a secure and reliable connection between the cable and the connector.



Fig. 3.1.6: Cable crimper

- **Mounting hardware:** Depending on the installation location, mounting hardware may be required to secure the antennas and radio units in place
- **Cable Tester:** A cable tester is used to check the connectivity of the cables. This tool helps ensure that the cables are properly terminated and are transmitting data correctly.



Fig. 3.1.7: Cable tester

• **Power Meter:** A power meter is used to measure the power output of the Wi-Fi backhaul equipment. This tool helps ensure that the equipment is operating within the desired power range.



Fig. 3.1.8: Power Meter

#### **Equipment**

- Wi-Fi Backhaul Equipment: This includes:
  - o Wi-Fi access points: These are the devices that provide wireless connectivity to the network. They can be standalone devices or built into routers or modems.



Fig. 3.1.9: Wireless Access Point

o Power over Ethernet (PoE) injectors or switches: These are devices that can power the access points over the same Ethernet cable that is used for data transmission.



Fig. 3.1.10: POE Injector

 Network switch or router: This is the device that connects all of the access points and provides connectivity to the internet



Fig. 3.1.11: Router

• **Broadband Modem:** The broadband modem is required to connect the Wi-Fi backhaul equipment to the internet.



Fig. 3.1.12: Modem

Antennas: Antennas are used to boost the signal strength of the Wi-Fi backhaul equipment. They
come in different types, such as omni-directional and directional, and can be used to provide
coverage to different areas.



Fig. 3.1.13: Antenna

#### 3.1.4 Steps to Obtain Cables/Equipment from the Company

**Step 1:** Determine what cables and equipment you need: Before you can request cables and equipment from the company, you should first determine what specific items you need. Make a list of the cables and equipment required to complete your project or task.

**Step 2:** Contact the company: Once you have determined the specific cables and equipment needed, contact the company responsible for providing these items. This could be your employer, an IT department, or a third-party supplier. You can typically reach out to the company via phone, email, or online contact form.

**Step 3:** Provide detailed information: When you contact the company, provide them with detailed information about the cables and equipment you need. Be specific about the type, quantity, and any other relevant information. If you are unsure about the specific items you need, the company may be able to provide guidance or recommendations.

**Step 4:** Verify availability and pricing: Once you have provided the company with the specific items you need, they will likely check their inventory to determine availability. They may also provide you with pricing information for the cables and equipment. If the items are not immediately available, they may be able to provide an estimated delivery date.

**Step 5:** Place the order: If the cables and equipment are available and you are satisfied with the pricing, you can place the order. You will likely need to provide payment information and a shipping address.

**Step 6:** Receive the cables and equipment: After the order is placed and processed, you will receive the cables and equipment. Depending on the company's policies and shipping methods, this could take anywhere from a few days to a few weeks.

**Step 7:** Test the cables and equipment: Before using the cables and equipment, it is important to test them to ensure they are functioning correctly. This can help identify any defects or issues early on, which can prevent delays or other problems down the line.

#### 3.1.5 Feeder Cable Laying

Feeder cable laying refers specifically to the installation of cables for telecommunications and networking systems, such as Wi-Fi systems or cellular networks. Feeder cables are typically used to connect the core network infrastructure, such as switches or base stations, to the access points or end-user devices. Feeder cable laying may involve specialized techniques and equipment, such as fiber-optic splicing equipment or specialized cable trays, to ensure that the cable is installed and protected properly.

The following steps describe a general process of cable laying:

- Planning: The planning stage is critical to the success of the cable laying process. A detailed
  plan should be created that considers factors such as the type of cables to be laid, the distance
  they need to cover, the terrain they will pass through, the equipment needed, and any permits
  or permissions that may be required. The plan should also consider potential obstacles, such as
  existing infrastructure, water bodies, or other physical barriers, and identify solutions to overcome
  them.
- **Site Preparation:** Once the plan is in place, the site where the cables will be laid must be prepared. This involves clearing the ground of debris or obstacles, marking out the route for the cable, and excavating trenches or channels for the cable to be laid in. The width and depth of the trench or channel will depend on the cable's type and size.
- Laying the Cable: The next step is to lay the cable in the trenches or channels. This may involve feeding the cable through conduits or ducts, pulling it along a path, or using specialized equipment such as cable plows or trenchers. The cable should be laid straight and secured in place, avoiding any sharp bends or kinks that could damage the cable or affect its performance. Care must be taken to avoid damaging the cable or interfering with any existing utility lines or infrastructure.
  - o Cable Feeding: The first step in cable laying is feeding the cable through any conduits or other obstacles that are present in the cable route. This may involve attaching the cable to a pulling rope or cable, then using a winch or other pulling equipment to draw it through the conduit or other obstacle.
  - Cable Pulling: Once the cable is fed through the conduit, the pulling process can begin. This may
    involve using a specialized cable pulling equipment such as a cable puller or winch to pull the
    cable along the prepared route. This equipment is typically operated by trained personnel who
    are familiar with the cable pulling process.
  - Cable Plowing: In some cases, cable plowing equipment may be used to install the feeder cable. Cable plows are specialized machines that create a channel in the ground and simultaneously lay the cable into the channel. This method can be faster and more efficient than traditional cable pulling techniques, especially in areas with soft soil or where trenching is not feasible.



Fig. 3.1.14: Cable Plowing Machine

- O Cable Protection: During cable laying, it is important to take steps to protect the cable from damage. This may involve placing warning tape over the cable to indicate its location, or using cable markers to indicate its depth below the surface. Additionally, in areas where the cable may be exposed to hazards such as water or sharp objects, protective sheaths or sleeves may be used to minimize the risk of damage.
- o **Cable Splicing:** In some cases, it may be necessary to splice two or more sections of cable together during the laying process. This may be done in the field by trained personnel using specialized splicing equipment. Splicing must be done carefully to ensure that the connection is strong and reliable and does not affect the cable's signal transmission properties.

o **Cable Tension:** The feeder cable must be properly tensioned during installation to prevent sagging or damage to the cable due to excessive tension. The appropriate tension level will depend on the type of cable being installed, as well as the distance and elevation changes that the cable must span.

After the feeder cable is laid, the connectors and accessories are installed to prepare the cable for connection to the wireless network equipment. The connectors and accessories include connectors, weatherproofing boots, grounding kits, and other equipment needed to make sure the cable is properly secured and protected against the weather and other environmental conditions.

Terminating and Splicing: Once the cable has been laid, it must be terminated at each end and spliced as needed. This may involve attaching connectors, crimping or soldering wires, or using specialized equipment to join fiber-optic cables. These processes must be performed carefully to ensure the cable is properly connected and the signal or power can flow uninterrupted. Proper labeling and documentation of the cable termination points and splices is essential for future maintenance or troubleshooting.



Fig. 3.1.15: Optical Fiber Splicer Machine

- Testing and Commissioning: After the cables are laid and terminated, they must be tested to ensure they are functioning correctly. This may involve testing for continuity, resistance, and signal strength, among other factors. Specialized test equipment such as TDRs, Optical Time-Domain Reflectometers (OTDR), and power meters are used to verify proper signal transmission, power levels and fiber attenuation. The test results should be documented and reviewed to ensure the cable meets the design specifications. Once testing is complete, the cables can be commissioned and put into service.
- **Restoration:** Finally, the site must be restored to its previous state or better. This may involve backfilling trenches or channels, landscaping, and cleaning up any debris or equipment. Restoration is an important part of the cable laying process as it ensures that the site is safe and functional for future use.

#### 3.1.6 Wi-Fi System Installation

Here are the general steps involved in Wi-Fi system installation:

- **Site survey:** This involves visiting the site where the Wi-Fi system is to be installed and conducting a survey to assess the area's size, shape, and other environmental factors that could affect the system's performance.
- **Network design:** Based on the site survey, a network design is created that outlines the number of access points required, their placement, and other components needed to ensure adequate coverage.
- **Equipment selection:** Once the network design is finalized, the appropriate Wi-Fi equipment is selected, including access points, switches, routers, and cabling.
- **Installation of network components:** The network components are then installed, which may involve running cables, mounting access points, and configuring routers and switches.
- **Configuration and testing:** The Wi-Fi system is then configured and tested to ensure that it is working correctly and providing the desired coverage.

## **3.1.7** Match Connectors to the Correct Type of Cable for Installation

Matching connectors to the correct type of cable is an important step in the installation process, as it ensures that the cable and connector are compatible and can transmit data effectively. Here are the steps to match connectors to the correct type of cable for installation:

The first step in matching connectors to the correct cable type is to identify the cable being used. Cables can vary in terms of their materials, diameter, and other properties, so it is important to know the exact type of cable being used.

Once the cable type is identified, the next step is to determine the type of connector that will be required for the installation. There are many different types of connectors, each with different physical characteristics and compatibility with different types of cables.

There are several types of connectors used in Wi-Fi backhaul installations. Some of the most common types include:

• **N-Type Connectors:** These connectors are commonly used in Wi-Fi backhaul systems as they offer good performance and low loss. N-type connectors are available in both male and female versions and are typically used with coaxial cables.



Fig. 3.1.16: N-Type Connectors

- **SMA Connectors:** SMA (SubMiniature version A) connectors are small-sized, high-frequency connectors that are commonly used in Wi-Fi backhaul installations. SMA connectors are typically used with smaller diameter coaxial cables.
- **RP-SMA Connectors:** RP-SMA (Reverse Polarity SMA) connectors are similar to SMA connectors, but with the polarity reversed. RP-SMA connectors are typically used in Wi-Fi access points and routers.



Fig. 3.1.17: SMA and RP SMA Connectors

- TNC Connectors: TNC (Threaded Neill-Concelman) connectors are similar to BNC connectors, but offer a threaded connection for added security. TNC connectors are commonly used in Wi-Fi backhaul systems as they offer good performance and low loss.
- **RP-TNC Connectors:** RP-TNC (Reverse Polarity TNC) connectors are similar to TNC connectors, but with the polarity reversed. RP-TNC connectors are commonly used in Wi-Fi access points and routers.



Fig. 3.1.18: TNC and RP TNC Connectors

• MCX Connectors: MCX (Micro Coaxial) connectors are smaller than SMA connectors and are commonly used in Wi-Fi access points and routers.



Fig. 3.1.19: MCX Connector

After identifying the required connector type, it is important to check the connector specifications to ensure that it is compatible with the specific type of cable being used. The specifications will indicate the cable diameter, conductor size, and other parameters that must match the cable being used.

Before connecting the connector to the cable, the end of the cable should be prepared by stripping the outer jacket and exposing the inner conductor wires. This may involve using specialized tools such as wire strippers or scissors.

After preparing the cable end, the connector can be installed onto the cable. This may involve using crimping tools or other specialized equipment to securely attach the connector to the cable.



Fig. 3.1.20: Crimping Tool

Once the connector is installed, it is important to test the connection to ensure that the cable and connector are transmitting data effectively. This may involve using specialized testing equipment to measure the signal strength and quality of the connection.

## **3.1.8 Installation and Usage of Cable Termination between Equipment and Antenna**

Cable termination refers to the process of connecting cables from equipment to an antenna, which is an important step in the installation of a wireless communication system. Here are the steps to install and use cable termination between equipment and antenna:

- Determine the required termination type: The first step in the installation of cable termination is to determine the type of termination that is required. This may involve selecting the appropriate connector type based on the equipment and antenna being used.
- Prepare the cable end: After determining the required termination type, the next step is to prepare the end of the cable that will be connected to the equipment or antenna. This may involve stripping the outer jacket and exposing the inner conductor wires.
- Install the connector: Once the cable end is prepared, the next step is to install the connector onto the cable. This may involve using specialized crimping tools or other equipment to securely attach the connector to the cable.
- Connect the termination to the equipment: After the connector is installed, the cable can be connected to the equipment using the appropriate port or interface. This may involve screwing the connector onto the port or plugging it into the interface.
- Connect the termination to the antenna: After connecting the cable termination to the equipment, the other end of the cable can be connected to the antenna. This may involve screwing the connector onto the antenna port or using other specialized equipment to securely attach the connector to the antenna.
- Test the connection: Once the cable termination is installed, it is important to test the connection to ensure that it is transmitting data effectively. This may involve using specialized testing equipment to measure the signal strength and quality of the connection.

To use cable termination between equipment and antenna, it is important to ensure that the
termination is installed correctly and that the connection is secure. This will help to ensure that the
wireless communication system is functioning effectively and that data is being transmitted accurately
between the equipment and antenna. It is also important to regularly check the termination and
connection for any signs of damage or wear, and to replace any damaged components as needed.

## 3.1.9 Electrical Principles to be Considered while Turning on the Wi-Fi System

When turning on a Wi-Fi system, there are several electrical principles that should be considered to ensure that the system functions properly and safely. Here are some key electrical principles to consider:

- **Voltage:** The voltage of the power supply must be appropriate for the Wi-Fi system being used. Voltage is the electrical potential difference between two points, and the system may be designed to operate at a specific voltage range. Using a power supply with a voltage outside of this range can damage the system or cause it to malfunction.
- **Current:** The current draw of the Wi-Fi system should also be considered when turning it on. Current is the flow of electrical charge through a circuit, and the system may be designed to draw a specific amount of current. Using a power supply that cannot deliver enough current can cause the system to malfunction or fail to operate.
- **Power:** Power is the rate at which electrical energy is transferred, and it is determined by the voltage and current being used. The power rating of the Wi-Fi system and its components should be considered when turning it on, to ensure that the power supply can provide enough power to operate the system effectively.
- **Circuit protection:** It is important to ensure that the Wi-Fi system and its components are protected from overvoltage, overcurrent, and other electrical faults. This can be accomplished through the use of fuses, circuit breakers, or other protection devices, which can prevent damage to the system in the event of an electrical fault.
- **Grounding:** Grounding is an important electrical principle to consider when turning on a Wi-Fi system. Grounding provides a low-resistance path for electrical current to flow to the earth, and can help to prevent electrical shock and other hazards. The system and its components should be properly grounded to ensure safe operation.

By considering these electrical principles when turning on a Wi-Fi system, it is possible to ensure that the system functions properly and safely, and that the risk of electrical hazards is minimized. It is also important to follow any manufacturer recommendations and safety guidelines for the specific Wi-Fi system being used, and to seek professional assistance if necessary.

## 3.1.10 Test the Cable and Joints for Transmission Loss and Strength

To test a cable and its joints for transmission loss and strength, there are several methods that can be used. Here are some common techniques:

#### **Cable Testing**

Cable testing is a crucial step in ensuring the quality and reliability of a cable installation. One common method of cable testing is to use a cable tester. A cable tester is a specialized device that can measure

various characteristics of the cable, such as the continuity of the conductors, the impedance, and the capacitance.

A cable tester typically consists of two units, a transmitter and a receiver. The transmitter is connected to one end of the cable being tested, and it sends a signal through the cable. The receiver is connected to the other end of the cable, and it receives the signal and analyzes it.



Fig. 3.1.21: Cable Tester

By using a cable tester, it is possible to identify any breaks or faults in the cable that could cause transmission loss. For example, if there is a break in one of the conductors, the cable tester will detect it and indicate that there is a fault. Similarly, if there is an issue with the impedance or capacitance of the cable, the cable tester will be able to identify it.

Some cable testers also have additional features, such as the ability to measure the length of the cable and the location of any faults or breaks. This can be useful for identifying the specific location of any issues in the cable.

#### **Time Domain Reflectometry (TDR)**

Time Domain Reflectometry (TDR) is a highly advanced technique for testing and analyzing the quality of a cable. TDR works by sending a high-frequency signal down the cable being tested, and measuring the reflections that occur at any discontinuities or faults in the cable.

The TDR tester consists of a pulse generator that sends a signal through the cable, and a receiver that detects and measures the reflections. The pulse generator sends a short electrical pulse down the cable, which then travels down the cable until it reaches the end or encounters any discontinuity or fault in the cable.

At any discontinuity or fault in the cable, a portion of the electrical signal is reflected back towards the TDR tester. The TDR tester then detects and measures the time it takes for the signal to travel to the fault and back, which corresponds to the distance between the TDR tester and the fault. The amplitude of the reflection is also measured, which indicates the severity of the fault.



Fig. 3.1.22: Time Domain Reflectometry (TDR)

By analyzing the reflections, it is possible to determine the location and severity of any faults or damage in the cable. The TDR tester can provide a graphical display of the signal reflections, known as a Time Domain Reflectogram (TDR), which provides a visual representation of the cable's quality.

TDR testing is a highly advanced technique and is used in more complex cable installations. It can be used to measure a wide range of cable characteristics, such as cable length, impedance, and capacitance. TDR is often used in applications that require precise measurement and analysis of cable quality, such as in telecommunications, data centers, and power transmission systems.

#### **VSWR Testing**

VSWR (Voltage Standing Wave Ratio) testing is an important method of measuring the reflection of radio frequency (RF) energy at the joints between two cables. It is used to identify any impedance mismatches or other issues that could cause transmission loss. VSWR is a measure of the efficiency of a radio frequency transmission system, and it is an indication of how well the system is matched to the antenna and cable.

In a transmission system, it is essential to match the impedance of the cable and the antenna to minimize the reflection of the radio frequency energy. Any mismatch in the impedance can result in a reflection of the energy that is not transferred to the antenna, causing transmission loss. VSWR is a measure of the ratio of the maximum voltage to the minimum voltage in a transmission line.

A VSWR meter is a specialized device that is used to measure the VSWR at the joints between two cables. The VSWR meter sends a signal down the cable and measures the ratio of the maximum voltage to the minimum voltage in the signal that is reflected back from the joint. The VSWR meter then compares the measured VSWR to the acceptable range for the specific cable type and application.

If the VSWR measurement is outside the acceptable range, it indicates that there is an impedance mismatch or other issue that could cause transmission loss. The VSWR meter can help identify the location of the impedance mismatch or issue, allowing for targeted troubleshooting and repair.

VSWR testing is an essential part of any cable installation process, especially in radio frequency transmission systems such as those used in telecommunications, broadcasting, and satellite communications. It helps to ensure that the transmission system is properly matched to the cable and antenna, and that the system is operating at its maximum efficiency.

#### **Pull Testing**

Pull testing is a critical method of testing the strength and durability of the cable and its joints. This method involves applying a controlled amount of force to the cable and measuring the amount of force required to cause it to fail. Pull testing is used to ensure that the cable and its joints can withstand the expected loads and stresses of the installation process and the environment in which it will operate.

During pull testing, a specific amount of tension is applied to the cable and is then gradually increased until the cable or its joints fail. The amount of force required to cause the failure is then recorded, and this information is used to determine whether the cable and its joints meet the required strength specifications.

Pull testing can be conducted using specialized equipment that applies tension to the cable and records the force applied. The equipment can also be programmed to apply a specific amount of tension for a specified period to simulate the effects of long-term use.

The results of the pull test are compared against the specifications of the cable and its joints to determine if they are suitable for use in the installation. If the cable or its joints fail to meet the required strength specifications, they must be replaced or repaired before installation can proceed.

Pull testing is an essential part of the cable installation process, particularly in applications where the cable will be subjected to high loads and stresses, such as telecommunications and power transmission. It helps to ensure that the cable and its joints are strong enough to withstand the expected loads and stresses, reducing the risk of failure or damage to the installation.

# **UNIT 3.2: Complete Documentation**

# **Unit Objectives**



# By the end of this unit, the participants will be able to:

- 1. Explain the importance of providing satisfactory customer service and taking customer feedback
- 2. Discuss necessary documentation required for installation and different payment modes
- 3. Demonstrate how to write and record appropriate technical forms, activity logs
- 4. State the safety norms to be followed and emergency contacts
- 5. Explain escalation matrix for reporting identified incidents, trouble sand/emergencies, e.g., system failures, fire and power failures

# **3.2.1** Importance of Satisfactory Customer Service

Providing satisfactory customer service is an essential aspect of any service-oriented job, and it is particularly important for an Wireless Technician who works directly with customers on a regular basis. There are several reasons why providing good customer service is important for an Wireless Technician:

- **Customer satisfaction:** The primary reason for providing good customer service is to ensure customer satisfaction. When customers are happy with the service they receive, they are more likely to return for future services and to recommend the technician to others.
- **Positive reputation:** Satisfactory customer service can also help build a positive reputation for the technician and the company they work for. This can lead to increased business through positive word-of-mouth referrals and repeat customers.
- **Increased revenue:** Happy customers are more likely to spend money on additional services or upgrades, which can increase revenue for the technician and the company they work for.
- **Better job performance:** Providing good customer service can also improve job performance by increasing productivity, reducing errors, and improving morale.

There are several specific steps an Wireless Technician can take to provide satisfactory customer service, including:

- Clear communication: The technician should communicate clearly and effectively with the customer, using language that the customer can understand. They should also listen carefully to the customer's needs and concerns.
- **Prompt response:** The technician should respond promptly to customer inquiries and concerns, demonstrating a sense of urgency and attentiveness.
- **Professional demeanor:** The technician should maintain a professional demeanor at all times, demonstrating respect and courtesy to the customer.
- **Knowledge and expertise:** The technician should have a deep understanding of the technology they are working with and be able to answer any technical questions the customer may have.
- Problem-solving skills: The technician should be able to identify and solve any problems the
  customer may be experiencing, using a combination of technical expertise and communication
  skills.

### **Taking Customer Feedback**

Taking customer feedback is crucial for an Wireless Technician as it helps them understand the customer's needs, preferences, and expectations. Customer feedback provides valuable insights that can be used to improve the quality of service, address customer concerns, and enhance the overall customer experience.

By listening to customer feedback, an Wireless Technician can identify areas where they need to improve and take necessary steps to address those issues. This can help them provide better service and build stronger relationships with customers.

Moreover, customer feedback also helps an Wireless Technician to identify trends and patterns in customer behavior, which can help them anticipate and address future issues proactively. This can lead to increased customer satisfaction and loyalty, as customers are more likely to return to a business that values their feedback and takes action to address their concerns.

Additionally, taking customer feedback can also help an Wireless Technician to identify their strengths and weaknesses, and work on improving their skills and knowledge. This can lead to personal and professional development, as well as increased job satisfaction.

# 3.2.2 Documentation Required for Installation -

The documentation required for the installation of Wi-Fi backhaul may vary depending on the specific project and location, but generally, the following documents are important:

- **Site survey report:** A report containing the details of the site survey, including the type of equipment needed, the layout of the area, and any potential obstacles or challenges that may affect the installation process.
- **Bill of Materials (BOM):** A list of all the materials, components, and equipment required for the installation, including their specifications, quantities, and costs.
- **Network diagram:** A diagram that shows the layout of the network and how all the devices will be connected, including access points, routers, switches, and other network components.
- **Installation manual:** A document that outlines the step-by-step procedures for installing and configuring the Wi-Fi backhaul equipment.
- **User manual:** A document that provides instructions and information on how to use the Wi-Fi backhaul system, including how to connect to the network, configure settings, and troubleshoot issues
- **Testing and commissioning report:** A report that outlines the results of the testing and commissioning process, including any issues or problems that were encountered and how they were resolved.
- **As-built drawings:** A set of drawings that show the actual layout and installation of the equipment, including the location of devices, cabling, and other components.
- Maintenance manual: A document that provides guidelines and instructions for maintaining the Wi-Fi backhaul system, including routine maintenance procedures, troubleshooting, and repair instructions.

# 3.2.3 Different Payment Modes

The payment modes in which an Wireless Technician can collect payment from the customer post installation includes:

- Cash: The customer can pay the Assistant Technician in cash for the services provided.
- Credit or Debit Cards: The Assistant Technician can accept payment from the customer using a
  credit or debit card. They may use a mobile card reader to process the payment or may manually
  enter the customer's payment information into a payment terminal.
- Unified Payments Interface (UPI): Unified Payments Interface (UPI) services such as PhonePe, GooglePay, PayPal, etc. may be used to accept payment from the customer.

# 3.2.4 Write and Record Appropriate Technical Forms, Activity Logs

Writing and recording appropriate technical forms and activity logs is an important part of the job of an Wireless Technician. The purpose of these forms and logs is to document the work that has been done, provide information to other technicians who may need to work on the system in the future, and to create a record of the work that has been done for the customer. Here are the steps to write and record appropriate technical forms and activity logs:

- Identify the type of form or log needed: There are different types of technical forms and activity logs used for different purposes, such as work orders, inspection forms, installation reports, and maintenance logs. Choose the appropriate form or log based on the specific work being done.
- **Fill in all necessary information:** Technical forms and activity logs should contain all relevant information about the work being done, including the date, time, location, equipment used, materials used, and any issues or challenges encountered. Make sure to fill in all necessary fields accurately and completely.
- Use clear and concise language: When filling out forms and logs, use clear and concise language that is easy to understand. Avoid technical jargon or abbreviations that may not be familiar to others who need to read the forms.
- **Be detailed:** Provide as much detail as possible about the work that has been done, including any tests performed, measurements taken, and any adjustments made to equipment. This information can be helpful to other technicians who may need to work on the system in the future.
- **Include any necessary attachments:** If there are any diagrams, photos, or other attachments that are relevant to the work being done, include them with the form or log.
- **Review and check for accuracy:** Before submitting the form or log, review it to ensure that all information is accurate and complete. Make any necessary corrections or additions.
- Store and organize forms and logs: Keep technical forms and activity logs in a safe and organized location where they can be easily accessed when needed. Make sure to label and date the forms so that they can be easily identified.

# 3.2.5 General Safety Norms to be Followed at Workplace

Safety is an essential consideration in any installation or maintenance work, including wireless technology installations. Here are some safety norms that an Wireless Technician should follow:

• Use proper Personal Protective Equipment (PPE): When working with wireless equipment, it is essential to use PPE to protect against potential hazards. This may include gloves, safety glasses, hard hats, earplugs, and high-visibility clothing.

- Turn off the equipment before working on it: Before working on any wireless equipment, make sure it is turned off to avoid electric shock.
- **Use insulated tools:** Insulated tools should be used when working on any electrical equipment to avoid the risk of electric shock.



Fig. 3.2.1: Insulated Tools

- **Follow the manufacturer's instructions:** Always follow the manufacturer's instructions when working with wireless equipment to ensure that you are following the recommended safety procedures.
- **Secure the equipment:** Make sure that the equipment is properly secured before starting any installation work to avoid any accidents.
- **Be aware of your surroundings:** Always be aware of your surroundings when working with wireless equipment to avoid potential hazards, such as tripping or falling.
- **Use caution when working at heights:** If working at heights, use proper safety equipment such as harnesses, lanyards, and safety nets.
- **Use caution when lifting heavy objects:** Use proper lifting techniques and equipment to avoid injury when lifting heavy objects.
- **Keep the work area clean and organized:** A clean and organized work area helps to reduce the risk of accidents and injuries.
- **Follow proper electrical safety procedures:** Follow proper electrical safety procedures, such as grounding and locking out equipment, to avoid electric shock and other hazards.

# **3.2.6 Escalation Matrix for Reporting Incidents**

An escalation matrix is a set of procedures and protocols that define the steps that need to be taken in the event of an incident or emergency. In the context of a Wi-Fi Backhaul installation, an escalation matrix helps to ensure that any issues or problems are reported, escalated and resolved in a timely and efficient manner. The matrix defines the hierarchy of contacts that need to be notified in case of incidents, troubles, and emergencies.

The escalation matrix typically starts with the first level of contact, which is usually the Wireless Technician who is responsible for the installation. If an issue or problem is identified, the Assistant Technician should follow the appropriate procedures for reporting and escalating the issue. This could involve contacting the second level of support, which could be a more experienced technician or supervisor, who can provide further assistance and guidance.

If the issue is not resolved at the second level, it may need to be escalated to the third level, which could be the network operations center or the customer support team. At this level, a more experienced and specialized team can help to diagnose and troubleshoot the issue, and provide more advanced support.

If the issue still cannot be resolved, it may need to be escalated to the fourth level, which could involve senior management or executives who can provide additional resources, funding, or other forms of support. At this level, the incident is typically treated as a high priority, and urgent action is taken to resolve the issue as quickly as possible.

The escalation matrix should also define the appropriate communication channels and protocols for reporting and escalating incidents. This could involve using a dedicated phone line or email address, or following a specific reporting format or template. The matrix should also define the response times and targets for each level of support, as well as the procedures for tracking and closing out incidents once they have been resolved.

# Summary 2



- Analysing Work Orders and Job Sheets
- Wi-Fi Backhaul
- Cables, Connectors, Tools and Equipment Required for Installation
- Steps to Obtain Cables/Equipment from the Company
- Feeder Cable Laying
- Wi-Fi System Installation
- Installation and Usage of Cable Termination between Equipment and Antenna
- Electrical Principles to be considered while turning on the Wi-Fi System
- Test the Cable and Joints for Transmission Loss and Strength
- Importance of Satisfactory Customer Service
- Documentation Required for Installation
- Different Payment Modes
- Write and Record Appropriate Technical Forms, Activity Logs
- Safety Norms to be followed
- **Escalation Matrix for reporting Incidents**

# – Exercise 🔯 ———

M	ultiple-choice Question						
1.	A provides detailed instru	ctions on what needs to be done					
	a. work-sheet	b. job-sheet					
	c. blank-sheet	d. None of the above					
2.	is a term used to desc connect one or more access points t	cribe the process of using wireless networking technology to o a wired network					
	a. Wi-Fi backhaul	b. Wi-Fi overhaul					
	c. Hi-Fi backhaul	d. None of the above					
3.	cable laying refers specifically to the installation of cables for telecommunications and networking systems						
	a. Reader	b. Weedier					
	c. Feeder	d. None of the above					
4.	is a report containing the	ne details of the site survey					
	a. Site Survey Report	b. Night Survey Report					
	c. Light Survey Report	d. None of the above					
5.	An is a set of procedures and protocols that define the steps that need to be taken in the event of an incident or emergency						
	a. calculation matrix	b. escalation matrix					
	c wireless matrix	d None of the above					

# **Descriptive Questions:**

- 1. Describe the process to conduct installation of Wi-Fi system
- 2. Discuss the safety norms to be follow at the workplace
- 3. Explain the significance of taking customer feedback
- 4. Explain the escalation matrix for reporting identified incidents
- 5. What are the electrical principles to be considered while turning on the Wi-Fi System?

Notes 🗐 –			

Scan the QR codes or click on the link to watch the related videos



https://www.youtube.com/ watch?v=P8j2H5J4fU4

How to Set Up a Wi-Fi Network



https://www.youtube.com/ watch?v=-DIbLZ3hL9M

Wireless OR Wired Backhaul Benefits



https://www.youtube.com/ watch?v=WnQ7L4WFrcQ

Why is customer service important?



https://www.youtube.com/watch?v=GUurzvS3DIY

What is a payment gateway and how does it work?









# 4. Prepare for Splicing Operations for New Installation

Unit 4.1 - Manage Tools and Spares

Unit 4.2 - Pre-Installation Procedures

Unit 4.3 - Installation of Optical Fibre

Unit 4.4 - Preparing the Cable for Splicing



# **Key Learning Outcomes**



# By the end of this module, the participants will be able to:

- 1. Discuss the characteristics of Optical Fibre
- 2. Identify the tools and equipment required for optical fibre splicing
- 3. Conduct fault analysis procedures and implement safety measures for different tools and mechanical equipment
- 4. Discuss the importance of calibrating the test equipment
- 5. Explain the colour coding of optical fibre cable
- 6. Demonstrate the steps to prepare the cable for splicing for new installation
- 7. Perform tests on OFC using an optical inspection microscope, OTDR and visual fault locator
- 8. Illustrate bare fibre testing

# **UNIT 4.1: Manage Tools and Spares**

# **Unit Objectives**



# By the end of this unit, the participants will be able to:

- 1. Explain the characteristics of Optical Fibre (like refraction, polarisation, attenuation, dispersion, etc.)
- 2. Identify various fibre optics tools

# 4.1.1 Characteristics of Optical Fibre

### **Total Internal Reflection**

When a ray of light crosses an interface into a medium with a higher refractive index, it bends towards the normal. Conversely, light travelling across an interface from a higher refractive index medium to a lower refractive index medium bends away from the normal.

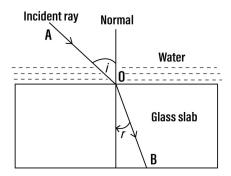


Fig. 4.1.1: Refraction of light

This has an interesting inference. At a specific angle, called the critical angle  $\theta c$ , the light travelling from a higher refractive index medium to a lower refractive index medium will be refracted at  $90^{\circ}$ . In other words, the light ray is refracted along the interface.

If the ray of light hits the interface at any angle larger than this critical angle, it will not pass through to the second medium. Instead, all of it will be reflected back into the first medium. This phenomenon is known as Total Internal Reflection.

Consider a ray of light passing from water into the air. The light emanating from the interface is bent towards the water. When the incident angle is increased sufficiently, the transmitted angle (in the air) reaches 90 degrees. It is at this point no light is transmitted into the air.

The critical angle  $\theta$ c is given by Snell's Law as:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Here,  $n_1$  and  $n_2$  are refractive indices of the media, and  $\theta_1$  and  $\theta_2$  are angles of incidence and refraction, respectively.

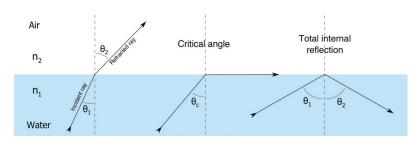


Fig. 4.1.2: Total Internal Reflection

To determine the critical angle, we find the value for  $\theta_1$  when  $\theta_2$  is equal to 90o and thus Sin  $\theta$ 1=1.

The resulting value of  $\theta_1$  is equal to the critical angle  $\theta c = \theta_1 = \arcsin(n_1/n_2)$ .

So the critical angle is only defined when  $n_1/n_2$  is less than 1.

Optical fibres are based wholly on the principle of total internal reflection. This is explained in the following picture.

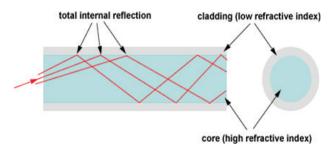


Fig. 4.1.3 Refraction in optical fibre

# **Polarisation**

A light wave that is vibrating in more than one plane is referred to as unpolarised light.

Polarised light waves are light waves in which the vibrations occur in a single plane. The process of transforming unpolarised light into polarised light is known as polarisation.

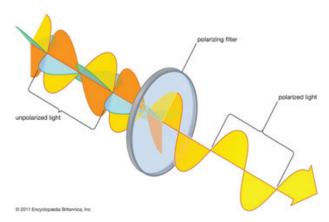


Fig. 4.1.4: Polarisation of Light

### **Attenuation**

The attenuation of an optical fibre is the amount of light lost between input and output. Total attenuation is the sum of all losses. The attenuation of the optical fibre is a result of two factors:

- **Absorption** The absorption is caused by the absorption of the light and conversion to heat by molecules in the glass.
- Scattering Scattering occurs when light collides with individual atoms in the glass, which is
  anisotropic. Light scattered at angles outside the numerical aperture of the fibre will be absorbed
  into the cladding or transmitted back toward the source

# Dispersion

Optical fibre dispersion describes the process of how an input signal broadens/spreads out as it propagates/travels down the fibre. Generally, dispersion in optical fibre cable includes modal dispersion, chromatic dispersion and polarisation mode dispersion.

# - 4.1.2 Various Optical Equipment

# **Fibre Optic Tools:**

It is important to have proper tools and fibre for complete telecom communication.

Tools for Insta	ıller's Toolbox	Overview			
Tubing Cutter-cuts through armoured cable		It is used to cut the cable jacket, and armour.			
Rotary Cable Slitting & Ringing Tool		It is used to cut cable jacket for removal			
Cable Jacket Stripper		It is used to cut 2-3mm cable jacket for removal.			
Fiber Optic Stripper		Helps to remove primary Coating from fiber without nicking the optic fiber. It can also cut 2-3mm cable jacket.			
Buffer Tube Stripper-to cut jacket/buffer tubes in loose tube cable	P. P.	It is similar to UTP jacket cutters and prevents fiber damage			

Tools for Insta	ller's Toolbox	Overview
Crimp Tool-crimps FO connector on the cable		It is used in termination.
Kevlar Scissors - super-sharp to cut Kevlar fibres in FO cable	8	To cut the fibres
Scribe used to cleave fibre when terminating		Sapphire or carbide are best.
Needle Nose Pliers - use when accessing and pulling cords or ripcords		Not to be used on other things.
Tweezers		Not to be used on other things.
Polishing Plate - place under polishing pad		For polishing.
Polishing Pad-place under polishing film		Provide polish surface
Polishing Puck-insert connector into this polishing tool, lay on polishing paper		Ferrule connectors
Safety glasses		Used to prevent eyes from obstacles
Connector Curing Oven - to cure epoxy/polish connectors		Portables and easy handling

Tools for Instal	ler's Toolbox	Overview
Lineman Scissors - heavy duty to cut through cables or other heavy materials		Used in cutting.
Flashlight Continuity Tester (MM only) or Visual Fault Locator (VFL-red laser-SM or MM) bright, visible light source for checking continuity or tracing fibers, VFL can find faults also		Testing purpose
Light source		Used for lighting
Power meter adapters		Can be used on 2.5mm ferrules
Reference Test Cables - tested and known to be low loss		To be used based on connector types
Connector Mating Adapters - with metal or ceramic alignment sleeves (NOT PLASTIC)		ST/ST, SC/SC, etc, or hybrid ST/ SC
Connector inspection microscope	XXXI - offense and a service of	To protect eyes from radiation
ST Bare fiber adapter - to test bare fibers		Used in testing
Optical Time Domain Reflecto meter (OTDR)	STATE STATE OF THE PROPERTY OF	Used in OSP cables and troubleshoot problems

Tools for Installe	r's Toolbox	Overview
Alcohol-saturated pads - to clean fiber and connectors during splice, termination, test	Service Control of the Control of th	Used in cleaning purpose
Lab wipes		For cleaning purpose
Trash bin small disposable container with top to hold fiber scraps		1-pint deli container with lid works well.
Black work mat		Helps see the fiber scraps to clean
Dry connector cleaner	O Electroic Cleaner	For cleaning purpose
Connector curing oven-to-cure epoxy/polish connectors		For cleaning purpose
Heat Cure, 2-Part Epoxy, 2.5 Gram	attended or for an attended or for a state of the state o	"BiPax" package has epoxy and hardener in plastic pack-age that is mixed in the package. Can be used with many connectors at one time
Cheap scissors to cut corner off epoxy package	n b b 6	Cheap once are available which can be used and throw.
Needle		Do not leave it open after use.

Tools for Insta	ller's Toolbox	Overview
Anaerobic Adhesive + Accelerator (optional) works well	1800717E 7649	Used in anaerobic connector termination.
Fusion splicer		Many manufacturers options are available
Fibre cleaver		Used for mechanical splicers
Fusion splice protectors	6	Use the type recommended by the fusion splicer, manufacturer
Mechanical splices		Used for restoration
Wipes and reagent-grade (99%+ pure) alcohol (ethanol)		For cleaning purpose.

Table 4.1.1: Tools and equipment

# **UNIT 4.2: Pre-Installation Procedures**

# **Unit Objectives**



# By the end of this unit, the participants will be able to:

- 1. Describe fibre optic cable specification tensile strength, bend radius, crush and impact, cable attenuation, fibre optic connectivity
- 2. Explain and outline factors affecting fibre optic cable natural and man-made
- 3. Demonstrate the correct procedure of unloading, unwrapping, storage, drum preparation and opening of optical fibre cable
- 4. Demonstrate and execute optical fibre laying pre-requisites

# **4.2.1** Specifications of Fibre Optic Cable –

### **Tensile Strength**

It is a protector which is applied to the cable to avoid damage. Short-term load is an initial stage of installing the cable. It gives strength to withstand the cable during installation. The installed cable is subjected to light pressure and load. This process is called operating load. The main goal of the optical fibre cable installation is to install it with less pressure and stress. So the load has to be calculated before the installation.

During the initial process, the cable can withstand the pressure and load that was given and can also resist additional pressure like pulling. The installer needs to be cautious about the force that is applied to the cables during installation. The tensile strength depends on the cable manufacturing process. This information can be found on the cable datasheet.

### **Bend Radius**

It is a small bend which can be resisted by cable. If the cable is bent beyond this limit, it can cause significant damage.

Non-recommended bending can cause increased fibre attenuation. Straightening cable can enhance the performance of the cable.

Two values are integrated with bend radius. Those are installation and long-term. The cable can resist some amount of pressure during installation. But they need to be calculated. Aer installation, the cable can be bent to a small bend radius. The bend radius depends on the cable size and construction.

People make mistakes in cable ben radii. A major mistake is pulling the cable through the small bend radius. The cable must be bent so that it goes through the trays between them. The cable needs to be kept away from sharp bends or corners.

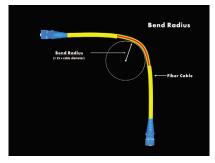


Fig. 4.2.1: Bend Radius

Most of the optical fibre cables are constructed with flexibility in the work area. But, bending the cable over corners can cause severe damage. The cable must be tightly prevented to avoid kinks and knots.

### **Crush and Impact**

- It aids in discovering the OPF performance and the stability to resist pressure and loads.
- In the testing procedure, cables are crushed between two plates and optical loss is measured.
- The amount of attenuation depends on the customer's needs.
- Cables are tested for breakage or damage in optical transmission characteristics.
- In the installation process, crush and impact are very important.
- Fibre cables can work in the same duct or tray as heavier power cables, and excess pressure needs to be avoided on the fibre cable.
- It is a must to avoid crossover of the cables over one another.
- Moving or shifting the installed cables can cause damage to the fibre optic cable.

Cable		Cable Structure	
Parameter	Loose Tube	Tight Buffer	Breakout
Bend Radius:	Larger	Smaller	Larger
Diameter:	Larger	Smaller	Larger
Tensile Strength: (Install):	Higher	Lower	Higher
Impact Resistane:	Lower	Higher	Higher
Crush Resistance:	Lower	Higher	Higher
Attentuation Change at Low Temperatures:	Lower	Higher	Higher

Fig. 4.2.2 Fibre optic specifications

### **Attenuation**

Crush and impact aid in discovering the durability and stability of the OFC. It helps to test the stability of the OFC that is crushed between two plates and whether the optical loss has been measured. The amount of attenuation can be fixed based on the customer's request.

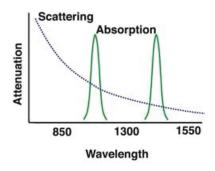


Fig. 4.2.3: Cable attenuation factors

### **Fibre Optic Cable Continuity**

This is the calculation of the intensity passed from the light source to the other end, the receiver, to check the continuity of the OFC. This can be used to assess the damage by calculating the intensity level.

# **Continuity Test:**

Send a light signal into the cable using a continuity tester. While you're doing this, look at the other end of the cable closely. If the light is detectable in the fibre's core, there are no breaks in the fibre, and your cable is fit for use.

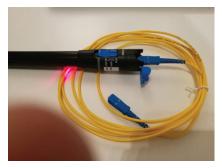


Fig. 4.2.4: Fibre Optics Continuity Tester

# 4.2.2 Factors Affecting OFC —

There are two types of factors which affect the OFC, viz., natural and man-made.

			External o	cables			Internal o	ables
Natural external fac	tors	Trur	Customer premises	Central office				
		Aerial	Buried	Duet	Tunnel	Under water	Buildi	ng
<b>-</b>	В	Cable sheatl	n contraction v	vith core thru	sting out		-	_
Temperature change	Α	Ir	ncrease of opti	ical loss due to	o high and	low temperature		
Very low	В	Embrittlement of cable sheath u	inder low temp	perature	_	_	-	_
temperature	А	Cru	ushing due to i	ce formation			-	_
	В	Excess strain due to wind pressure	-	-	_	-	-	_
Wind	А	Periodical excess strain due to cable dancing	-	-	_	-	-	-
Salt water	В	Corrosion of metal catenary	Corrosion of armour	-	_	Corrosion of armour	-	_
Rain and hot spring	В	Corrosion of metal catenary	Corrosion spri	due to hot ings		-	-	-
Snow and ice	А	Sheath degradation, crushing and excess strain due to snow and ice	-	-	_	Sheath degradation and crushing due to ice	-	-
Water and moisture	А	Increase in optical loss due	to water pene	etration. Decre	ease of stre	ength of fibre	-	_
Sunshine	В	Degradation of sheath by UV rays	-	-	_	-	-	_
Lightning	В	Crushing damage due to lightning a	and haz-ards to	personnel			-	-
Earthquakes and ship. ground subsidence and falling stones	В	Sheath deg-radation and impulsive excess strain due to falling stones		Cutting of cables due to ground movements		-	-	-
Condition of soil	В	-	Corrosion of armour	-	-	-	-	-
Rodents, birds and insects	В	Sheath damage due to birds, rodents	s and insects	-	-	-	-	-
Hydrogen	А	Increase	e in optical los	s due to hydro	ogen		-	_
Water flow	В	-	-	-	_	Cable damage	-	_
Mould growth	В	_	_	Sheath damage	_	-	Sheath damage	_

Fig. 4.2.5 (a): Natural Factors

	i							ables
Man-made factors			Customer premises	Central office				
		Aerial	Buried	Duet	Tunnel	Under water	Buildin	ıg
Factory smoke and air	В	Corrosion of metal	-	-	-	-	-	-
pollution	В	Chemical attack on sheath	-	-	-	-	-	-
Traffic (cars, trucks)	В	-	due to creep. Tra	sheath and joints nsient optical loss tion of fibres	-	-	-	-
Induced voltage (AC traction systems, power lines)	В	Damage to	Damage to cable and hazards to personnel			-	-	-
DC current	В	-	Electrolytic corrosion	_	-	-	-	-
Petroleum gas leakage	В	-	Sheath degradation due to chemical attack	-	-	-	-	-
Fire	В	Sheath (and cable core) burning	-	-	Sheath (and cable core) burning	-	Sheath (and ca burnin	
Nuclear radiation	В			Under consideration	1		-	-
Hydrogen	Α		Increase i	n optical loss due to	hydrogen		-	-
L	В		Cuttin	g or breaking of the	cables		_	-
	A/B	B-Strain	due pulling-in for ins	stallation	A-Strain due pulling	g-in for installation	-	-
Installation practices		-	_	_	A-I	Bending at pulley for	rinstallation	
	A/B	B-Bending & pulley for installation		B-Bending and squeezing due to burying machine		-	-	_

Fig. 4.2.5 (a): Man-made Factors

				External cables			Internal ca	ables
Man-made factors			Customer premises	Central office				
		Aerial	Buried	Duet	Tunnel	Under water	Building	
Factory smoke and air	В	Corrosion of metal	-	-	-	-	-	_
pollution	В	Chemical attack on sheath	-	-	-	-	-	_
Traffic (cars, trucks)	В	-	Damage to cable sheath and joints  due to creep. Transient optical loss due to vibration of fibres			-	-	-
Induced voltage (AC traction systems, power lines)	n systems, B Damage to cable and hazards to personnel				-	-	-	-
DC current	В	-	Electrolytic corrosion	-	_	-	_	-
Petroleum gas leakage	В	-	Sheath degradation due to chemical attack	-	-	-	-	-
Fire	В	Sheath (and cable core) burning	-	-	Sheath (and cable core) burning	-	Sheath (and ca burnin	
Nuclear radiation	В			Under consideration	ı		_	-
Hydrogen	Α		Increase i	n optical loss due to	hydrogen		-	_
	В		Cuttin	g or breaking of the	cables		-	_
	A/B	B-Strain	due pulling-in for in:	stallation	A-Strain due pullin	g-in for installation	-	-
Installation practices		_	_	-	A-	Bending at pulley for	r installation	
·	A/B	B-Bending & pulley for installation	B-Bending and s burying		A-Bending at curve in duct	-	-	_

Fig. 4.2.5 (c): Mechanical Factors

# **4.2.3 Factors Affecting Choosing of Cables**

Let us understand how to choose cables on the basis of various factors that affect the cable performance:

Mechanical and environmental factors	Coated optical fibres	Cable core	Strength member	Water blocking materials	Sheath materials		
Residual fibre strain	А	А	А	_	В		
Impulsive fibre strain	А	А	-	_	А		
Fibre macro-bending	А	А	В	_	А		
Fibre microbend-ing	А	А	В	В	В		
Water	А	А	-	А	А		
Moisture	В	_	_	_	А		
Hydrogen	В	В	В	В	В		
Lightning	_	-	А	В	А		
Nuclear radiation	Under consideration						

A. Primary factor to be considered

Table: 4.2.1: Considerable factors for choosing cables

# **4.2.4** Handling Optical Fibre Cable

### **Handling Process**

Gentle handling is needed during OFC handling and installation, and even a little damage can cause performance reduction. In case of any damage, the OFC needs to be replaced to avoid damage, and OFC needs to be handled carefully.

Always wear a suitable safety Helmet, safety glasses with side shields, and protective gloves while handling OFC. Handle the fibre optic splinters similar to glass splinters. Never look directly through the end of fibre cables till you ensure that there is no light source at the other end.

### **Cable Unloading**

- Precautions to be taken while cable loading/unloading:
- Must not drop the cable drum on the floor, which can cause damage to the cable
- Roll the drum from the truck onto the receiving platform, and this needs to be done at the same height.
- A forklift can act as an alternative to unloading the drums from the truck.
- Do not lose control while rolling the drums
- Before handling the next drum, roll the drum away from the boom of the ramp.



Fig. 4.2.6: Unloading OFC

B. Secondary factor to be considered

### **Cable Unwrapping**

- Precautions need to be taken while cable unwrapping:
- Drum wrappers help to protect the OFC from damage.
- All drums are wrapped by wooden laggings to avoid damage.
- Removing the whole wrapping from the drum before cable installation is not advised.

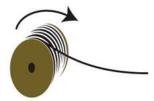


Fig. 4.2.7: Unwrapping OFC

# **Cable Storage**

- Store the drums in an upright position. Any other position can cause winding defects.
- If the storage place is small, then store the completely wrapped drums on their flanges' edge.

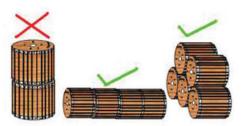


Fig. 4.2.8: Storing OFC

### **Environmental Storage Issues:**

• Wooden storage also can have a negative impact on the OFC. Wood materials can get degraded due to environmental factors, which can cause the degradation of wood.

# Important Way to Address the issue

- Degradation can be avoided with in-house storage.
- In the case of storing outside, the wood storage needs to be hard, and no moist material should come in contact.
- Wood also needs to be prevented from insects which can cause degradation.
- It is important to close the drum using polythene to avoid moisture getting into the drum.

# 4.2.5 Pre Installation - Drum Inspection

One must check on the following points:

- It is important to test the drum for attenuation and damage before taking them to a site.
- Make sure that flanges are stencilled.
- Examine the above points of drum inspection before dispatching.
- Always have a backup drum.

# **Cable Inspection**

Have a check on the following:

- In case of less clarification, remove the cable and examine it thoroughly.
- Have a check on the optical continuity, attenuation and length of the OFC.
- In case of any damage, contact the supplier for the replacement.
- Find the inner and outer end of the OFC.
- · Remove pulling grips & end caps at both ends.
- Check the type and quantity of the cable
- Inspect the damage.
- Check on the manufacturer's default mistakes.

# Opening the drum, check on the following:

- Drums need to be closed with wooden material with the help of an aluminium or iron strip.
- Remove the beans carefully to avoid damage to the cable.
- Use a strip cutter to cut.
- Place the hammer in between the iron strip cut and press the hammer at the opposite end so that the bean comes out of the flange.
- Carefully remove the beans without damaging the cable.
- Bend the straight nails with caution to avoid injury.
- Take out the thermal wrapper given over the cable. Preparation of Drum
- To prevent the cable from rubbing the drum flanges, arrange the cable drum in the pulling direction.
- To avoid the cable coming in contact with the floor, pay -out the cable from the top of the drum.

### **Preparation of Drum:**

- To prevent the cable from rubbing the drum flanges, arrange the cable drum in the pulling direction.
- To avoid the cable coming in contact with the floor, pay out the cable from the top of the drum.



Fig. 4.2.9: Preparing the drum

# 4.2.6 Colour Coding of Optical Fibre Cable

Colour codes are used in OFC to identify fibres, cables and connectors.

### **Cable Jacket Colours**

Coloured outer jackets and/or prints may be used on Premises Distribution Cable, Premises Interconnect Cable or Interconnect Cord, or Premises Breakout Cable to identify the classification and fibre sizes of the fibre. Outdoor cables are generally black for protection against UV light, and markings are printed on the cable.

When coloured jackets are used to identify the type of fibre in cable containing only one fibre type, the colours shall be as indicated in the below table.

Other colours may be used, providing that the print on the outer jacket identifies fibre classifications. Such colours should be as agreed upon between manufacturer and user.

Unless otherwise specified, the outer jacket of the premises cable containing more than one fibre type shall use a printed legend to identify the quantities and types of fibres within the cable. The below table shows the preferred nomenclature for the various fibre types, for example, "12 Fibre, 8 x 50/125, 4 x SM." Some manufacturers use black as the jacket colour for hybrid or composite cables.

When the print on the outer jacket of the premises cable is used to identify the types and classifications of the fibre, the nomenclature of the below table is preferred for the various fibre types.

Fiber Type	Color Code		
	Non-military Applica-tions(3)	Military Applications	Suggested Print Nomenclature
Multimode (50/125) (OM2)	Orange	Orange	OM2, 50/125
Multimode (50/125) (850 nm Laser optimized) (OM3, OM4)	Aqua	Undefined	OM3 or OM4, 850 LO 50/125
Multimode (50/125) (850 nm Laser optimized) (OM5)	Lime Green	Undefined	OM5
Multimode (62.5/125) (OM1)	Orange	Slate	OM1, 62.5/125
Multimode (100/140)	Orange	Green	100/140
Single-mode (OS1, OS1a, OS2)	Yellow	Yellow	OS1, OS1a, OS2, SM/NZDS, SM
Polarization Maintaining Single-mode	Blue	Undefined	Undefined (2)

Fig. 4.2.10: Cable jacket colours

### **Connector Colour Codes**

Since the earliest days of fibre optics, orange, black or grey was multi-mode and yellow single mode. However, the arrival of metallic connectors like the FC and ST made connector colour coding difficult, so coloured strain relief boots were often used.

Fiber type	Connector Body	Strain Relief/ Mating Adapter
62.5/125	Beige	Beige
50/125 OM2	Black	Black
50/125 laser optimized (OM3, OM4)	Aqua	Aqua

Fiber type	Connector Body	Strain Relief/ Mating Adapter
OM5 wideband fiber	Lime Green	Lime Green
Singlemode	Blue	Blue
Singlemode APC	Green	Green

Fig. 4.2.11: Connector Colour Codes

### **Fibre Colour Codes**

Individual fibres will be colour coded for identification inside the cable or inside each tube in a loose tube cable. Fibres follow the convention created for telephone wires, except fibres are identified individually, not in pairs.

Buffer tubes follow the same colour sequence up to 12 tubes, then tubes 13-24 will repeat the colours with a black stripe (black will have a yellow stripe), tubes 25-36 will follow the same colour with an orange stripe, 37-48 use a green stripe, following the same colour code sequence for the stripe. Tubes containing more than 12 fibres will use binder tape to separate fibres into groups. Ribbon cables follow this colour sequence also.

For splicing, colour fibres are generally spliced to ensure continuity of colour codes throughout a cable run.

Fiber Number	Color
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Rose
12	Aqua

Fig. 4.2.12: Fibre Colour Codes

# **Unit 4.3: Installation of Optical Fibre**

# **Unit Objectives**



# By the end of this unit, the participants will be able to:

- 1. Demonstrate and monitor installation of optical fibre trenching, aerial cabling, ducting, figureeight, cable pulling, blowing, and termination perform effective tests
- 2. Demonstrate effective reporting and documentation skills

# 4.3.1 Installing OFC -

The actual installation process involves setting the cable, terminating it and then testing it. The following needs to be considered while installing an OFC:

- Always have the cable pulling plan.
- Make sure you have all the authorisation and permission documents.
- Make sure to have all the tools and devices while working.
- Make sure to share the plans with the installation team and stakeholders.
- It is a must for the installation team to know the access points and the splice locations.
- Once the network design gets completed, start the installation to make the operation communication system as per the design.
- The process of installation helps in choosing the contractor.
- The contractor needs to work with the customer during the installation project, which has the following stages:
  - o Designing the plan
  - Installing
  - Testing
  - Troubleshooting
  - o Documenting
  - Restoring

# **Steps of OFC Installation**

- Once the plan has been made for the installation, the physical work starts based on the design
- The installation process turns the plan into an operating communication system
- It is important for the contractor to have experience in the process of installation

Following are the steps for installing an optical Fibre cable:

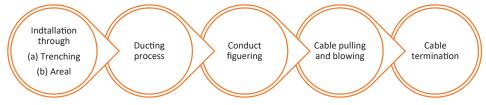


Fig. 4.3.1: OFC cable installation steps

### Step 1 (a): Trenching

Trenching is a construction technique that involves digging a narrow channel in the ground for the installation, maintenance, or inspection of cables. This process takes time, and it is effective for short-distance applications

While digging the channel, obstructions are examined to avoid cable damage.

Trenching is often carried out in urban & suburban areas. It can be done using a machine or by manual methods. An appropriate width for a trench is 4 inches and a hole 20cm from the stand. The cable left for future splicing must have protective caps that must be sealed.

Always use warning tape to protect the OFC to prevent future digging. Mostly OFCs are buried under 3-4 feet to reduce the digging at the same place.

# **Process of Trenching:**

- Dig a trench and bury the duct. It is about 4 inch plastic pipe and could have a pre-installed innerduct with a pulling tape to support the cable pulling process.
- For streets and sidewalks, directional boring is done to avoid surface digging.
- In dielectric cables and ducts, conductive marker tapes may be placed over the duct to facilitate future cable location and to warn anyone digging near the cable.



Fig. 4.3.2: Micro-trenching for optical fibre laying

- Trenching is generally done by using machinery.
   Some regions may need the trench to be dug by hand but to maintain speed; hand digging should only be done if essential.
- A trench should not be wider or deeper than what is required to maintain optimum trenching speed. The recommended minimum practical width of a trench is 4".

### **Precautions for Trenching:**

- The cable should be buried at an undisturbed place.
- Ensure the cable is properly placed in the roadside trench and that future extending must not affect it.
- Take care of the route, which should not be affected by any natural process like drainage or other causes.
- Keep a label to indicate to others that the OFC has been installed.

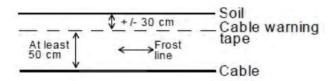


Fig. 4.3.3: Trenching precautions

# Step 1 (b): Aerial Cabling

An aerial cable is an insulated cable containing required fibres for a telecommunication line, which is suspended between utility poles or electricity pylons.

The aerial installation also requires specialised equipment and procedure. It is used in long-duration operations.

Cables in aerial runs can be damaged by the wind, ice, stretch and pull. Hence, external support is a must during installation. This process uses a strong wire which is used to secure the cable.

The cable is lashed for protection. The lashers are chosen with the use of lashing tools. It is an armour buffered tube fibre cable.

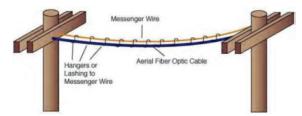


Fig. 4.3.4: Aerial cable installation

# **Step 2: Ducting Process**

Ducts (or conduits) offer a highly protective environment for fibre-optic cables. They are typically buried, and then the cables are air-blown, jetted, pulled or pushed into the duct.

The major advantage of this process is that an old cable can be removed and a new cable can be installed. It causes no damage to the surrounding.

Ducting can be done through a manual or a mechanical process. A duct is made up of PVC material and must be twice the diameter of an OFC. Ducts are coated with an inner lining to protect the OFC from rubbing.

Various colours of lining are available for identification purposes. The installer measures the length of the duct, and it needs to be accurate and placed in the proper position.



Fig. 4.3.5: Duct installation of OFC

# **Step 3: Conduct figuring**

### Figure 8'ing'

- Mark two adjacent circles on the floor of 1.5 to 2-meter diameter so that they make a figure eight.
- Place pulled the cable from a pole or a pay-out trailer on this mark to make several layers, one on top of another.
- A cardboard sheet could be placed over each layer.

- Long lengths of cables and the ones with more weight require to be un-drummed to create more than one figure eight coils. This will facilitate turning over such coils for pulling in another direction.
- Turning figure 8 loop needs at least three persons; one at the centre and one at each end of the circle.
- Control winding of the cable either with hands or with cable drum brake to avert free running or jerking of the cable.



Fig. 4.3.6: Fig.ure 8'ing' of OFC

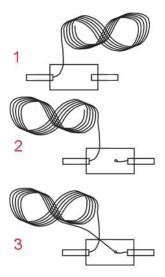


Fig. 4.3.7: Step-by-step process of Fig.ure 8'ing' of OFC

# Step 4: Cable Pulling & Blowing

### **Cable Pulling:**

- Most organisations use cable connections for short distances and straight ways,
- which can be easily pulled with a hand. No equipment is needed.
- If the cable components are not locked, then the elongation in the jacket can occur, which can cause pullback of the cable.
- Equipment can be used to pull a cable with high mechanical force.
- Removing the jacket when pulling the cable using a pulling grip is important.
- It is essential to notice the pressure and force applied to the cable.
- It is necessary to use lubricants while pulling.
- It is very important to give only limited force while pulling.
- When using power in pulling, tension monitoring equipment should be used.

- · Avoid twisting or bending during pulling
- · For long runs, use two or more stages of pulling.
- Make sure enough cable is stored in the shape of 8.
- Initiate a pulling process in the middle location and then proceed in both directions.
- Rack the cable after pulling.
- The allowed pulling level is 3 feet/sec.

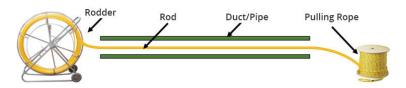


Fig. 4.3.8: Cable pulling

# **Cable Blowing:**

The following steps need to be taken for cable blowing:

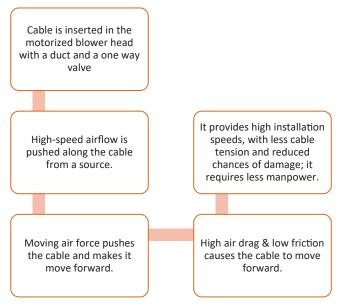


Fig. 4.3.9: Steps for cable blowing

# Single Length Cable Blowing

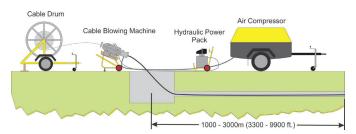


Fig. 4.3.10: Cable blowing process

# **Step 5: OFC Termination Method**

There are 2 methods for terminating the fibre: The first is through the use of connectors that form a temporary joint, and the other is through splicing, which is actually connecting two bare fibre ends directly. The most common termination methods are:

- No-epoxy/no-polish
- Epoxy-and-polish
- · Pigtail splicing

# Steps to terminate OFC using fibre boot:



Put on a fibre boot



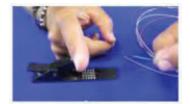
Measure 14 cm for striping as per specifications



Strip the fibre using a wire stripper



Use alcohol wipes to clean any residue



Give the fibre a very slight bend



Put the fibre in a cleaver holder at the 10.5 cm mark (as per specs) and cleave the fibre



Put the fibre in the connector & squeeze the holder



Slide the boot, and the connection is complete

Table: 4.3.11: Steps to terminate OFC using fibre boot

# **4.3.2 Testing and Closing Activities**

After installation, splicing and termination of the optical fibre, it must be tested for the following:

- Continuity and polarity
- End-to-end insertion loss
- Troubleshoot problems, if any
- Ensure marking for identification of route for future maintenance and troubleshooting
- Ensure appropriate cable markings as per recommended guidelines
- Backfill and clear site from debris and other items



Fig. 4.3.11: Testing equipment

# **4.3.3** Reporting and Documentation

Documentation is essential for reference and troubleshooting purposes. It is important to document the fibre designing and installation process of the fibre cable plant.

Major advantages of documentation:

- Proper planning and making a layout reduces the time and cost.
- The materials are pre-determined to avoid confusion.
- It leaves a path to update the existing plan.
- It speeds up the cable pulling and installation.
- It helps to track the process and to identify the mistakes.
- The testing documentation can help show the installation's accuracy and faults.
- It helps for routing the path easily.

Information record about the cable, splice, fibre, paths, etc. is a must and should be captured as follows:

### Cable

- Manufacturer, type, ID, length & drum number
- Splice and terminalon points (at distance markers)

### Fibre

Fibre type and size, splice and connectionon data, losses

### Connection

• Types (splice or connectors and types), fibres connected, losses

### Paths

• Where the link path goes in every cable

### Storage

 A database that contains component, connetion, and test data can be used to store most of the data.

Fig. 4.3.12: Information record

# **Record storage importance:**

- It is very important to store the records in a safe way.
- Always have more than one copy of the document.
- Spare copy is important while storing on a computer or paper.
- Make sure only an authorised person gets access to the records.

# Content and update of the report:

Always make sure to capture the information given below:

- Pending issues
- Challenges
- Faults & serviceability
- NOC for cable integration
- Final closure of the job

# **UNIT 4.4: Preparing the Cable for Splicing**

# **Unit Objectives**



### By the end of this unit, the participants will be able to:

- 1. Inspect Optical Time Domain Reflectometer (OTDR), Power Meter, Splicer, Cleaver, and other mechanical tools/equipment for any fault and calibration status
- 2. Discuss the importance of calibrating the test equipment
- 3. Demonstrate the steps of preparing the cable for splicing for new installation

# 4.4.1 Instruments used for Testing and Splicing of OFC

# **Optical Time Domain Reflectometer (OTDR)**

An Optical Time Domain Reflectometer (OTDR) is a device that tests the integrity of a fibre cable. It is used for building, maintaining, certifying, and troubleshooting fibre optic systems. It uses Rayleigh scattering and Fresnel reflections to measure fibres' characteristics. Rayleigh scattering refers to the irregular scattering generated as optical signals transmitting in the fibre.

Optical Time Domain Reflectometer distance and attenuation scales are calibrated using the External Source Method. Commonly used methods based on recirculating loop and reference attenuation artefact are used to check the obtained results.



Fig. 4.4.1: Optical Time Domain Reflectometer

# **Power Meter**

An optical power meter (OPM) is a device used to measure the power in an optical signal. The term usually refers to a device for testing the average power in fibre optic systems.



Fig. 4.4.2: Optic Power Meter

### **Splicer**

An optical fibre splicing machine is a core-to-core alignment module used to perform the fusion splicing process, fusing or welding two fibres together, usually by an electric arc.



Fig. 4.4.3: Fusion splicer machine

# - 4.4.2 Calibration of Test Equipment

The objective of calibration is to minimise any measurement uncertainty by ensuring the precision of test equipment. Calibration measures and controls errors or uncertainties within the measurement processes to an acceptable level.

Manufacturer's specifications will direct how often to calibrate their tools. However, critical measurements may require different intervals. Most equipment in the fibre optic industry generally has an annual requirement.

Regular instrument calibration is necessary because their measurements' accuracy starts to drop over time. You need to ensure that the instruments don't get out of calibration.

You will notice that the accuracy of the major components will vary over time. However, this shift is minor and won't affect the measurements if you maintain a good calibration schedule, as timely calibrating of your equipment will identify and correct the changes.

There are three main reasons for calibrating the instruments:

- To ensure readings from an instrument are consistent with other measurements.
- To determine the accuracy of the instrument readings.
- To establish the reliability of the instrument, i.e., that it can be trusted.

# Calibration of fibre optical communication system:

### • Optical Time Domain Reflectometer

Calibrating kilometric attenuation and fibre optical distance realising a fibre-optical-artefact-reflectometer calibration procedure

### Optical Power Meter Calibration

Calibrating optical power meter for multi-mode/Single mode/plastic data communication networks including fibre optical receiver's absolute calibration factor and non-linearity, traceable to PTB and METAS

#### • Optical Light Source Verification

Calibrating optical power, stability, half-value of width, wavelength on fibre optical sources and transmitters

#### Optical Attenuator Verification

Calibrating fibre optical attenuation, linearity and repeatability.

#### PMD Calibration

NPL traceable PMD artefact for 10ps Low Mode Coupled PMD (Polarization Mode Dispersion).

## 4.4.3 Steps of Preparing the Cable for Splicing for New Installation

The first step is to mark the cable before putting it into the splicer. If you miss doing it, you will need to check which fibres go to which module, which is very inconvenient and confusing.

For marking, the below-shown paper labels are used, which usually come with the splice closure.



Fig. 4.4.4: Markings for optical fibre splicing

The next step is measuring fibres in the fibre optic cable organiser. However, when fusing a large number of optical fibres, they should still be measured, and the easiest way should be chosen: in a circle, without tricky complex loops and channel transitions. With most cable organisers, it is necessary to measure out: there will be serious problems when laying fibres unless you measure fibres in advance and think about how they will fit into the cable organiser after fusion.

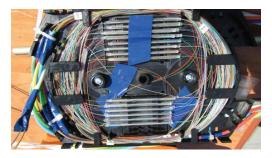


Fig. 4.4.5: Fibre optic cable organiser

When two optical fibres that are to be fused are in the modules, which enter the cable organiser "counter" each other, it is enough to measure each of them by simply laying several (usually two) turns and cutting off above the cradle, where it is planned to lay the FSPK (Fusion Splice Protection Kit) of this splice.

#### Use a protective sleeve (FSKP)

These are disposable composite heat shrink sleeve that protects the splice. These generally come with fibre optic splice closures/ODFs, and are inexpensive.

It consists of 3 parts: a tube of readily fusible plastic inside, a plastic tube with shrink properties outside, and iron wire for rigidity. The protective sleeves are put on one of the fibres to be fused (prior to fusion); when fibres are successfully fused, it is pushed to the splice site so that to completely hide the glass, and a slightly stretched fibre is put into the fusion splicer oven for about 20-40 seconds. The inner plastic melts inside the oven, wrapping the fused fibres, and the outer plastic is heat shrunk.



Fig. 4.4.6: Fusion Splice Protection Kit

When you cut the fibre optic with a fibre optic stripper, it is important to do everything slowly and carefully so that not to break optical fibres. If you cut the optical fibre too much, then after the fibre has been cleaved, the remaining tip will be too short, and the fibre container rollers may not be able to trap it. If you cut too little, then this cleaved tip will be so long that it won't fit in the fibre container and will stick out of it. Both options are undesirable.

However, suppose 2-3 splices in a row are unsuccessful. In that case, the fibre becomes short, and to save fibre, it is necessary to cut it short deliberately, just enough for the cleaver to cleave. The remaining tip can be put into the fibre container with tweezers or insulated with electrical tape.

## 



- Discussing the characteristics of Optical Fibre
- Identifying the tools and equipment required for optical fibre splicing
- Conducting fault analysis procedures and implement safety measures for different tools and mechanical equipment
- Discussing the importance of calibrating the test equipment
- Explaining the colour coding of optical fibre cable
- Demonstrating the steps to prepare the cable for splicing for new installation
- Performing tests on OFC using an optical inspection microscope, OTDR and visual fault locator
- Illustrating bare fibre testing

4. What is Trenching? Explain.

5. Describe OFC termination method.

	Г
<b>Exercise</b>	

Multiple-choice Question							
1.	When a ray of light crosses an interface into a metowards the	edium with a higher refractive index, it bends					
	a) normal	b) abnormal					
	c) new normal	d) none of the above					
2.	A light wave that is vibrating in more than one plane	e is referred to as					
	a) unpolarised light	b) polarised light					
	c) bipolarised light	d) none of the above					
3.	The of an optical fibre is the amount of	flight lost between input and output.					
	a) attenuation	b) attention					
	c) accention	d) none of the above					
4.	It is a which is applied to the cable to	avoid damage.					
	a) protector	b) detector					
	c) projtector	d) none of the above					
5.	help to protect the OFC from damage.						
	a) Drum wrappers	b) guitar wrappers					
	c) keyboard wrappers	d) None of the above					
An	swer the following:						
1.	Explain the characteristics of Optical Fibre.						
2.	What is Total Internal Reflection?						
3.	Describe the process of installing OFC.						

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Scan the QR codes or click on the link to watch the related videos



https://www.youtube.com/ watch?v=G-UyeFDsXII

Characteristics of Optical Fibre



https://www.youtube.com/ watch?v=SDPfA8k0dUc

Various Optical Equipment



https://www.youtube.com/ watch?v=77dOO5hvd58

Specifications of Fibre Optic Cable



https://www.youtube.com/ watch?v=1oYYB7AGeMo

Factors Affecting Choosing of Cables



https://www.youtube.com/ watch?v=eCpujviAo9g

Colour Coding of Optical Fibre Cable



https://www.youtube.com/ watch?v=fYwBgqDdLLQ

Installing OFC









# 5. In-building FTTH/X Cabling

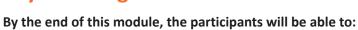
Unit 5.1 - Basics of Fiber Optics

Unit 5.2 - Installation of Optical Fibers

Unit 5.3 - Testing Installed Network



## – Key Learning Outcomes 🙄



- 1. Demonstrate cable installation through cable trays (horizontal/vertical)
- 2. Show how to install cables through conduits
- 3. Show how to install cables through the false ceiling
- 4. Illustrate the procedure for terminations at ONT and TO

## **UNIT 5.1: Basics of Fiber Optics**

## **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Distinguish fiber optic cable types and characteristics for in-building deployments
- 2. Demonstrate appropriate fiber handling practices
- 3. Describe the fiber cable components (strength members, cable sheath, core, cladding etc.)
- 4. Illustrate the VLF principal and testing features

## **5.1.1 Types of Fiber Optics Cables** -

There are several types of fiber optic cables, each with its own unique characteristics and uses. Some of the most common types of fiber optic cables include:

- Single-mode fiber: This type of fiber has a small core (9-10 microns) and is designed to support a
  single light mode, allowing for high bandwidth and long distances. Single-mode fiber is commonly
  used for high-speed data transmission, including long-haul telecommunication and cable television
  networks.
- Multi-mode fiber: This type of fiber has a larger core (50-62.5 microns) and supports multiple light modes, allowing for lower bandwidth and shorter distances. Multi-mode fiber is commonly used for short-distance data transmission, including local area networks (LANs) and metropolitan area networks (MANs).
- Indoor/Outdoor fiber: This type of fiber is designed to be used both indoors and outdoors and is typically used in campus networks and data centers. Indoor/outdoor fiber is typically armoured and weather-resistant, making it suitable for use in harsh environments.
- Ruggedized fiber: This type of fiber is designed for use in rugged and harsh environments, including
  industrial applications and military installations. Ruggedized fiber is typically armoured and
  reinforced to provide high levels of durability and protection from physical damage.
- **Bend-insensitive fiber:** This type of fiber is designed to be more flexible and bend-resistant, making it ideal for use in tight spaces and challenging installation environments. Bend-insensitive fiber is also less likely to experience signal loss when bent, making it a popular choice for data center and data communication applications.
- **Specialty fiber:** This type of fiber includes a variety of unique fibers, including polarization-maintaining fiber, dispersion-shifted fiber, and erbium-doped fiber amplifiers. These fibers are used for specialized applications, including high-speed data transmission, high-power laser delivery, and wavelength division multiplexing (WDM).

Each type of fiber optic cable has its own unique properties and characteristics that make it suited for specific applications. When choosing a fiber optic cable, it is important to consider your application's specific requirements, including the transmission's distance, the bandwidth required, and the environment in which the cable will be used.

For in-building deployments, two main types of optical fiber are commonly used: Multimode and Single-mode fiber.

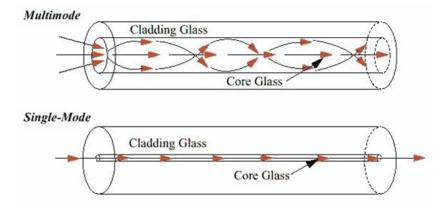


Fig. 5.1.1: Multimode and Single Mode Fiber

#### **Multimode Fiber:**

- Has a larger core diameter (50 or 62.5 micrometers) that allows multiple light rays to propagate through it.
- Can support higher bandwidth over short distances (up to 2 km).
- Typically used in building-to-building and desktop applications.
- Multimode fiber is less expensive and easier to install and terminate compared to single-mode fiber.

#### **Single-Mode Fiber:**

- Has a smaller core diameter (9 micrometers) that supports only one light ray at a time.
- Can support higher bandwidth over longer distances (up to 100 km).
- Typically used in long-haul and high-speed applications.
- Single-mode fiber is more expensive and requires special equipment for installation and termination compared to multimode fiber.

### - 5.1.2 Bend Radius —

Bend radius refers to the minimum radius that an optical fiber cable can bend without causing any damage to the cable or affecting the performance of the optical signal. The bend radius is a critical factor to consider when installing optical fiber cable, as excessive bending can cause the cable to become damaged, leading to signal loss, attenuation, and increased bit error rate.

The bend radius of an optical fiber cable is specified by the cable manufacturer and is dependent on several factors, including the type of fiber, the size and composition of the cable, and the type of protective coating. Generally, optical fiber cables have a minimum bend radius of 10 times the cable diameter, but this can vary depending on the specific cable design and manufacturing specifications.

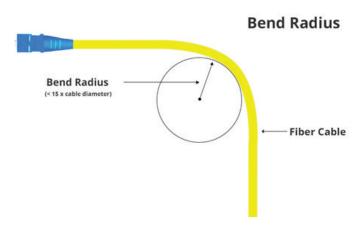


Fig. 5.1.2: Bend Radius

To ensure proper performance and avoid damage to the cable, it is important to maintain the specified bend radius during installation and avoid bending the cable too tightly. This can be done using cable ties, trays, or other support structures to keep the cable in place and prevent excessive bending.

The bend radius of an optical fiber cable can be measured using a variety of tools and techniques during in-building installation. Some common methods include:

#### **Callipers**

Measuring the bend radius of an optical fiber cable using callipers is a simple and straightforward process. The steps involved in the procedure are as follows:

- Locate the tightest bend in the cable: Find the point in the cable where it is bent the most tightly. This is the point where you will measure the bend radius.
- Mark the cable: Use the marker to make a small mark on the cable at the tightest bend.
- Measure the diameter of the cable: Place the jaws of the callipers around the cable at the marked point and adjust them until they grip the cable tightly. Read the diameter of the cable that is displayed on the callipers.
- Calculate the bend radius: Multiply the diameter of the cable by 10 to obtain the minimum bend radius. For example, if the diameter of the cable is 2 mm, the bend radius would be 20 mm.
- Repeat the measurement at other points: If necessary, repeat the measurement at other points along the cable to verify that the minimum bend radius is not being exceeded.

By following these steps, you can easily measure the bend radius of an optical fiber cable using callipers and ensure that it is within the specified limits during installation.

#### **Bend Radius Gauges**

These are specialized tools specifically designed to measure the bend radius of optical fiber cables. They are usually made of plastic or metal and have a curved surface that fits around the cable to measure its diameter. Steps to measure the bend radius:

- Locate the Optical Fiber Cable: Find the optical fiber cable that you want to measure the bend radius of.
- **Prepare the Cable:** Clean the cable and remove any dirt or debris that might interfere with the measurement.

- **Insert the Cable into the Gauge:** Carefully insert the cable into the bend radius gauge so that it passes through the gauge's measuring slot.
- Read the Measurement: Look at the gauge's display to read the bend radius measurement. Most bend radius gauges will give you a digital readout, but some gauges may have a traditional analogue display.
- **Repeat the Measurement:** Repeat the measurement several times to ensure that you have an accurate reading.

## 5.1.3 Parts of Optical Fiber Cable -

An optical fiber cable is composed of several key components:

- **Core:** The core is the center of the optical fiber cable and is made of highly transparent glass or plastic. It is the part of the cable that carries the light signals over long distances.
- **Cladding:** The cladding is a layer of material surrounding the core that has a lower refractive index. It helps to reflect the light back into the core, preventing it from escaping and ensuring that the signal remains intact.
- **Buffer Coating:** The buffer coating is a protective layer around the cladding, which helps to protect the optical fiber from mechanical damage and environmental factors.
- **Strength Members:** Strength members are used to provide mechanical strength to the optical fiber cable, allowing it to be properly handled, installed, and protected. These can include aramid fibers, stainless steel wires, or a combination of both.
- Cable Sheath: The cable sheath is the outer layer of the optical fiber cable, providing a protective and durable layer that helps to keep the other components of the cable safe and secure. This layer can be made of materials like PVC, TPU, or a UV-resistant polymer, and is designed to withstand harsh environmental conditions and mechanical stress.

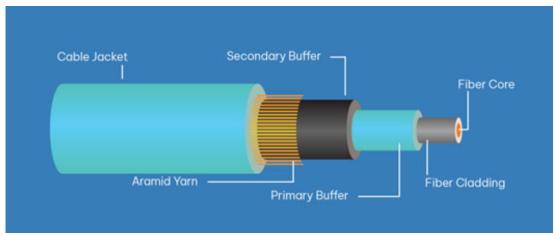


Fig. 5.1.3: Parts of Optical Fiber

These components work together to ensure that optical signals are transmitted over long distances with minimal loss and maximum reliability. The specific components used in an optical fiber cable can vary based on the type of cable, the intended use, and the environmental conditions it will be exposed to.

## 5.1.4 VLF Testing

VLF (Very Low Frequency) testing is a diagnostic technique used to detect faults in optical fiber networks. It is used to identify and locate high resistance faults, such as breaks or cracks, in the optical fiber cable.

The principal of VLF (Very Low Frequency) testing is to detect faults in optical fiber networks by using very low frequency electrical signals. The VLF test principle uses signals with a frequency of a few kilohertz, which are low enough not to interfere with the optical signals being transmitted over the fiber. The test signal is injected into the fiber using a high impedance source and received at the far end of the fiber using a high impedance probe.

The VLF test procedure involves injecting the test signal into the fiber and measuring the received signal at the far end of the fiber. If there is a fault in the fiber, the received signal will be reduced, indicating the presence of a fault. The location of the fault can be determined by measuring the change in the received signal at different points along the fiber.

The VLF test principle is particularly useful for detecting faults in optical fiber networks because it can be used to detect faults that are not visible with optical time domain reflectometry (OTDR) testing, such as breaks or cracks in the cladding of the fiber. The VLF test principle is also useful for detecting faults in underground or aerial optical fiber networks, where it is not possible to access the fibers for direct inspection.

## **UNIT 5.2: Installation of Optical Fibers**

## **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Discuss about fusion splicing
- 2. Conduct an inspection of the sites to identify the cabling path from the outdoor fiber landing point to the ONT installation point
- 3. Explain the importance and relevance of managing cable slack and cable management
- 4. Calculate the horizontal and vertical cable length to manage the cable slack
- 5. Demonstrate how to measure the pre-existing load and post- installation load compliance of the cable trays
- 6. Demonstrate cable installation through conduits on false ceiling
- 7. Demonstrate fiber pulling through conduits using appropriate tools (like fish tape) and technique (strength member)
- 8. Illustrate the process to secure excess fiber at the termination point

## **5.2.1 Fusion Splicing**

It is a method to join fiber optic cables together to form a permanent connection. Here, a splicer machine or an electric arc is used to produce heat and fuse/weld glass ends that are precisely aligned together for seamless transmission of light. It has a much lower attenuation of around 0.1 dB.



Fig. 5.2.1: Fusion Splicer

Fusion splicing is used in a variety of optical fiber networks, including telecommunication, data communication, and cable television systems. The process is used to create a permanent and reliable connection between two fibers, ensuring high-quality signal transmission with minimal signal loss. This is especially important in longer distance installations, where signal degradation due to splice loss can significantly impact network performance.

## **5.2.2 Identify the Cabling Path**

Inspecting sites and identifying the cabling path from the outdoor fiber landing point to the ONT (Optical Network Terminal) installation point is an important step in the installation of an optical fiber network.

This process involves several steps which are outlined below:

- **Site Inspection:** The first step is to inspect the site and determine the location of the outdoor fiber landing point and the ONT installation point. This helps to determine the best cabling path that can be used to connect the two points.
- Cabling Path Identification: Inspecting the cabling path from the outdoor fiber landing point to the ONT (Optical Network Terminal) installation point is a critical step in ensuring the success of a fiber optic network installation. The following are the steps to inspect the cabling path:
  - o **Locate the outdoor fiber landing point:** This is the point where the fiber optic cable enters the building. It is typically located near the telephone or utility pole.
  - **Verify the fiber count:** Confirm the number of fibers in the cable to ensure that it matches the specifications for the installation.
  - o **Check the condition of the fiber optic cable:** Look for any damage, such as cuts, cracks, or broken fibers. If there is any damage, the cable may need to be repaired or replaced.
  - o **Identify the cabling path:** Trace the path of the fiber optic cable from the outdoor landing point to the ONT installation point. This may involve crawling through attics, basements, or conduit runs.
  - o **Check for obstacles:** Look for any obstacles that could impede the installation, such as air ducts, pipes, or electrical wiring.
  - Mark the cabling path: Mark the cabling path with tape or markers so that it can be easily located later.
- Documenting the Cabling Path: Once the cabling path has been identified, it is important to
  document the cabling path, including the location of the outdoor fiber landing point, the ONT
  installation point, and the route of the cable. This information can guide the installation process
  and help resolve any issues that may arise during the installation.
- Mapping the Cabling Path: To ensure that the installation process is efficient and effective, it is important to map the cabling path, including any obstacles that may need to be overcome, such as walls, ceilings, and floors. This information can be used to determine the best tools and equipment needed for the installation process.
- Assessing the Tools and Equipment: Once the cabling path has been identified and mapped, it
  is important to assess the tools and equipment that will be needed for the installation. This may
  include fish tapes, cable pulleys, and conduit. The tools and equipment should be chosen based
  on the specific requirements of the installation, such as the type of cable that will be used, the
  distance between the two points, and the presence of any obstacles.

By following these steps, the assistant technicians can ensure that the installation of an optical fiber network is efficient, effective, and that the cabling path is properly identified and documented.

## **5.2.3** Managing Cable Slack

Cable slack management is a crucial aspect of fiber optic network installation and maintenance. Cable slack refers to the extra length of cable that is left after the cable has been installed and terminated. Proper cable slack management helps to ensure that the fiber optic cable is not damaged during installation or maintenance, and that it provides reliable and stable performance over time.

The main objective of cable slack management is to maintain a minimum bend radius for the optical fibers, so that it does not exceed the maximum limit specified by the manufacturer.

To manage cable slack, the following steps are generally followed:

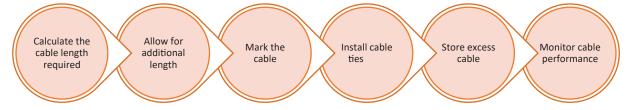


Fig. 5.2.2: Steps to Manage Cable slack

Calculating the horizontal and vertical cable length is an important step in managing the cable slack in an optical fiber network. The cable slack is the excess length of cable that is left in the installation to allow for future maintenance or adjustments to the network. Proper cable management helps to ensure that the network operates efficiently and reliably.

To calculate the horizontal cable length, you will need to measure the distance between the outdoor fiber landing point and the Optical Network Terminal (ONT) installation point, along the horizontal plane. This distance will be the total length of cable required, minus the length of the vertical cable that will be used to connect the horizontal cable to the ONT.



Fig. 5.5.3: Optical Network Terminal (ONT)

To calculate the vertical cable length, you will need to measure the distance between the outdoor fiber landing point and the ONT installation point, along the vertical plane. This distance will typically be the height of the building or structure, minus any underground distance between the fiber landing point and the ONT installation point.

Once you have calculated the horizontal and vertical cable lengths, you can then determine the amount of cable slack that is required. The amount of cable slack that is needed will depend on the type of installation, the type of cable, and the intended use of the network.

For example, in a residential installation, a standard recommendation is to leave around 3 meters (10 feet) of cable slack. In a data center or other high-density installation, the amount of cable slack may be much larger, allowing for easier maintenance and future network expansions.

It is important to properly label the cable and neatly coil and secure the excess cable in a cable management system or a designated slack storage area to manage the cable slack. This will help to ensure that the network operates efficiently and that the cable is protected from damage.

The importance of cable management lies in the following points:

- **Protection of cable:** Cable slack management helps to protect the fiber optic cable from damage due to bending, crushing or kinking. This is particularly important for tight-buffered fibers, which are more vulnerable to damage due to their smaller diameter.
- **Reliable performance:** Proper cable slack management ensures that the cable remains stable and secure, and that the optical performance of the cable is not degraded over time.
- **Easy maintenance:** Cable slack management makes it easier to access the cable for maintenance and troubleshooting. This helps to reduce downtime and ensure that the network is up and running as quickly as possible.
- Improved cable management: Good cable management helps to ensure that the cable is organized and easy to manage. This makes it easier to install and maintain the network, and helps to reduce the risk of cable damage.
- Cost savings: Proper cable slack management can help to reduce the cost of installation and maintenance by minimizing the risk of cable damage, reducing downtime, and improving network performance.

## **5.2.4** Pre-Existing Load and Post-Installation Load Compliance of the Cable Trays

Measuring the pre-existing load and post-installation load compliance of cable trays is an important step in ensuring the safety and reliability of the cable installation. This step helps to determine the load-bearing capacity of the cable trays and to ensure that the cables are installed in such a way that they do not pose any risk to the structure of the building.



Fig. 5.2.4: Cable Tray

To measure the pre-existing load and post-installation load compliance of cable trays, the following steps can be followed:

- Assess the weight of the cables: The weight of the cables to be installed in the cable tray should be determined to calculate the total load on the tray.
- Measure the load capacity of the cable tray: Measure the cable tray to determine its length, width, and height. Using this measurement, calculate the area of the cable tray. Check the specifications of the cable tray system to determine its maximum load capacity. This information can typically be obtained from the manufacturer or from the installation manual.
- **Inspect the cable tray:** Before installing the cables, the cable tray should be inspected to ensure that it is in good condition and free of any damage or corrosion.
- **Install the cables:** The cables should be installed in the cable tray in an organized and neat manner, ensuring that the load is distributed evenly.
- Measure the post-installation load: After the cables have been installed, the post-installation load
  should be measured by placing a load cell or weight gauge on the cable tray. Measuring the postinstallation load of optical fiber cable trays involves determining the amount of weight and stress
  the trays are subjected to after they have been installed and cables have been laid within them.

The following steps outline the procedure for measuring the post-installation load of cable trays:

- Obtain necessary equipment: To measure the post-installation load of cable trays, you will need a load cell, a data logger, and a calibrating weight.
- o **Install load cell:** The load cell should be installed on the cable tray at the location where you wish to measure the load. The load cell should be securely attached to the cable tray and should be level.
- o **Connect data logger:** The data logger should be connected to the load cell using a cable. The data logger will record the readings from the load cell and will store the data for later analysis.
- o **Apply load:** The cable tray should be loaded with the cable and any other components (such as splices, connectors, and closures) that will be installed in it. The load should be evenly distributed across the tray.
- o **Record data:** The data logger should be started and allowed to record data for a sufficient length of time to ensure that an accurate representation of the post-installation load is obtained.
- o **Analyze data:** The data recorded by the data logger should be analyzed to determine the post-installation load of the cable tray. The data should be compared to the cable tray's load specifications to ensure that the post-installation load is within the acceptable range.
- Repeat measurement: The post-installation load of the cable tray should be measured at
  multiple locations to ensure that the load is uniformly distributed across the entire tray. The
  measurement should be repeated as necessary to ensure that an accurate representation of
  the post-installation load is obtained.
- Compare the pre-existing and post-installation load: The pre-existing load and post-installation load should be compared to determine if the load capacity of the cable tray has been exceeded. If the load capacity has been exceeded, the cables should be rearranged, or additional cable trays should be added to distribute the load.
- Check for any signs of damage or deformation: After the load has been measured, the cable tray should be inspected for any signs of damage or deformation, such as cracks or bending. If any damage is found, the cable tray should be repaired or replaced.

## **5.2.5 Laying Optical Fiber along Identified Tray Tracks**

The procedure for laying optical fiber along the identified tray tracks using an appropriate cable pulling method involves several steps:

- Prepare the cable: Check the cable for any damage or defects, and remove any loose fibers or debris. Cut the cable to the desired length and prepare the connector end by stripping and splicing if necessary.
- Mark the cable path: Mark the cable path along the tray tracks with chalk or a marker to ensure the cable is laid correctly.
- **Install cable clamps:** Install cable clamps along the tray tracks to secure the cable in place and prevent it from moving.
- Pull the cable: Choose an appropriate cable pulling method depending on the distance, bend radius
  requirements, and other factors. Some common cable pulling methods include: hand pulling, winch
  pulling, and cable pulling machines.
- **Tension the cable:** Once the cable is pulled into place, tension it to ensure it is tight and secure.
- **Secure the cable:** Secure the cable to the tray using cable ties or clamps, making sure to leave enough slack for future moves, adds, and changes.
- **Test the cable:** Test the cable to make sure it is working properly, and check for any potential problems, such as broken fibers or connectors.
- **Document the installation:** Document the installation, including the cable path, the number of splices, and the cable length, to help with future maintenance and troubleshooting.

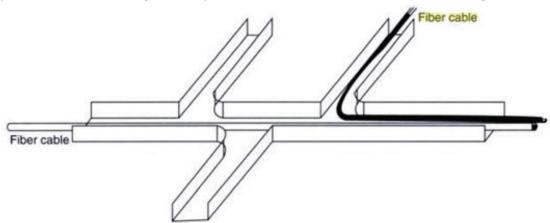


Fig. 5.2.5: Installation of Fiber Optics along Tray tracks

#### How to tie the optical fiber along the cable tray?

The procedure to tie the optical fiber along the cable tray involves several steps to ensure that the fiber is properly secured and protected during installation and over the long-term.

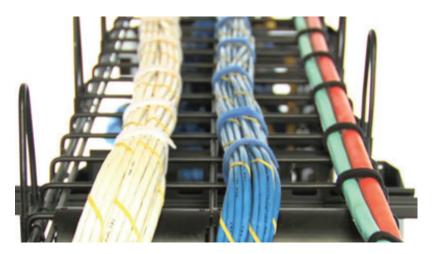


Fig. 5.2.6: Optical Fiber Tie

The following is a general overview of the procedure:

• Choose the appropriate ties: Cable ties should be chosen based on the size and type of the optical fiber cable. Ties made from a strong, flexible material such as nylon or Velcro are recommended for optical fiber cables.



Fig. 5.2.7: Velcro Ties

Fig. 5.2.8: Plastic Ties

- Cut the ties to the appropriate length: The length of the ties should be determined based on the size of the fiber cable and the amount of slack required for the installation. It is recommended to cut the ties longer than needed and trim them down as required during installation.
- Secure the fiber to the tray: Begin by securing one end of the fiber to the tray using the ties. Loop the tie around the fiber and the tray, and tighten it securely. Repeat this process, securing the fiber to the tray at regular intervals along the length of the tray.
- **Use cable supports:** If the fiber cable is long, it may be necessary to use cable supports to keep the fiber from sagging. Cable supports can be added to the tray by tying the fiber to the support at regular intervals along the length of the fiber.
- **Trim excess tie length:** Once the fiber is securely tied to the tray, trim the excess length from the ties to avoid any tripping hazards.

## **5.2.6 Fiber Pulling Through Conduits**

Fiber pulling through conduits is a critical step in the installation of optical fiber networks. It involves the installation of optical fiber cables from one location to another through a conduit, which is a protective tube used to house and protect the cable.

The process of fiber pulling requires the use of appropriate tools and techniques to ensure that the fiber is installed without damage and with sufficient cable slack to prevent tension on the fibers.

- **Determine the path of the conduit:** The first step in fiber pulling through conduits is to determine the path of the conduit. This involves mapping out the route that the conduit will take and identifying any potential obstacles that may need to be avoided, such as corners, bends, or other obstructions.
- Prepare the conduit: The next step is to prepare the conduit. This involves cleaning the inside of
  the conduit to remove any debris and dust and ensuring that it is free of any sharp edges or rough
  spots that could damage the fiber cable.
- **Install the strength member:** A strength member is a material, such as a rope or cable, that provides additional support to the fiber cable during the pulling process. The strength member is installed into the conduit before the fiber cable is pulled through.
- **Use the fish tape:** The fish tape is a tool used to help guide the fiber cable through the conduit. The fish tape is inserted into the conduit and used to pull the fiber cable through.



Fig. 5.2.9: Fish Tape

- Pull the fiber cable: The fiber cable is then pulled through the conduit using the strength member
  and the fish tape. The cable is pulled in a smooth and steady manner to avoid kinking or damaging
  the fibers.
- Maintain cable slack: As the cable is pulled through the conduit, it is important to maintain a
  sufficient amount of cable slack to allow for movement and to prevent tension on the fibers. This
  can be achieved by using a cable slack storage reel or by tying off the cable in loops along the
  conduit.
- **Inspect the cable:** After the fiber cable has been pulled through the conduit, it is important to inspect it for any damage or defects. If any damage is found, it should be repaired or replaced before proceeding with the installation.



Fig. 5.2.10: Pulling Fiber through Conducts

## 5.2.7 Securing Excess Fiber at Termination Point -

Securing excess fiber at the termination point is an important step in the installation of an optical fiber network. This step ensures that the fiber is protected from damage, and prevents it from becoming tangled or knotted.

There are several methods for securing excess fiber, including:



#### Cable ties or zip ties

Cable ties or zip ties can be used to wrap the excess fiber around the cable sheath or to secure it to the conduit. This is a simple and effective method for securing excess fiber.



#### Fiber organizers or spools

Fiber organizers or spools are designed specifically for storing excess fiber. They provide a secure and organized way to store excess fiber and keep it protected.



#### **Optical fiber management panels**

Optical fiber management panels provide a centralized location for terminating and organizing optical fiber cables. They can be used to store excess fiber in a secure and organized manner, while also providing protection from damage.



#### Fiber holders or clips

Fiber holders or clips are designed to hold the excess fiber in place. They can be attached to the conduit or cable tray, and provide a secure way to store excess fiber.

Fig. 5.2.11: Ways of Securing Excess Fiber

## **5.2.8 Cable Installation Through Conduits on False Ceiling**

The procedure of installing optical fiber cables through conduits on a false ceiling involves multiple steps:

- **Planning:** Before starting the installation, it is important to plan the route of the cables and make sure that it is in accordance with the building codes and regulations. The path should be free of any obstructions and should have sufficient space for the conduit and the cables.
- Cutting the conduit: The conduit can be cut to the required length using a saw or a cutter.
- **Mounting the conduit:** The conduit should be mounted to the false ceiling using appropriate fittings, such as conduit clips or conduit hangers. It is important to ensure that the conduit is level and properly secured to prevent it from shifting or moving during the cable installation.

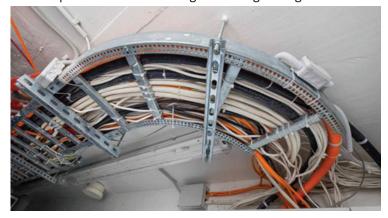


Fig. 2.2.12: Cables through Ceiling

- **Pulling the cables:** The optical fiber cables can be pulled through the conduit using a pulling eye and a pulling rope. A fish tape can also be used to thread the cables through the conduit. It is important to ensure that the cables are not bent beyond the minimum bend radius to avoid damaging the fibers
- **Securing the cables:** The excess cables should be secured at the termination point to prevent them from moving or shifting. This can be done using cable ties, conduit clamps, or other cable management accessories.



Fig. 2.2.13: Securing Extra Cable at the Termination Point

• **Testing the cables:** After the cables have been installed and secured, they should be tested to ensure that they are functioning properly. This can be done using an optical time domain reflectometer (OTDR) or other testing equipment.

## **UNIT 5.3: Testing Installed Network**

## **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Illustrate fiber termination at Optical Network Terminal (ONT) & Telecommunication Outlet (TO)
- 2. Demonstrate the process to configure the ONT after providing the power supply
- 3. Conduct ONT test using an IP network
- 4. Operate Visual Fault Locator (VFL) for the installed fiber run
- 5. Demonstrate the process to test the live fiber using fiber detection meter
- 6. Practice recording the test values

## 5.3.1 Fiber Termination at Optical Network Terminal (ONT)& Telecommunication Outlet (TO)

#### **Optical Network Terminal (ONT)**

An Optical Network Terminal (ONT) is a device that connects a fiber-optic cable to the end user's equipment. It is used in Fiber-to-the-Home (FTTH) networks to provide high-speed internet, television, and telephone services to homes and businesses.

The ONT takes the optical signals from the fiber-optic cable and converts them into electrical signals that can be used by the end user's equipment. The ONT also performs the reverse function of converting the electrical signals from the end user's equipment into optical signals that can be transmitted over the fiber-optic cable.

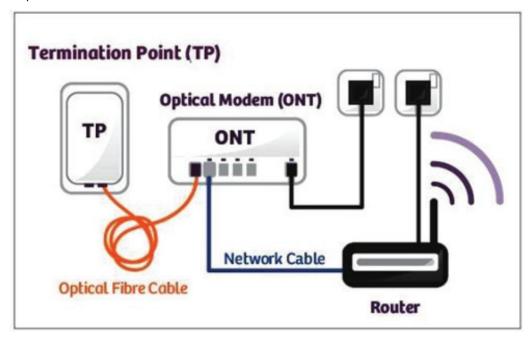


Fig. 5.3.1: Pictorial Diagram of ONT

The ONT is important for several reasons:

- **High-speed connectivity:** ONTs allow for high-speed connectivity, providing users with fast and reliable internet, television, and telephone services.
- **Easy installation:** ONTs are easy to install and do not require extensive cabling work, making them a convenient option for homes and businesses.
- **Flexibility:** ONTs can be easily reconfigured or relocated as needed, providing users with the flexibility to change their service providers or upgrade their services.
- **Increased reliability:** Optical fiber networks are known for their reliability, and the ONT provides the final connection to ensure that this reliability extends to the end user.

Overall, the ONT is an essential component of fiber-optic networks, providing the interface between the fiber-optic network and the end user's equipment and allowing for high-speed, reliable, and flexible services.

Fiber termination at the Optical Network Terminal (ONT) is the process of connecting the optical fiber cable to the ONT, which acts as the interface between the optical fiber network and the customer's equipment. This process involves stripping the protective coating from the optical fiber, cleaving the fiber to a precise length, and then splicing the fiber to the pigtail of the ONT.



Fig. 5.3.2: Optical Network Terminal (ONT)

The significance of fiber termination at the ONT is that it allows the conversion of the optical signals into electrical signals that can be used by the customer's equipment. This conversion is performed by the ONT's optical-electrical converter, which converts the optical signals into electrical signals that can be transmitted over copper cables to the customer's equipment.

Fiber termination at the ONT is important for several reasons.

Firstly, it ensures that the optical signals are converted into electrical signals in a controlled and standardized manner, which helps to ensure the reliability and consistency of the signals.

Secondly, the ONT acts as a protective barrier for the optical signals, helping to prevent any damage to the optical fiber from the customer's equipment.

Finally, the ONT provides the customer with a convenient and accessible point of connection to the optical fiber network, simplifying the installation process and reducing the costs associated with deploying fiber optic networks.

#### **Configuring the ONT**

The ONT is responsible for converting the optical signals from the fiber-optic cable into electrical signals that can be used by devices such as computers and routers.

The following is a general outline of the steps involved in configuring an ONT:

- **Connect the ONT to a power source:** The ONT must be connected to a power source before it can be configured.
- **Connect the ONT to a computer or router:** The ONT must be connected to a computer or router to allow for configuration. This is typically done using an Ethernet cable.
- Access the ONT's configuration interface: To configure the ONT, you will need to access its configuration interface. This is usually done by accessing the ONT's IP address using a web browser.
- Login to the ONT: Once you have accessed the ONT's configuration interface, you will need to log in using the ONT's username and password.
- Configure the ONT's settings: Once logged in, you can configure the ONT's settings, such as IP address, subnet mask, and default gateway.
- **Test the connection:** After configuring the ONT's settings, it is important to test the connection to make sure that everything is working correctly.
- **Save the configuration:** Finally, make sure to save the ONT's configuration before exiting the configuration interface.

#### **Testing ONT using IP Network**

To test the Optical Network Terminal (ONT) using an IP network, you will need to follow these steps:

- Connect the ONT to the network: Connect the ONT to the network using an Ethernet cable. The cable should be connected to the LAN port of the ONT and to a switch or router that is connected to the network.
- **Power up the ONT:** Turn on the power supply to the ONT. You should see the status LED turn on to indicate that the ONT is powered up.
- Assign an IP address: Assign an IP address to the ONT. This can be done either through the router's web interface or by using a command line interface. The IP address should be in the same subnet as the other devices on the network.

## Steps to assign an IP address to an Optical Network Terminal (ONT) using a router's web interface:

- 1. Open a web browser and type in the router's IP address. Enter the username and password to log into the router's web interface.
- 2. Navigate to the DHCP client list, which displays the connected devices and their IP addresses.
- 3. Find the ONT in the list of connected devices. The ONT will likely be listed as a device with a manufacturer name or as "unknown".
- 4. Click on the "Edit" or "Modify" button next to the ONT in the DHCP client list. Select the option to assign a static IP address and enter the desired IP address, subnet mask, and default gateway

- 5. Click on the "Save" or "Apply" button to save the changes. The router will update the IP address for the ONT.
- 6. To test if the ONT is working, try accessing its web interface using the newly assigned IP address. If successful, the ONT is now connected to the IP network and ready for use.

#### The process to assign an IP address to ONT using the command line interface:

- 1. Connect to the CLI of your router or switch using a terminal program such as Putty, HyperTerminal, or Telnet.
- 2. Login to the device using the appropriate credentials.
- 3. Enter the command prompt mode by typing the appropriate command for your device. For example, you may need to type "enable" to enter the privileged mode on some devices.
- 4. Type the command "configure terminal" to enter the configuration mode.
- 5. Type the command "interface [interface-name]" to specify the interface where the ONT is connected. The interface name may vary depending on your device.
- 6. Type the command "ip address [ip-address] [subnet-mask]" to assign an IP address and subnet mask to the specified interface. For example, you may type "ip address 192.168.1.100 255.255.255.0".
- 7. Type the command "no shutdown" to enable the interface.
- 8. Type the command "exit" to exit the configuration mode.
- 9. Type the command "write memory" to save the changes to the device's configuration
- **Ping the ONT:** Use the ping command to verify that the ONT is reachable from the network. This will test if the ONT is configured properly and if there are any connectivity issues.
- **Test the ONT's network connectivity:** Test the ONT's network connectivity by pinging a device on the network, such as a router or switch, from the ONT. This will verify that the ONT is able to communicate with other devices on the network.
- **Test the ONT's optical connectivity:** Test the ONT's optical connectivity by using an optical power meter to measure the optical power at the ONT. This will verify that the ONT is receiving optical power from the fiber optic cable and is able to convert it into electrical signals.
- Test the ONT's data connectivity: Test the ONT's data connectivity using a network analyzer to verify that the ONT can transmit and receive data properly. This will test the integrity of the ONT's Ethernet interface and verify that the ONT is able to communicate with other devices on the network.

#### **Telecommunication Outlet (TO)**

A telecommunications outlet (TO) is a standardized, modular jack that provides a physical interface for connecting telecommunication equipment such as phones, computers, and other devices. The TO is typically installed in a wall or other surface and serves as a convenient location for users to connect their devices to the telecommunications network.



Fig. 5.3.3: Telecommunications Outlet (TO)

TOs are standardized to ensure compatibility with a wide range of devices and to make it easier to install, maintain, and upgrade the telecommunications infrastructure. The standardization of TOs helps to ensure that all users have access to a consistent level of service and makes it easier for telecommunications service providers to upgrade their networks as needed.

Telecommunication Outlet (TO) refers to a location in a building where an optical fiber terminates and provides a connection point for user equipment such as a computer, telephone or other communication device. The fiber termination at the TO involves attaching the optical fiber to a connector, which is then plugged into the appropriate port on the communication device.

The fiber termination process at the TO typically involves the following steps:

- **Prepare the fiber:** This involves removing any excess fiber, cleaning the fiber end and inspecting it for any damage or contamination.
- Attach the connector: A connector such as an SC, LC or ST connector is attached to the optical fiber using an appropriate tool such as a connector crimper.
- Clean the connector: The connector should be cleaned to remove any dirt or debris before installation.
- **Install the connector in the TO:** The connector is then inserted into the appropriate port on the TO and secured in place.
- **Test the connection:** The connection should be tested using an optical power meter or light source to ensure that the connection is stable and that there is no loss of signal.

## - 5.3.2 Visual Fault Locator (VFL) -

A Visual Fault Locator (VFL) is a handheld device that is used to detect faults in optical fiber cables. It works by emitting a bright, visible laser light into the fiber, which makes it easy to locate the fault. VFLs are commonly used for testing and troubleshooting optical fiber networks, and are an important tool for ensuring the reliability and performance of the network.



Fig. 5.3.4: Visual Fault Locator (VFL)

To operate a Visual Fault Locator (VFL), follow these steps:

- **Connect the VFL to the optical fiber:** Connect the VFL to the optical fiber using the appropriate connector. The connector should be clean and free of debris, to ensure a good connection.
- **Turn on the VFL:** Turn on the VFL by pressing the power button. The VFL will emit a bright, visible laser light into the fiber.
- Check for faults: Begin at one end of the fiber and inspect the entire length of the fiber, looking for any visible breaks or bends in the fiber. The VFL will make it easier to detect these faults, as the light from the laser will not be able to pass through the broken or bent portion of the fiber.
- Locate the fault: If a fault is found, use the VFL to locate the exact location of the fault. This can be done by moving the VFL closer or further away from the fault, until the light from the laser is no longer visible.
- **Repair the fault:** Once the fault has been located, it can be repaired by splicing or terminating the fiber at that point.



Fig. 5.3.5: Using a Visual Fault Locator (VFL)

It is important to follow proper safety procedures when using a Visual Fault Locator (VFL), as the laser light emitted by the VFL can be hazardous to the eyes. Always wear protective eye gear and follow the manufacturer's instructions for the safe use of the VFL.

## **5.3.3 Test Live Fiber using Fiber Detection Meter**

A fiber detection meter is an instrument used to detect live optical fibers in order to avoid damage during installation or maintenance. The device sends out a low-power light source through a connector, and the light is received at the other end of the fiber through another connector. If the fiber is live, the light will be transmitted through the fiber and the device will display a signal indicating that the fiber is active.

To test a live fiber using a fiber detection meter, follow these steps:

- Connect the source port of the meter to the optical fiber connector at one end of the fiber.
- Connect the receiver port of the meter to the optical fiber connector at the other end of the fiber.
- Turn on the meter and set it to the appropriate wavelength for the optical fiber being tested.
- Observe the readings on the meter's display. If the fiber is live, the meter should display a signal indicating the presence of a light source at the other end of the fiber.
- If the fiber is live, the meter may also display the optical power level and the optical return loss, which can be used to assess the quality of the fiber connection.
- Repeat the test at different points along the fiber to ensure that the fiber is live throughout its length.

## **Summary**



- Types of fiber optics cables: Fiber optics cables come in various types such as single-mode, multimode, loose-tube, tight-buffered, armored, and aerial cables, each designed for specific applications and environments, offering different bandwidth capacities and transmission characteristics.
- Bend radius: Bend radius refers to the minimum radius at which a fiber optic cable can be safely bent without causing excessive signal loss or damage. It is an important parameter to consider during cable installation to maintain signal integrity and prevent cable failure.
- Parts of optical fiber cable: Optical fiber cables consist of several components including the core (central part carrying the light signal), cladding (outer layer surrounding the core), buffer (protective layer over the cladding), strength members (provide tensile strength), and cable jacket (outer protective layer).
- Very low-frequency testing: Very low-frequency testing involves analyzing the performance of fiber optic cables by subjecting them to low-frequency electrical signals, allowing detection of potential faults or defects that may impact the cable's transmission capabilities.
- Fusion splicing: Fusion splicing is a method of joining two fiber optic cables together by melting and fusing their fiber ends using a fusion splicer, creating a continuous and low-loss connection that enables efficient transmission of optical signals.
- Identify the cabling path: Identifying the cabling path involves determining the route or pathway through which the fiber optic cable will be installed, considering factors such as existing infrastructure, obstacles, distance, and accessibility, ensuring a proper and efficient installation.
- Managing cable slack: Cable slack management involves properly organizing and securing any
  excess length of fiber optic cable to avoid strain, entanglement, or damage. It helps maintain the
  integrity of the cable and ensures ease of maintenance and future modifications.
- Pre-existing load and post-installation load compliance of the cable trays: Cable trays, used to support and route fiber optic cables, should be assessed for their load-bearing capacity before installation to ensure they can withstand the weight of the cables. Compliance with load requirements is crucial both during and after installation to maintain cable tray integrity.
- Laying optical fiber along identified tray tracks: Optical fiber cables are laid along the identified tray tracks, ensuring proper alignment and support within cable trays to protect the cables and maintain their performance.
- Fiber pulling through conduits: Fiber pulling refers to the process of pulling the fiber optic cable through conduits or ducts using appropriate pulling techniques and equipment, ensuring smooth and controlled installation without causing excessive tension or damage to the cable.
- Securing excess fiber at termination point: Excess fiber at the termination point is properly secured and managed, ensuring it is protected and does not interfere with the operation or accessibility of the fiber optic connection.
- Cable installation through conduits on false ceiling: Cable installation through conduits on a false ceiling involves routing and securing fiber optic cables within conduits installed above the false ceiling, allowing for neat and concealed cable management.
- Fiber Termination at Optical Network Terminal (ONT) & Telecommunication Outlet (TO): Fiber termination involves connecting the fiber optic cable to the optical network terminal or telecommunication outlet, enabling the interface between the fiber optic network and end-user devices for data transmission.
- Visual Fault Locator (VFL): A visual fault locator is a handheld device that emits visible red light into the fiber optic cable, allowing technicians to visually locate breaks, bends, or faults in the cable by observing the light leakage or interruption.
- Test Live Fiber using Fiber Detection Meter: Fiber detection meter or fiber identifier is used to
  identify and test live fiber optic cables without disconnecting them. It detects the presence of light
  signals and measures signal strength, enabling troubleshooting and identification of specific fibers
  in a network.

## **Exercise**

Multiple-choice Question				
1.	Α	is a handheld device that is used to	o detect faults in optical fiber cables.	
	a. Visual Fault	Locator (VFL)	b. Sensors	

c. Valves d. Switches

refers to the minimum radius that an optical fiber cable can bend without causing any damage to the cable

a. Bend radius b. Fibre properties

c. Radius gauge d. Cable measurement

3. The \_\_\_\_\_ core is the center of the optical fiber cable and is made of highly transparent glass or plastic.

a. Core b. Buffer

c. VLF d. ONT point

4. \_\_\_\_\_\_is a method to join fiber optic cables together to form a permanent connection.

a. Fusion Splicing b. Fibre termination

c. Cabling path d. Cable staking

5. \_\_\_\_\_ through conduits is a critical step in the installation of optical fiber networks.

a. Fiber pulling b. Fibre manipulating

c. Fibre optimizing d. Fibre cutting

#### Answer the following:

- 1. Describe different types of fibre optic cables.
- 2. What are the Parts of Optical Fiber Cable?
- 3. Describe the process that is initiated to identify the Cabling Path.
- 4. What is fiber pulling through conduits?
- 5. Describe the function of visual fault locator.

Notes 🗐 -			

Scan the QR codes or click on the link to watch the related videos



https://www.youtube.com/watch?v=wGaJMVQt7qc

Bend Radius - EXFO's Animated Glossary of Fiber Optics

https://www.youtube.com/watch?v=PFlegqsQFrs

How To Fusion Splice Fiber Optic Cable - Animated

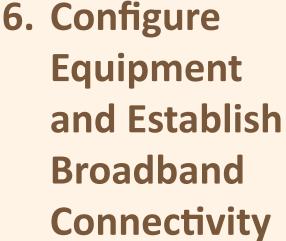


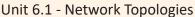












Unit 6.2 - Basic Commands

Unit 6.3 - Connectivity of CPE and End User Devices

Unit 6.4 - Configuration Testing

Unit 6.5 - Comprehension and Interpretation of Technical Data

Unit 3.6 - Executing Speed Test and Analyze



## – Key Learning Outcomes 🙄

#### By the end of this module, the participants will be able to:

- 1. Understand the network topologies.
- 2. Understand the basic command related to networking.
- 3. Understand the connectivity of CPE and End User devices.
- 4. Understand the Configuration of CPE and End User devices.
- 5. Understand the process of configuration testing.
- 6. Understand technical data.
- 7. Execute speed test and its analysis.

## **UNIT 6.1: Network Topologies**

## **Unit Objectives**



By the end of this unit, the participants will be able to:

1. Understand the network topologies

## 6.1.1 Topology -

Schematic description of the planning of a network is referred to as topology when discussing communication networks.

Network geometry is defined in following two ways:

- 1. Physical topology
- 2. Logical (or signal) topology
- **Bus network topology:** This topology has each workstation connected through the main cable called bus. Or simply put, all devices are connected sequentially to every other in the network.
- **Star network topology:** has the central device, the server, connected to all other computers in a network. In this type, each computer is indirectly connected to each other through the server.

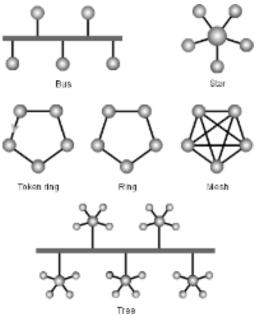


Fig. 6.1.1: Types of topologies

• Ring topology: has all computers connected in a closed loop configuration.

Signal travels in a singular direction if a Token Ring protocol is used either on star or on ring topology.

The mesh network topology consists of two types: full mesh and partial mesh. When each system is interconnected directly it's called as full mesh topology. In case where some systems are connected to

each other while the others are only connected to those, which exchange data in abidance, is referred to as partial mesh topology.

When two or more-star networks are connected together it's referred to astree network topology.

**Logical (or signal) topology:** is the path used by signals to follow from node to node. In most of the cases logical topology and physical topology is the same.

#### 6.1.2 Broadband Network Element -

#### **Network Gateway**

The network point which is like an entrance to another network is called as gateway. Host nodes are referred to as either of the ones which a specific user uses and also the computer that serves pages to users. The computers that are responsible for controlling traffic, whether it's within the company or at service provider end are denoted as gateway nodes.

#### **IP** address

**Internet** Protocol is the full form of IP addresses. Any computer is identified by an IP address on TCP/IP network.

Any IP address is 32 numeric numbers, which are written as set of four numbers and are separated by periods. The range of these numbers varies from zero to 255. For example, 1.150.12.240 can be an IP address.

Unique and random IP addresses can be assigned on an isolated network. In case of a private network, one is required to use only registered IP addresseses, which ensures there is no duplicity.

An IP address can be **static or dynamic**. In case of static IP address, the address never changes unlike in case of a dynamic IP address which is a temporary address that gets assigned to a system every time it's connected to Internet. There are two standards for IP addresses. They are IPv4 and IPv6, where "v" stands for version.

Most of the systems are configured on IPv4 address system. Many of them are now moving to new IPv6 address system. The differences between the two versions are as follows:

- IPv4 uses 32 binary bits. This type of address is written in a format which is separated by dots and is set of four numbers. For example: 216.27.61.137. Each number is the decimal representation for an eight-digit binary number, also called an octet. The decimal representation is called base-10 and the eight-digit binary representation is called base- 2.
- IPv6 uses 128 binary bits. The address is represented by eight groups of hexadecimal numbers separated by colons. For example2001: cdba:0000:0000:0000:0000:3257:9652. The hexadecimal representation is also called base-16. Groups of numbers with all zeros, are mostly removed in order to save space, leaving a colon separating the groups, to mark the gap. For example, the previous example is written as 2001: cdba::3257:9652.

#### **Subnet Mask**

Helps in routing traffic within a subnet through a series of numbers. On an arrival of any packet at any organization's gateway, it routes it to its desired destination subnet number. A router identifies these number series to understand the routing. For an instance, in a binary mask,

- a "1" over a number denotes "Look at the number underneath;"
- a "0" denotes "Don't look."

Using such a mask prevents the router from handling the whole32 bit address. The router looks only at the bits selected by the mask.

Using the previous example, the combination of the network number and subnet number acquires 24 bits or three of the quads. The appropriate subnet mask for the packet would be: 255.255.255.0. It may also be represented as a string of all 1's for the first three quads and 0's for the host number. Subnet masking allows the routers to transfer the packets more quickly.

#### **Ethernet Address**

In computers or printers, a number which is assigned by a manufacturer to its hardware is referred to as an Ethernet or wireless address. To ensure the uniqueness of Ethernet and Wireless number all the manufactures work together under a code.

An Ethernet address, also known as wireless hardware address, is a 6-byte hexadecimal number. For example, 080007A9B2FC. Each byte is represented as two hexadecimal digits that makes the address of twelve hexadecimal digits, where each of these digits have a number between 0 to 9 and a letter from A to F (can be either upper / lowercase).

Sometimes a '0x' is written before the value to indicate that the value should be interpreted as a hexadecimal one. But, the '0x' should not be taken as part of the value.

It is commonly seen that these are separated by six pairs of hexadecimal digits with colons or dashes. The letters A-F, are considered as hexadecimal digits. For example like: 08:00:07: A9:B2:FC or 00-00-94-ba-0e-cc. Leading zeros can be dropped; and the address is represented as 8:0:7:A9:B2:FC or 0:0:94:ba:e:cc.

Note: One should not confuse an Ethernet address with an IPv4 address.

#### **MAC Address**

It doesn't matter if one works in a wired network or wireless environment because it anyways takes software and hardware together for data transfer. For the right data to reach a specific system requires the addresses. It is important for the hardware to have its own address because of NIC; interface card. NIC is a circuit card through your computer gets connected to a network.

NIC converts date into electrical signals.

Every NIC has a hardware address called MAC; Media Access Control, which is related to hardware, as IP addresses are linked to TCP/IP.

Network adapter gets its unique MAC address during the time of manufacturing, and the IP address gets translated to MAC address by ARP (Address Resolution Protocol).

MAC address at times is also stated as the burned-in address (BIA). For example, 00:0a:95:9d:68:16 is a MAC address for an Ethernet NIC.

Dell, Belkin, Nortel and Cisco are some common manufacturers of NIC. These manufacturers put a unique number sequence, known as Organizationally Unique Identifier (OUI), in front of the MAC address identifying them as the manufacturer.

Example are as follows:

Dell: 00-14-22
Nortel: 00-04-DC:
Cisco: 00-40-96
Belkin: 00-30-BD

Larger manufacturers may have more than one set of OUIs.

#### **Networks and MAC addresses**

While diagnosing network issue MAC addresses are considered to be reliable because of their fixed addressed.

#### **Wireless Routers and MAC Filtering**

MAC filtering is a measure of security implemented on wireless networks to prevent unauthorized access by intruders or hackers. In such set up router are configured in a manner that they only accept traffic from specified addresses. This way, only approved MAC addresses computers communicate through the network.



• MAC filtering is a measure of security implemented on wireless networks to prevent unauthorized access by intruders or hackers.

# **Exercise**

#### Answer the following questions:

- 1. What are the important topologies for networks?
- 2. What is a mesh network?
- 3. What do you mean MAC Address?

#### **Multiple-choice Quesions**

1. A term that refers to the way in which the nodes of a network are linked together.

a. Network

b. Topology

c. Connection

d. Interconnectivity

2. A network comprising multiple topologies

a. Complex

b. Hybrid

c. Bus

d. Star

3. What is the maximum number of IP addresses that can be assigned to hosts on a local subnet that uses the 255.255.224 subnet mask?

a. 14

b. 15

c. 16

d. 30

4. If a host on a network has the address 172.16.45.14/30, what is the subnetwork this host belongs to?

a. 172.16.45.0

b. 172.16.45.4

c. 172.16.45.8

d. 172.16.45.12

#### **UNIT 6.2: Basic Commands**

# - Unit Objectives



#### By the end of this unit, the participants will be able to:

1. Understand the basic commands related to networking

#### **6.2.1 IPCONFIG Command List**

#### **IPCONFIG Command ipconfig**

It is used to check the current IP and TCP setting. This even allows you to check the default gateway along with finding the subnet mask.

```
- 0
C:\Windows\system32\cmd.exe
Microsoft Vindows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.
                                                 All rights reserved.
C:\Users\LEADERZWALK>ipconfig
Windows IP Configuration
PPP adapter TATA PHOTON+:
   Connection-specific DNS Suffix
   IPv4 Address.....
Subnet Mask .....
Default Gateway ....
                                            59.161.177.173
255.255.255.255
0.0.0.0
Wireless LAN adapter Wireless Network Connection 2:
   Media disconnected
Ethernet adapter Local Area Connection:
   Media State . .
                                          : Media disconnected
   Connection-specific DNS Suffix
```

#### ipconfig /all

This command lets a user check all information related to IP, DNS server and MAC Address. One can even find the IP address of the gateway with this command.

#### ipconfig /release

This command helps in obtaining a new IP Address from DHCP server and releasing the current IP information.

#### ipconfig /renew

In case the system issettoobtainanewlPaddressonitwonthiscommandhelpsinrenewing thesame.

#### ipconfig /displaydns

Used for viewing the existing DNS Resolver Cache Logs.

#### ipconfig /flushdns

Flushes/clears current DNS Resolver Cache Logs.

#### ipconfig /registerdns

This is used for refreshing the DNS settings. This comes handy while trouble shooting connection problems with ISP such as failing to acquire a dynamic IP address or failed attempt while connecting to the ISP DNS server.

#### 6.2.2 PING Command List —

#### Ping

This is a primary TCP/IP command and is used to troubleshoot connectivity, name resolution and reachability. It verifies IP-level connectivity of a computer with another TCP/IP computer by sending Internet Control Message Protocol (ICMP) Echo request messages.

#### **PING Command**

In all of these examples "xxx.xxx.xxx.xxx" is an example of a Domain Name or an IP Address.

#### Ping xxx.xxx.xxx

To Ping an IP Address, type Ping followed by the IP address in the command prompt. "xxx.xxx.xxx" is representing the address here.

#### Ping <<site>>.com (web address)

To ping a website, the domain name of the website is to be typed following Ping. In case one is aware of websites IP Address, he/she may ping that too.

#### **Ping Command Switches**

The switches may be used together.

#### Continuous Ping (Ping xxx.xxx.xx.xx -t)

This will continue to run the ping process till Ctrl + C is used to stop. This is useful while troubleshooting intermittent connections.

#### Number of Pings (Ping xxx.xxx.xx.xx -n 10)

The switch "n" is used to set the number of pings. By default, the ping command transmits 4 packets of 32 bytes each.

#### Size of Packet (Ping xxx.xxx.xx.xx -I 1500)

By default, 32 bytes is used for sending packets. One can set the size up to the maximum of 65500 bytes. This comes handy while running a stress test on any local network.

#### Time Out (Ping xxx.xxx.xx.xx -w 5000)

The time given, is in milliseconds. Default timeout is 4,000 milliseconds, amounting to 4 seconds.

#### Resolving Host name Address (Ping -a xxx.xxx.xx)

This is used for finding the model number of a router. Host of an IP address can be resolved by using this command.



ipconfig is used to search for the IP Address of the device, Default Gateway and Subnet Mask.

# Fill in the blanks: 1. Ipconfig command stands for \_\_\_\_\_\_. 2. Ipconfig displays all current \_\_\_\_\_ and refreshes \_\_\_\_\_\_ settings. 3. \_\_\_\_\_ command flushes the DNS cache. 4. The command which refreshes DHCP registers is \_\_\_\_\_ 5. \_\_\_\_ command display the contents of DNS cache 6. \_\_\_\_ command is useful while troubleshooting intermittent connections. 7. The switch \_\_\_\_ is used to set the number of pings. 8. \_\_\_\_ is a primary TCP/IP command and is used to troubleshoot connectivity, name resolution and reachability. 9. To ping a website \_\_\_\_ command is used. 10. \_\_\_\_ will continue to run the ping process till Ctrl + C is used to stop.

# **UNIT 6.3: Connectivity of CPE and End User Devices**

# - Unit Objectives 🤎



#### By the end of this unit, the participants will be able to:

- 1. Understand the connectivity of CPE and End-User Devices
- 2. Understand the configuration of CPE and End-User Devices

# - 6.3.1 Broadband Connectivity

A telecommunications hardware that is positioned at customer's home or at the business of a customer is referred to as CPE device. Some examples of such equipment are set-top boxes which are used for cable, digital subscriber line or broadband routers, VoIP base stations, telephone handsets, etc.

In most cases, such devices need to support Wi-Fi 6 or 10G connections to mobile phones, laptops, tablets, game consoles, and smart home devices. Internet of Things (IoT) devices are challenging as they can't connect to main CPE.

Following illustrations explains the broadband connectivity from the main infrastructure to end users' devices. Which can be a computer, telephone, television sets, and digital cameras. Packet based infrastructure is allowed by the gateway equipment.

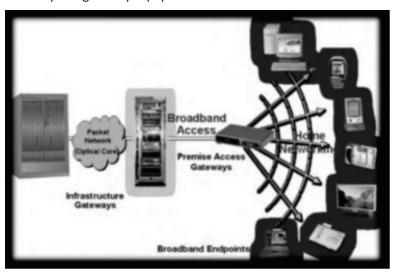


Fig. 6.3.1: Broadband Connectivity

#### 6.3.2 Connectivity -

OncetheinstallationofCPEiscompletedonecanconnecteitheracomputerorotherdevices to the Internet.

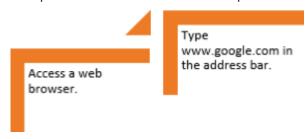
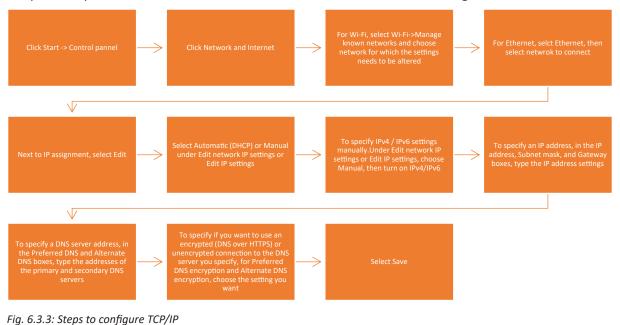


Fig. 6.3.2: Steps for Internet browsing

If the desired website opens, it means the Internet is connected. If not, recheck the website address. If the problem persists, it's advised to check the cable connection and re -configure the modem/router.





• Take a backup of the router setting in case you face any issues while setting up the new configuration.



- 1. Demonstrate configuration of ICP/TP in Windows 11 and write the steps.
- 2. Demonstrate configuration of ICP/TP in MAC and write the steps.
- 3. Explain CPE.

# **UNIT 6.4: Configuration Testing**

# **Unit Objectives**



By the end of this unit, the participants will be able to:

1. Understand configuration testing.

# 6.4.1 Verifying IP address in Windows 11 for WiFi

Once TCP/IP configuration is complete in windows 11, go for verifying the IP Address

Click Start -> Settings-> Network & internet > Wi-Fi and then select the Wi-Fi network

Under Properties, look for your IP address listed next to IPv4 address.

Fig. 6.4.1: Steps to test TCP/IP configuration Windows 11

# **6.4.2 Verifying IP address in Windows 11 for Ethernet**

Once TCP/IP configuration is complete in windows vista, go to Verifying the IP Address.

Click Start -> Settings-> Network & internet > Ethernet and then select the Wi-Fi network

Under Properties, look for your IP address listed next to IPv4 address.

Fig. 6.4.2: Steps to test TCP/IP

If your Internet suddenly starts running slow, you should go to www.speedtest.net.in to check the speed at client's site.

# **Exercise**



- 1. What do you mean by configuration testing?
- 2. How will you do configuration testing?
- 3. Why configuration testing is important?

# **UNIT 6.5: Comprehension and Interpretation of Technical**Data

# - Unit Objectives



By the end of this unit, the participants will be able to:

1. Comprehend and interpret technical data

# 6.5.1 Interpretation of Technical Data -

It is very important for a broadband technician to know how to interpret the technical data. He should be aware of technical data and its interpretation.

Let's learn to read and understand IP Configuration and network problems.

Configuration of Internet protocol is the backbone of Internet service and networking. Various settings on the system can be checked with IP Config utilities. In such a case, one should start from finding a network issue.

To start with, open command prompt and type "ipconfig /all". Only type the command itself into a command window. Start - Run - "ipconfig /all..." should not be typed.

Export the data to text file for easy access, type the following commands one by one:

- "ipconfig /all >c:\ipconfig.txt" (less the "")
- "notepad c:\ipconfig.txt" (less the ""), for immediate examination.
- Or, copy file to another computer by typing "c: \ipconfig.txt", for comparative examination.

The following image shows an example of IPConfig ("ipconfig /all") from a pair of computers on a LAN:

```
Windows IP Configuration

Host Name . . . . . : Search1

Primary Dns Suffix . . . : Node

Type . . . . . . : Broadcast IP

Routing Enabled . . . : No

WINS Proxy Enabled . . . : No

DNS Suffix Search List . . : search.net

Ethernet adapter Local Area

connection:

Connection-specific DNS Suffix :
```

```
Description . . . . . . . . . . . . . 3Com Ether Link XL 10/100 PCI For
Complete PC Management NIC (3C905C-TX)
Physical Address. . . . . . . : 00-04-76-D7-C5-6A
Dhcp Enabled. . . . . . . . : Yes
Auto configuration Enabled . . . . : Yes
IP Address . . . . . . . . . : 92.168.1.50
Subnet Mask . . . . . . . . . : 255.255.255.0
Default Gateway . . . . . . . : 192.168.1.1
DHCP Server . . . . . . . . . : 192.168.1.1
            . . . . . . . . . . . : 192.168.1.11
DNS Servers
192.168.1.33
Lease Obtained . . . . . . . . . . . . . . Wednesday, April 16, 20 15 11:19:12
Lease Expires . . . . . . . . . . . . . Wednesday, April 23, 20 15 11:19:12
 Windows IP Configuration
 Host Name . . . . . . . . : PChuck2
 Primary Dns Suffix . . . . . :
 Node Type . . . . . . . . : Hybrid IP
 Routing Enabled. . . . . . : No
 WINS Proxy Enabled. . . . . . : No
 DNS Suffix Search List. . . . : search.net
Ethernet adapter Local Area
connection:
Connection-specific DNS Suffix:
Description . . . . . . . . . . . . . . . 3Com Ether Link XL 10/100 PCI For
Complete PC Management NIC (3C905C-TX)
Physical Address. . . . . . . : 00-04-76-D7-76-BC
Dhcp Enabled. . . . . . . . . : Yes
Auto configuration Enabled . . . . : Yes
Default Gateway . . . . . . . : 192.168.1.1
DHCP Server . . . . . . . . . : 192.168.1.1
DNS Servers . . . . . . . . . : 192.168.1.11
192.168.1.33
Primary WINS Server . . . . . : 192.168.1.1
Lease Obtained . . . . . . . . . . . . . Wednesday, April 16, 2015 11:53:45
Lease Expires . . . . . . . . . . . . . . . . . Wednesday, April 23, 2015 11:53:45
What does this tell us?
Host Name . . . . . : Search1
This is the name of the computer, as seen by Internet Protocol.
Primary Dns Suffix . ... :
DNS Suffix Search List. . . . . : search.net
```



Broadband in telecommunication is a method which allows a wide bandwidth data transmission having multiple signals and traffic types. It can be transmitted through coaxial cable, optical fibre, radio or twisted pair.

# – Exercise 🔯



- 1. What do you mean by technical data?
- 2. How do you interpret technical data?
- 3. What does DNS server number indicates?

# **UNIT 6.6: Executing Speed Test and Analyze**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

1. Understand how to run, read and communicate speed tests

# 6.6.1 Speed Test measures -

To measure Internet connection's ultimate speed, like, speed of uploading and downloading information by accessing nearby test servers, speed tests are required.

The test impersonates online activity of a user in a controlled setting by downloading sample files and recording speeds. These tests are helpful for isolating ISP's performance as a variable in the quality of the connection. Speed tests won't project absolute Internet speed, but they will give a nearby estimate. Results may vary depending on location and the time of day.

Speed test results match what's stated in ISP plan given to the user.

#### **Certain terminologies**

- **Download speed:** how fast data can be fetched from the server to user's location, measured in megabits per second (Mbps)
- **Upload speed:** how fast data is sent to others, measured in megabits per second (Mbps)
- Megabits per second (Mbps): a unit of measure for bandwidth
- Latency: the time data took to travel to its destination and returned back to user
- Ping: a tool to measure latency between user's system and remote destination

#### How to run a speed test

Switch off any slow applications (Photoshop, Spotify, etc.) before running speed test as it will interfere with measurement. Search Google for "Internet speed tests," there are number of options available. Speedtest.net by Ookla is effective.

By clicking on "Begin" option at home page, system will attempt to download a file from the server. As the download completes, download speed will be measured. Once the download process completes, system will attempt to upload a file to the test server, therefore calculating the upload speed.

Download speed here is expressed in Mbps (Megabits per second. 1 Mbps is the equivalent of 1,000 Kbps (Kilobits per second), and 1,000 Mbps is the equivalent of 1 Gbps (Gigabits per second).

#### **Interpret the Results**

Both upload and download speed should have a score almost close to ISP's service plan. In most of the cases, connections are planned to download faster than they upload. The majority of online activity like loading web pages or streaming music-consists of downloads. Upload speed is necessary when there is a need to send big files via email or for video conferencing.

In a gigabit connection, hardware like an ethernet cable, solid-state drive, and CPU needs to be checked to analyze the challenges for an effective Internet speed. Most of the services, display "ping" results,

which are measured in milliseconds, accompanied by download/upload speed. This refers to the latency of the connection.

#### Troubleshoot a faulty speed test

Check for the devices connected to network which may interfere

- Ensure healthy condition of hardware equipment like computer, router, modem, and cables
- In case of cable, check each end of the coaxial connection for any looseness or damage
- Disconnect attached equipment for 30 seconds
- If Wi-Fi is used, switch it off and put your system on modem directly

#### 6.6.2 Communication with client —

- It is very critical to communicate the speed results and analysis with the client. However, prior to that, it is equally important to listen to the problem of the client by giving utmost attention while client is speaking or asking questions. This will help to understand their thought process and expectations.
- Treat the client with respect. Client can be aggravated owing to the challenges of connection, staying calm and composed in that situation will resolve half of the matter. Words like "Sorry" and "Thanks for your patience" are considered to do magic, so try them often.
- Circulate all important correspondence, updates, and action plans via email to client to keep them updated. Keeping them informed will assure client that the action is happening and wins their confidence.
- Make yourself available over the phone and always respond to emails within the specific timelines
  and keep a close watch on timely closures. Following such practices will improve your reputation
  and you will be respected by everyone.
- Keep client updated on the reasons for lower speed and what could be the possible scenarios of it. Educate client by sharing some useful tips on maintaining the connection effectively.

Exercise	

#### Answer the following questions:

- 1. Explain the process of running a speed test.
- 2. How will you explain latency?

#### **Multiple-choice Quesions**

	•		
1.	a tool to measure late	ency between user	's system and remote destination.
2.	To measure Internet connection's ult nearby test servers, speed tests are re-	•	by accessing
3.	is a unit of measure	e for bandwidth.	
4.	1 Mbps is the equivalent ofper second).	and	is equivalent of 1 Gbps (Gigabits
_			Carlo Carlo and Language and Arthurst and Carlo and Carl

- 5. In case of cable, check each end of the \_\_\_\_\_ connection for any looseness or damage.
- 6. Educate client by sharing some useful tips on \_\_\_\_\_\_ effectively.

otes 🗏			

Scan the QR codes or click on the link to watch the related videos



https://youtu.be/uSKdjjw5zow?si=QsrvvkJsV2RTsyJh

Network Topology











# 7. Troubleshoot and Rectify Faults

- Unit 7.1 Escalation Matrix
- Unit 7.2 Problem Solving
- Unit 7.3 Identifying and Repairing Faulty Cables and Connectors
- Unit 7.4 Electro Magnetic Interference (EMI) and Compatibility (EMC)
- Unit 7.5 Crimping and Soldering
- Unit 7.6 Troubleshooting of Cable and Connector
- Unit 7.7 Troubleshooting of CPE (Modem, Router, Switch)
- Unit 7.8 Troubleshooting Configuration and Connectivity of CPE faults
- Unit 7.9 Troubleshooting and Repairing of Client's Broadband Service



# - Key Learning Outcomes 🙄



#### By the end of this module, the participants will be able to:

- 1. State the importance and function of escalation matrix.
- 2. Understand the process of problem-solving.
- 3. Understand how to identify cables and connectors correctly.
- 4. Understand the importance of EMI and EMC.
- 5. Understand the process of crimping and soldering.
- 6. Demonstrate troubleshooting of cable and connector.
- 7. Demonstrate troubleshooting of CPE (Modem, Router, and Switch).
- 8. Demonstrate the troubleshooting of configuration and connectivity.

#### **UNIT 7.1: Escalation Matrix**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

1. State the importance and function of escalation matrix

#### 7.1.1 Escalation Matrix -

Escalation matrix is a process of set protocols and procedures which defines the steps while handling any potential dispute and/or problem. These are proved beneficial while dealing with issues and delays. This matrix usually takes care of the following types of problems and can be modified to include more fields as needed:

- Operational (scheduling, service cancellations, etc.)
- Logistical (delivery, in transit missing products, etc.)
- Technical (error messages, etc.)

Let us take Escalation Matrix Guideline of the company "Vistara" for example.

The Escalation Matrix allows you to specify more than one user to be contacted or notified in case of critical issues. This contact information is presented to the service delivery NOC when the service ticket is created or updated. This helps you notify the right people at the right time about critical errors. These alerts need to be informed about irrespective of the business hours. The point to note is that, the escalation matrix is time zone specific and is usually available 24 by 7. The key features of escalation matrix are as follows:

- The escalation levels are based on schedules.
- The service is available 24X7 and schedules are allocated accordingly.
- The schedules are time zone specific.
- You can now define multiple matrices for a given customer or partner.
- A matrix can be defined at more than one levels ranging from partner and customer level to a combination of sites, device groups and devices.

This implies that you can now have exclusive user group's notified of issues depending on device roles or locations or issue types.

To view the escalations list, go to Navigation:

- Log on to Vistara.
- Go to Setup option.
- Select Escalation Matrix (New).

In the Escalations List page, a new column Applicable For is added to get a sneak peek into the customers, sites, device groups and devices associated with the escalation matrix.

#### 7.1.2 Escalation Matrix Format

Let us take the sample escalation matrix format to understand it:

#### **Problem Escalation Matrix**

#### How to Use This Form

The left side of the columns reflects the time you spend waiting to reach someone before trying to contact someone else to help you solve your problem or resolve your issue. The right side of the columns reflect the time you spend not getting a resolution before you have to escalate to the next level.

Type of Escalation	e of Escalation Level Level I Project Team Project		3rd Es	calation	4th Escalation Level Sales Manager		5th Escalation Level Project Sponsor		6th Escalation Level Executive Level			
Operational											Account Manager	
	14 hr.	2 hrs.	34 hr.	2 hrs.	16 hr.	2 hrs.	34 hr.	2 hrs.	16 hr.	2 hrs.	16 hr.	2 hrs.
Scheduling	1	-								-		
Obtaining Instructions							1					
Customer Information												
Service Information	3										1	
Obtaining Materials												
Performance Issues			11.00								100	
Service Cancellations												
Logistical	Project	Team	Projec		Accou		Sales ?	Manager	Projec	t Sponsor	Execu	tive Leve
	14 hr.	2 hrs.	14 hr.	2 hrs.	14 hr.	2 hrs.	14 hr.	2 hrs.	1/4 hr.	2 hrs.	½ hr.	2 hrs.
Product Delivery	1		1	- 11					1		1	
DOA Product												
Missing Product							-					
Order Cancellations							-					
Order Verification												
Order Status			-	- 1					-	- 19		
Other												

Fig. 7.1.1: Sample of an escalation matrix form

# Tips 🖳

In situations when there is an issue or incident which is not addressed with the given turnaround time, escalation polices/matrix ensure that the concerned person is updated about the matter.

Any company, using Escalation Management tool(s)can make sure that any escalated task is reassigned within the time limit and ensure completions which will safeguard the company from facing a potential loss or embarrassment.

# Exercise 🔯

- 1. What do you mean by escalation?
- 2. What is the need of preparing escalation matrix?
- 3. What kind of information can you get from an escalation matrix form?

# **UNIT 7.2: Problem Solving**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

1. Understand the process of problem solving

#### 7.2.1 Reporting the Problem

Typically, customers want that their problems should be easy to report, quickly acknowledged and timely acted upon with compassion and fairness.

Some ideas to achieve the key principles that can help a technician act on the reported problem and thus help in developing good complaints management systems are as follows.

#### **Report the Problem**

You should ensure that your contact details are readily available to the customers —e.g., in the appropriate section of the telephone book.

#### When the problem is reported

- Appreciate the customer for bringing the issues forward
- Handle the customer in an empathic and courteous manner
- Talk to the customer to understand the concern in detail, rather than purely relying on the written documents and previous records
- Be attentive and patient while customer is sharing the concern
- Probe to make sure you have clearly understood the problem
- Don't become judgmental, defensive, or put the blame on customer
- Acknowledge by narrating the summary of the problem to the customer
- Be responsive and share the action plan along with time frame to the customer

# 7.2.2 Solving the Problem -

- Take ownership and explain your intentions to the customer
- Learn and understand the complete situation by referring to old records, if any
- Involve the customer to be a part of the solution, keep him posted about your steps
- Take verbal consent from the customer that he agrees with the solution which you propose
- Don't over-promise and stay within the limits of policies of the company. If the customer is over demanding and is asking for something which is not doable, explain the policies or take him/her to the company website. If he/she is still adamant, you may refer him/her to the Citizens Advice Bureau to check his/her legal rights
- In situations that have no legal obligations, one can offer a resolution that works best in customer favour. For example, if the customer is entitled for a repair, by law, one can offer him a replacement, keeping customer satisfaction in mind.

- Always give tentative time lines to the customer, rather than promising exact time frames. However, in case of delay, always make sure to keep the customer updated about the new timelines.
- Share the measure your company will take to ensure such situation(s) never arise in future.

# 7.2.3 Following up after the Problem -

- Maintain a record of conversation including the important points along with the offered resolution.
- Make sure customer agrees to your method of solution to his problem.
- Records all the issues and complaints.
- These records will help in analysing the measures used for handling complaints and identifying products or services which are prone to more issues complaints.
- One will be able to identify the turnaround time for handling grievances.

#### Use the information to decide

- Do I have right resources to handle each issue?
- Is each team member aware of the protocols which need to be followed to resolve any
- situation/problem?
- Do I need to a refresher to update myself on the product?
- Should this brand be stocked?

#### **Making repairs**

Using the right kind of machinery for repairs ensures the work is done with the set quality standards and time limits. This is important for restoring customers' faith.

#### 7.2.4 Checklist —

The following check list will come in handy in various type of trades and situations, when carry out repairs:

- Exhibit your understanding of the problem and respect urgency
- Explain briefly in a layman's term the cause and action plan for the customer's problem
- Sharethetimeframewiththecustomerandtakehis/herverbalagreementonthesame
- Informaboutthecostinvolvedinfixingthecustomer'sissueincasehe/sheisnotcovered under warranty. It is advised to always give a quote in writing to avoid conflicts at the time of payment
- Bepatientandinformativewhile explaining the cause of the problem to the customer and never argue if he retaliates.
- Thoroughlyinvestigatethecausebeforefixingtheproblemandgiveprecautionaryadvice, if necessary
- Do everything possible under your power to keep your promise
- Inform the customer in case there is any change in plan from the one decided at the beginning:
  - o Always note contact details of the customer
  - o Notify the customer once the issue is fixed
  - Give the customer record of the work performed

- o As an additional measure, ensure the customer has the manual. In some cases, you may also educate the customer about the steps performed to resolve the current issue and how to present it from reoccurring
- o Share your contact details and encourage the customer to update you in case the same issue arises

# Tips

- While finding solutions to a problem one either uses a standard method or at times goes with ad hoc ones.
- Whether someone is involved in resolving a client's issue, offering support to the ones already involved in a resolution or finding new ways to solve a reoccurring problem, no what which stage you start from, but a fundamental part of every technician's role is to find ways to solve complications.

# **Exercise**

- 1. What do you mean by problem solving?
- 2. List the problems which you can encounter in your work life.
- 3. Prepare a checklist for solving a problem.

# **UNIT 7.3: Identifying and Repairing Faulty Cables and Connectors**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Understand how to identify faulty cables and connectors correctly
- 2. Test the cables using signal level meters / OTDR
- 3. Repair and replace faulty connectors or damaged cables

# 7.3.1 Identify Faulty Cables/Connectors

Cables/connectors are under a relentless rotation of heating and cooling, expansion and contraction. Whenever a switch is used or appliances are plugged in, usual result is that wire connections loosen over time.

Electrical system has a lot of precautions against bad cabling or connections hazards, such as grounding system, circuit breakers, and other standard protection. Yet, we can encounter sparking every time there is a loose wire connection in system.

Here are some common cabling / connector issues with recommended solutions:

#### 1. Loose cable connections at Switches and Outlets

Screw terminal connections at wall switches and outlets become loose. These areas get maximum electric traffic, these are the first to be looked at. Loose wire connections at a switch, outlet, or light fixture are often signaled by a buzzing or crackling sound or by a light fixture that flickers.

To address this situation, first turn off the power to the suspected wall switch, light fixture, or outlet. Now remove the cover plate and use a flashlight to examine the screw terminals inside where the cables are connected. If there are any loose cables, tighten the screw terminals.

If device is made with the push-in fittings, remove them and reconnect the cables to the screw terminals on the device. If there are pass-through wire connections inside the box that are made with connector, check these to ensure the cables are tightly joined together.

#### 2. Wire Connections Made with Electrical Tape

When wires are joined together with electrical tape rather than a wire nut or other sanctioned connector, there is a danger of a possible hazard. To address this situation, turn off the power to the circuit and remove electrical tape from cables and clean them. After getting sure of amount of exposed wire (about 3/4 inch), join the wires together with an approved connector.

If ends look damaged, remove the ends of wires and undress about 3/4 inch of insulation to make a Proper Connection.

#### 3. Two or More Wires Under One Screw Terminal

There could be a situation when two or more wires are held under a single screw terminal on a switch or outlet. This can lead to distinct fire hazards. It is acceptable to have a single wire under each of the two screw terminals on the side of an outlet or switch, but it is a code violation to have two wires wedged under a single screw.

Immediately switch off the power. Remove two offending wires from their screw terminal. Cut a 6-inch wire of the identical color. Strip 3/4 inch of insulation from each end of the pigtail, then join

one end to the two wires you just disconnected, using a wire connector. Attach the free end of the wire to the screw terminal that once held the two wires.

This creates a bridge connecting wires to the desired screw terminal on the outlet or switch.

#### 4. Loose Connections on Circuit Breaker Terminals

When the hot wires on circuit breakers in the key service panel are not strongly connected to the breaker. In this case, lights flicker, or problems on fixtures all along the circuit are faced. After making connections to circuit breakers, ensure to strip the proper amount of wire insulation from the wire and make sure that only the bare wire is placed under the terminal slot before tightening.

To address this problem, turn off the breaker and then unclip it from the hot bus bar in the main service panel. She/he will check the hot wire connected to the breaker to validate that the screw is tight and that there is no insulation under the terminal and no exposure of excess bare copper wire. After the repair, put breaker back into place on the hot bus bar and turn the breaker back on.

#### 5. Faulty Neutral Wire Connections at Circuit Breaker Panels

When the white circuit wireis not correctly mounted to the neutral bus bar in the main service panel, hazards are prone to occur.

To address the problem, the electrician will check to validate the neutral wire is sufficiently exposed and correctly attached to the neutral bus bar.

# Tips

Make sure the pigtail wire is the same wire gauge as the circuit wires. A 15-amp circuit normally uses 14-gauge wire; a 20-amp circuit uses 12-gauge wire.

# 7.3.2 Cable Testing using OTDR/Signal Level Meters

OTDR stands for Optical Time-Domain Reflectometer. It is an optoelectronic instrument for understanding the character of an optical fiber. For testing, continuous light pulses are injected into the optical fiber, and light is mined from the same end of theoptical fiber. This light is either scattered or reflected along with the fiber. The scattered or reflected light demarcates the depiction of optical fiber.

#### **Testing a Fiber Optic Cable**

This test will acquire a trace of a single-mode or multimode fiber optic cable plant, including the loss of all fiber, splices, and connectors.

#### Equipment required to execute this test

- 1. OTDR of fiber to be tested
- 2. Use same fiber type and size as cable plant for launch and reference and need connectors compatible with the reference cables

#### **Test Procedure**

**Step 1:** Start the OTDR and allow it to warm up.

**Step 2:** Carefully clean connectors and adapters.

- Step 3: Connect launch cable to OTDR. Connect receiving cable to the far end of the cable.
- **Step 4:** Configure the test parameters on the OTDR.
- Step 5: Connect wire to test to end of launch cable. Connect receiving cable to the far end of the cable
- Step 6: Get a trace.

#### Signal level meters

The signal level meter is also known as Field Strength Meter (FSM). It is used for installation of new equipment in a network as well as for finding faults and for timely maintenance

It also ensures that signal levels are delivered as required.

#### **Types of Signal Level Meters**

Commonly, Signal Level Meters are categorized in three groups:

- 1. CCTV Signal Level Meters: Today CCTV testers come with equipped functions to program the cameras and evaluate wide range of variables; thus, one device is enough. It is able to test and also program the cameras from a location with a particular device, thereby saving money and time.
- 2. Satellite & CATV Signal Level Meters: They are used to test and measure the quality of TV and satellite signals, ensuring that the signal levels are delivered as essential. Signal levels are measured over a definite frequency assortment, usually articulated in decibel-milliwatts, dBm.

Guidelines to use a sound level meter:

- position sound level meter at a sufficient distance from obstacles or reflectors
- position microphone of sound level meter about 1.3 –1.5 m above the ground
- position microphone of the sound level meter in the direction of the sound source

# 7.3.3 Connecting a Cable to an RJ-45 Connector -

Following tools are used to build cables with RJ45 connectors.

#### **Tools**

- Cat 3 cable or Cat 5cable
- RJ45 connectors
- Wire stripping and crimping tool

**Step 1:** Cut the outer jacket of the wire by about 1-1.5 inches by using a wire stripper.

**Caution:** Be careful while cutting the outer jacket, the wires inside the jacket should not get damaged.

**Step 2:** Before installing the wire, arrange them in the order in which they are supposed to go in the RJ45 connector.

**Note:** Arrangement of the wires order depends on the connection which you are making. The connection may be crossover, rollover or straight -through.

**Step 3:** After the wires are arranged in the specified order, cut them at least ½ inch from the point, which will be used for installation.

**Step 4:** Push the cables into the connector, for ensuring that the wires are below the gold crimping pins, towards the end of the cable and. One should confirm that each wire has gone into the right place.

**Step 5:** Specific tool should be used for crimping the cable. To check the connection, tug the cable slightly. Accordingly crimp again, if required.

**Note:** With the use of crimping tool, the wires are pressed into the plastic wedge and to the cable jacket. This keeps the cable in its place. The crimping pins are then pushed into the wires to respective connector channels.

The following figure shows installing cable in an RJ45 connector:

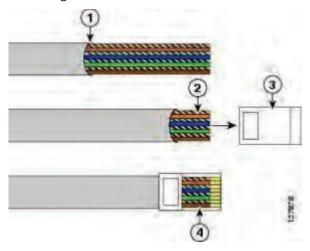


Fig. 7.3.1: Illustration of installing a cable in RJ45 connector

- 1. Cut the outer jacket of the wire
- 2. Cut the wire into 1 and 1/2 inch in length
- 3. RJ45 connector
- 4. Cable installed in RJ45 connector

# Tips 🖳

- The cable which is used to connect a computer to a router console is called as a rollover cable. It is also referred as null-modem cable.
- A twisted pair copper cable used for local area network (LAN)which has a RJ-45 connector at each end is referred to as Straight-through cable.

# Fill in the blanks. 1. \_\_\_\_\_\_\_ is an optoelectronic instrument for understanding the character of an optical fiber. 2. The two types of Signal Level Meters are \_\_\_\_\_\_ and \_\_\_\_\_.

# UNIT 7.4: Electro Magnetic Interference (EMI) and Compatibility (EMC)

# **Unit Objectives**



By the end of this unit, the participants will be able to:

1. Understand the importance of EMI and EMC.

#### 7.4.1 Need of EMI & EMC -

The most significant elements in electronic products and system integration are;

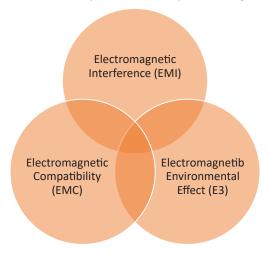


Fig. 7.4.1: Elements in electronic products and system integration

By law, any product, before entering the market must comply with international EMC standards. These standards are put into place to control and regulate the radiations which are emitted from every electronic product.

All electronic products should be immune to electromagnetic intrusion some of which are Electrical Fast Transients (EFT) and Electrostatic Discharge (ESD). The need for such is because these systems at times may get exposed to extreme electromagnetic environments (lightning strikes or (EMP) electromagnetic pulses) and they should be able to withstand the situation.

Both EMI and EMC are vital for product development companies across the world. Accurate guidelines must be adhered to by manufacturers while designing the product, which will ensure clearance of the product after EMI/EMC testing. Using EMI/EMC compliant components in the design have proven to be beneficial for many manufacturers.

All the details should be taken into consideration right from the initial stage; else one will be waiting time to meet such needs. The basic different between EMI/EMC are discussed as following. The products under developments should always maintain specific military or industrial standards.

As mentioned, for all manufactured devices, EMI and EMC levels should always be verified by regular testing.

# 7.4.2 Electromagnetic Interference (EMI) -

#### **Electromagnetic Interference (EMI)**

EM waves are radiated from mostly every device which can affect the working of the nearby wireless or FR systems. This phenomenon is referred to as EMI. Thus, EMI levels should be maintained within the limits to ensure the adjoining systems perform appropriately.

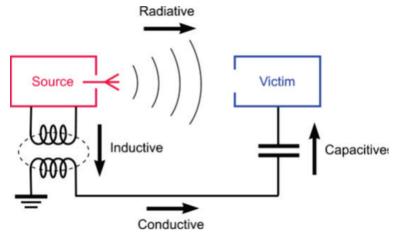


Fig. 7.4.2: Electromagnetic interference

# 7.4.3 Electromagnetic Compatibility (EMC) -

The electric noise produced by every device passes through cables, which can affect the working of adjoining devices connected to the same electric system. This is termed as EMC levels, and these should also be maintained within certain limits, for accurate functioning of the other systems.

# Tips

The EMC standards are required for trouble free co-existence and satisfactory operation. They are required to ensure compatibility between electrical and electronic control of all systems. Standards are required from manufacturers considering the user's interaction and knowledge on EMI will be in most cases very limited.

# **Exercise**

- 1. What is EMI?
- 2. What is EMC?
- 3. What is the difference between EMI and EMC?

# **UNIT 7.5: Crimping and Soldering**

# - Unit Objectives 🏻 🏻



#### By the end of this unit, the participants will be able to:

1. Understand the process of crimping and soldering.

# 7.5.1 Crimping vs. Soldering -

These days a defective coaxial connection is attributed for reducing performance of digital systems like Ethernet, Wi-Fi, and WLANs and also in high-end videos like DTV, SDTV and HDTV. In earlier days, an improperly installed CCTV connector caused a 1dB or less loss on a CCTV system. But, in recent days, the same bad connection can cause a 10dB loss on a 1GHz system.

Some essential factors which should be considered while establishing a coaxial connections and cable assemblies will be discussed in this topic.

Right tools and skills are the most important aspect weather someone is using soldering or crimping method for assembly

Solderorcrimpmethodshaveprovedtobemoresustainablewhenitcomessolidmechanical and electrical connections such as installing contact between the connector's centre to the centre conductor of the cable or assemblies which needs to preform over 1GHz.

# 7.5.2 Soldering –

This fabrication method is often considered the most labour-intensive as it is a preferred method while performing heavy-duty tasks and is reliable in making connections and can be applied on cable with solid or stranded centre conductors.

Advantages for connectorization by solder method are as follows:

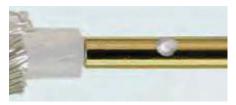


Fig. 7.5.1: Soldering

#### **Preferred**

- Solder is shiny and smooth aroundjoint
- Outside joint there is no visible evidence of solderflow
- The hole created by solder filled with pinsurface

The prime tools in use is a solder iron with low-wattage and with variety of IPS. To hold the work in right place, installation is done by using a decent vise. Apart from this, only materials that are used are flux and solder.



Fig. 7.5.2: Joint after soldering

#### **Preferred**

- Solder is shiny and smooth around joint
- Outside joint there is no visible evidence of solder flow
- For non-optimum technique soldering is tolerant. Disadvantages of solder method:
- While terminating soldering takes more time.
- In case of cold soldering there can be occurrence of solder not holding the joint properly.
- Solder fatigue and small cracks are evident in case of exposure to excessive vibration.
- In case of mechanical or temperature stresses soldering can become inconsistent.
- One should take precaution and control the heat while soldering as this can garble the cable.

#### **Nonconforming**

- 1. Minimum 75% fill is observed in braid indicates
- 2. Contour of pin can be altered by cavity
- 3. Electricals also gets affected



#### **Nonconforming**

- 1. Minimum 75% fill is observed in braid indicates
- 2. Contour of pin can be altered by cavity
- 3. Electricals also gets affected



#### **Nonconforming**

1. Dielectric melted past OD + 20% maximum

- 2. Dielectric flare interferes with assembly
- 3. Pin gets melted with dielectric



#### **Preferred**

- 1. 90-degree stripping is shown in dielectric
- 2. Melting is non-evident



Fig. 7.5.3: Disadvantage of solder methods

# - **7.5.3 Crimping** —

One of the most preferred methods to terminate connectors on coax cable sometimes also referred to as workhorse of the trade.

Following reasons explain why crimp method is popular:

- Reduction in installation time as soldering is not required.
- An experienced technician will not take more than fifteen seconds for installing a crimp to the crimp connector. Reduction in assembly time is essential because these days lesser number of technicians are required to retain more equipment. Categories like computers, network cables and digital videos are mostly crimped.
- In case of thermal cycling some good connections will keep the metal adequately past the yield point, still allowing enough space for "spring back".
- A crimp connection to be good should be air tight and does not wick: hence at time is also called as "cold weld".
- Can be used on solids and or marooned conductors.

#### **Preferred**

- Equally distribution on the surface of all 6 crimp
- Crimp die positioned within pin step down



Fig. 7.5.4: Crimping

Disadvantages of the crimp method are:



Fig. 7.5.5: Crimping disadvantages

In case the crimping is not done by a professional, there are chances that it will not seat accurately and may affect the specifications. This further affects the quality and continuity in the signal.

Once a wire is crimped it is not good for re-installation and also can't be un- crimped, so in case of repair the complete assembly needs to be replaced.

- Solid wires may not be able to hold the crimping, and this may lead to failure.
- Wire can shift and loosen in rare circumstances of frequent flex conditions. This is more evident in clamp connectors rather than crimped ferrule stud connectors.
- Always ensure to use the right type of connector for the coax. Avoid double crimping, particularly at the contact; this is known as "flagging" or "dog ears".

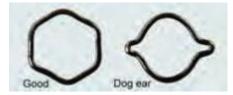


Fig. 7.5.6: Visualization of flagging and dog ears

#### Ferrule CrOSS Section

- 1. Equal pressure with hexagon shape on all sides.
- 2. Ensure the crimping is done in such a way that "dog ear" is not formed.

3. Wrong crimp occurs either because of unequal pressure, inappropriate die or in some cause because of very hard ferrule material used.

It is vital to use right tools when connecting a crimping connector to ferrules. In case of normal duty work use a ratchet crimp tool such as the RFA -4005-20, and in case of heavy duty tasks apply a piston driven crimp handle, such as the RFA-4009-20. Make sure that the crimp die and connector are of right type.

To relieve stress on the coax a bell mouth crimped connector is used. Savings can be observed in case of cutting the material for large jobs in advance.





Fig. 7.5.7: Bell mouth crimper



A crimping tool is used for joining two pieces of metal together. The process involves deforming one or both cables to grip them. This process is referred to as crimping.

# **Exercise**

#### Answer the following questions:

- 1. What do you mean by soldering?
- 2. What do you mean by crimping?
- 3. How will you ensure that crimping and soldering have been done properly?

#### Fill in the blanks.

- 1. The tools used in Soldering are \_\_\_\_\_, \_\_\_\_ and flux.
- 2. Crimping and Soldering are methods used to establish \_\_\_\_\_ connections.

# **UNIT 7.6: Troubleshooting of Cable and Connector**

# – Unit Objectives 🏻 🏻



By the end of this unit, the participants will be able to:

1. Demonstrate troubleshooting of cable and connector.

# - 7.6.1 Problems during First Startup -

Symptom	Problem	Solutions
All LED indicators are not working.	No power to router.	<ol> <li>Perform the following tasks sequentially:</li> <li>Ensure power switch is ON.</li> <li>Ensure all connections are secure from the power supply.</li> <li>Ensure there is no power cut.</li> <li>If all above points are checked, then faulty power supply can be the reason.</li> </ol>
Internet indicator not blinking	<ul> <li>Issue with cable:</li> <li>Either the cable is not connected in proper manner.</li> <li>The cable is damaged.</li> </ul>	<ol> <li>Perform the following tasks sequentially:</li> <li>Ensure the device is connected in accurate manner.</li> <li>Check plugs and connectors</li> <li>Ensure there is no physical damage to the cable.</li> </ol>
No connection to Ethernet devices. (The indicators 1 to 4 are off)	<ul> <li>Problem with cable</li> <li>Either the cable is not connected in proper manner.</li> <li>The cable is damaged.</li> </ul>	Perform the following tasks in order:  1. Ensure device is connected accurately.  2. Check plugs and connectors.  3. Ensure there is no physical damage on cable.
Not able to connect to Internet	<ul> <li>Either the Ethernet switch or modem is not connected or switched on.</li> <li>Issue with broadband or WAN service.</li> <li>Router is not configured in right manner.</li> </ul>	<ul> <li>Reconnect the modem or Ethernet switch again and confirm the power supply.</li> <li>Check the Internet service.</li> <li>Re configure the Router.</li> </ul>

#### - 7.6.2 Problems in Router ———

Symptom	Problem	Solutions
Issue with Ethernet connection. (Computer LEDs 1 to 4 are off)	A cable-related issue:     Disconnected cable.     Damaged cable.	Perform the following tasks in order:  1. Check if connections at either end are secure.  2. Check if the cable is not damaged.
Broadband or Ethernet connection is irregular or broken. (The Internet 1 LED on the front panel is off)	A cable-related issue:     Disconnected cable.     Damaged cable.	Perform the following tasks in order:  1. Check if connections at either end are secure.  2. Check if the cable is not damaged. If it is damaged, replace it with the new one.
(The Internet 1 LED is On but front panel LED is off)	Problem with broadband line or WAN service.	Check with the service provider to ensure the service is not interrupted.

# Tips

Types of network cables depend on the network's physical layer, size and topology. Different types of networks cables are coaxial cable, optical fibre cable and twisted pair cables. The devices can be at a smaller distance of few meters over Ethernet or large distances over the interconnections of the Internet.

# **Exercise**

- 1. List various kinds of problems associated with cable and connectors.
- 2. How will you troubleshoot problems associated with cables and connectors?

## **UNIT 7.7: Troubleshooting of CPE (Modem, Router, Switch)**

## – Unit Objectives 🥝



By the end of this unit, the participants will be able to:

1. Demonstrate troubleshooting of CPE (modem, router and switch).

## 7.7.1 Diagnosing the Cable Modem

On the front side of the modem, the status lights indicate the connection status between the modem network and also the connection between the modem, a computer and the local network.



Fig. 7.7.1: Front Panel

In normal operation, the status lights provide the information as in the table below.

Symptom	Problem	Solutions
Power	Startup diagnostics in progress.	The cable modem is powered on.
Receive	Downstream channel connection scan for receiving.	Connected downstream channel.
Send	Upstream channel scan connection.	Connected upstream channel.
Online	Network connection scan.	Process of startup is complete.

Symptom	Problem	Solutions
PC/ Activity	Receiving and communicating data.	Network device OR a computer is connected on the panel or either as USB or Ethernet connectors.
Standby	No flashing of lights	Once Standby button is on the Internet gets disconnected. If standby light is on, the rest of the lights will be off.

Fig. 7.7.2: Status light information

### Back/Rear Panel

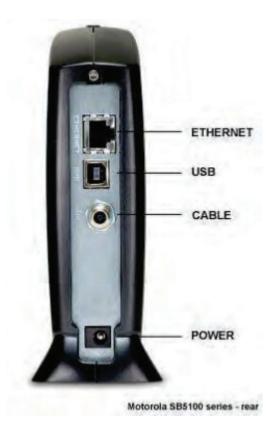


Fig. 7.7.3: Rear Panel

Power socket and connectors for cable is found at the back of the panel.

Туре	Description
Ethernet	For the computers that are Ethernet compatible, an Ethernet port initiates the connection with RJ-45 connector.
USB	USB compatible computers get USB connections through USB ports.
COAX Cable	The CABLE port ensures connection to the coaxial cable also coined as COAX cable.
Power	Modem gets its connection from the power port.

Fig. 7.7.4: Ports at the back of the panel

### 7.7.2 Troubleshoot a Cable Broadband Connection -

### **Power Cycle Equipment**

Occasionally, electrical devices will stop functioning properly, and cause a loss of connectivity. The first step in troubleshooting these issues is restarting the devices involved. This typically means that one needs to switch off the power for all devices such as the cable modem, router, switches, hubs and other systems. Then, after doing this, restart the devices after waiting for a minute, typically starting with the modem.

Once the modem is connected to the network, this will be indicated by four green lights (not blinking but solid) on the cable modem, network devices such as routers/switches can be restarted. Finally, restart the computer system.

Restarting or resetting the cable modem might take up to 5-30 mins.

#### **Network Status**

Unplanned network outages can interrupt the cable broadband service.

In the section below, you will find the solution for most common problems while the modem is not connected to the cable modem network.

## 7.7.3 Trouble shooting using the Cable Modem Indicators

The most frequent and common problems while the modem is not connected to the cable modem network are:

Modem Light	Status	Problem	Solution	
	OFF	Show no power.	Confirm the supply of power.	
Power	Flashing	Normal operation has been interrupted due to error.	Reset the modem after checking the coax cable.	
Receive	Flashing	Searching for cable connection.	Check the cable connection and try resetting the modem.	



In most of the routers the reboot process remains the same, which is done by unplugging the power supply to router, waiting for few seconds and then plugging in the cable back. In case of a modem which is connected separately, follow the same process for the modem.

## **Exercise**

#### Answer the following questions:

- 1. List the process to diagnose a cable modem.
- 2. List the steps to be followed to troubleshoot cable modem indicator.
- 3. List the steps to be followed to troubleshoot cable broadband connection.

## **UNIT 7.8: Troubleshooting Configuration and Connectivity of CPE faults**

## Unit Objectives



By the end of this unit, the participants will be able to:

1. Troubleshoot configuration and connectivity.

### 7.8.1 Troubleshoot "No Data Traner"

In the table below, you will find solution to most common problems while the modem is connected to the cable modem network, indicated by four solid green lights and the PC/ Activity indicator orange solid or flashing. No data transfer means you can't open a website in your browser, the email server can't be found to send or receive email, or another program can't connect to a server.

Modem Light	Status	Problem	Solution
Standby	OFF	1. No connection between cable modem and computer or router.  2. Local area connection is disabled.	<ul> <li>Push the standby-button at the top.</li> <li>1. Check Ethernet or USB cable. If possible, try another cable.</li> <li>2. Enable the Local Area Connection as below.</li> <li>Windows 7: Control Panel  → Network and Internet → Network Connections</li> <li>Windows Vista: Control Panel → Network and Sharing Centre → Manage network connection</li> <li>Windows XP: Control Panel → Network Connections</li> <li>Windows 2000: Control Panel → Network and Dial-up Connections</li> </ul>
	Blinking	An error has occurred during normal operation or can't connect to any server.	<ol> <li>Check the cables and try resetting the modem. In case the cable is in right manner and the resetting also doesn't work one should call Customer Help.</li> <li>Verify the connection settings and check if the connection is set up with the IP addresses assigned to the connection.</li> </ol>

Modem Light	Status	Problem	Solution		
	Blinking	Can't connect to some	It is possible that servers on the Internet are down temporarily. Try to open a connection to the server after some time.		
PC/ Activity		servers	You can also check connection with a server; it will give you: IP address, a trace route from your system.		
	OFF	No coaxial cable connection	Check all connections of the cable and reset the modem.		
Send	Flashing	Scanning for the upstream frequency.	Check all connections of the cable and reset the modem.		
Online	Flashing	Scanning for the network connection.	Check all connections of the cable and reset the modem.		
Activity	Blinking	Transmitting or receiving data	No Problem		
	ON	Modem is in standby mode (the other indicators are OFF)	Push the standby-button at the top.		
Standby			Computer to the server you can't connect to and the time the trace route has been done.		
	ON	No data transfer	Unplug Ethernet or USB cable from computer and reconnect cable. Make sure the PC/ Activity indicator is blinking.		



In windows operated systems one can check the status of wireless network from control panel, network connection and ensure that it is enabled. If it is not enabled, right click and enable it. While using a laptop user must check the function key or physical button to ensure airplane mode is not on. In case of using a USB adapter, unplug the same and then reconnect.

## **Exercise**

### Answer the following questions:

- 1. List the problems commonly associated with connectivity and configuration.
- 2. How will you troubleshoot connectivity and configuration problems?

## **UNIT 7.9: Troubleshooting and Repairing of Client's Broadband Service**

## - Unit Objectives



#### By the end of this unit, the participants will be able to:

- 1. Understand common causes of broken Internet connection
- 2. Learn how to diagnose Internet connection

## 7.9.1 Common Causes of Broken Internet Connection

#### 1. Slow Connection

These are the possible reasons why Internet connection would be ineffective:

- device is located far from router
- bandwidth is spread too thin, specifically if there are multiple devices connected
- Ultimate working hours where good population is connected at once, so congestion (e.g., libraries, hotels, universities, etc.)

#### 2. No Connection at all

Connection is lost due to:

- Problems in router or modem
- Complete service disconnection, due to weather, construction work or power problems

#### 3. Service Fluctuations

Challenges at Internet service providers' (ISPs) end, often result in irregular Internet speed

#### 4. Equipment Failure

Damaged modem or router results in power blackout damaging the wires. Upgrading of outdated equipment is essential.

#### 5. Operator Error

The most common operator errors that cause faulty Internet include wires plugged into the wrong jack, bad firewall rules set up and duplicating IP addresses.

## 7.9.2 Diagnosing Internet Connection

#### 1. Check equipment like the modem, the router, the line, and your device or computer.

For instance, network cables may be loose or accidentally unplugged.

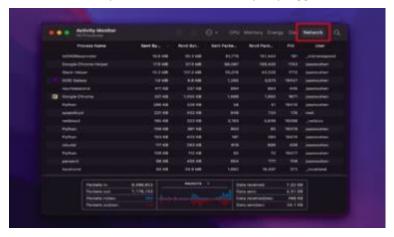


Fig. 7.9.2a: Network screen (Pic credit: https://www.pcmag.com/)

#### 2. Check for functioning of website

Use the tool Down for Everyone or Just Me to check if the website is working. If it says the site is down just on your end, then proceed to diagnosing the problem.

#### 3. Use Ping command

The Ping command sends a small data from your computer to another, in order to see if there is a connection.

To ping a website on a Windows computer: Search for CMD. On the black box, type "ping <www.website.com>" (e.g. ping www.google.com)

To ping a website from a MAC: Open Applications, then Utilities, then Terminal. On the box, type "ping <www.website.com>" (e.g. ping www.google.com), then press enter.

4. If the box indicates "reply from" followed by numbers, then your Internet is working well. If it, however, indicates anything other than "reply from" (e.g. "request timed out" or "destination host unreachable"), then the problem is on your end.

#### 5. Check for DNS server problems

To check, access a website via its IP address. Google's IP address, for example, is http://216.58.197.78. If one can access the website via its IP but not through its URL, then DNS has issues.

#### 6. Check Internet package

If Internet is working, but is slower than expected, log on to a site like Speedtest.net and run a speed test. Number in megabits per second denoting the speed of system will be shared.



Fig.7.9.2b: Speed Test screen

## – Exercise 🔯

### Answer the following questions:

- 1. Name a few common causes of broken Internet Connection.
- 2. Name a few things to check while diagnosing Internet connection.

otes 🗏			

Scan the QR codes or click on the link to watch the related videos



https://youtu.be/2Xuv\_gSICQg?si=AY4WqG-drdIJ85Og

Security escalation matrix











## 8. Repairing Handsets

Unit 8.1 - Prepare for Repairing a Handset

Unit 8.2 - Basic Electronics of a Mobile Phone

Unit 8.3 - Resetting a Phone

Unit 8.4 - Fixing the Firmware Participant

Unit 8.5 - Hardware Repair Tools

Unit 8.6 - Basic Troubleshooting

Unit 8.7 - Safety Guidelines

Unit 8.8 - Report and Document Daily Activities



## – Key Learning Outcomes 🙄



#### By the end of this module, the participants will be able to:

- 1. Repair a handset
- 2. Outline and explain the basic electronics of a cell phone
- 3. Outline and explain the various parts and components that makes up a mobile handset
- 4. Identify and make use of common handset repair tools
- 5. Disassemble a mobile phone
- 6. Troubleshoot common handset problems
- 7. Understand and follow standard safety precautions while repairing a handset
- 8. List and outline radiation safety laws for mobile handsets in India

## **UNIT 8.1: Prepare for Repairing a Handset**

## **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Identify the faulty devices
- 2. Assist your supervisor in analyzing problems reported by the customer team
- 3. Understand the importance of adhering to the SLA
- 4. Identify the costs of repair
- 5. Understand the formation of alternating and direct current

## 8.1.1 Identify the faulty handheld devices from the customer care executives or front-end executives



Customer Service Executives are the backbone of businesses that frequently interact with their clients.

These specialists assist businesses in creating and upholding reliable relationships with clients and customers. In addition, they go by the name front-end executives.

The handheld device must be collected for repair after the Handheld Devices (Handset & Tablet)

Technician has recorded the details of the malfunction.

The following Standard Repair Procedure are important for on-the-job performance:

- Adhere to the recommended practises listed by the mobile phone manufacturer for each model.
- Wear ESD wrist straps or aprons and take anti-static precautions before working.
- When handling hardware modules, adhere to standard operating procedures, such as handling
- PCB with ESD standards.
- Use the brand's suggested tools for the particular job.
- By adhering to standard operating procedure, keep material handling defects to a minimum.

## 8.1.2 Analyse issues reported by the customer/ front-end team



The supervisor's responsibility is to keep an eye on the workers and ensure that they are carrying out all job responsibilities.

The supervisor's overall responsibilities include communicating organisational needs, monitoring employee performance, offering direction and support, identifying areas for development, and managing the mutually beneficial relationship between staff and the organisation to ensure that both parties succeed.

#### Handsets Repair Engineer needs to assist Supervisor in followings:

- Respond to walk-in consumers' questions about mobile phone repairs.
- Assist clients in inspecting and troubleshooting their mobile devices and providing any solutions (such as repairing of phones).
- Run test machinery and/or upgrade software.
- Assist clients in attaching their accessories (such as screen protectors and phone covers).
- Use and maintain tools and equipment for repairs.
- Making sure there are enough tools and equipment for repairs ordering tools as needed.

#### Supervisor also do supervise of Staff/Handsets Repair Engineer as per below:

- Verify that staff is taking care of clients.
- Verify that the service offered by the technician and personnel is satisfactory.
- Supervising phone technicians' timely completion of repairs on clients' mobile phones.
- Planning and setting up staff and technician work schedules.
- Assume the responsibilities of any absent technicians or workers.

## 8.1.3 Importance of Service Level Agreement (SLA)

- The term "service-level agreement" (SLA) refers to a legal agreement between a service provider and its clients that outlines the services they will deliver and the service standards they are required to uphold.
- An SLA is a more comprehensive and generalized term for a service-level commitment (SLC). An SLA
  has two teams and is bidirectional, therefore the two are different. An SLC, on the other hand, is a
  single directional commitment that specifies what a team may always promise its clients.

#### Why are SLAs important?

Service providers require SLAs to manage customer expectations, specify the severity levels, and spell out the conditions in which they are not responsible for outages or poor performance. Customers can also gain from SLAs because the agreement outlines the service's performance parameters, which can be compared to those of competing suppliers, and specifies how service problems will be resolved.

One of the two fundamental contracts that service providers have with their clients is often the SLA. A master service agreement is frequently created by service providers to lay out the fundamental

guidelines under which they will conduct business with clients.

The master service agreement of the service provider frequently includes the SLA by reference. The SLA provides more detail to the services offered and the criteria that will be used to assess their performance compared to the other two service contracts. The services that are part of the service offering are specified in service commitments.

Although it is believed that SLAs were first utilised by network service providers, they are now often used in a variety of IT-related fields. IT service providers, managed service providers, cloud computing providers, and internet service providers are a few examples of industries that set SLAs.

#### A customer service-level agreement includes:

- exact details of the service expected by the customer;
- provisions of the service availability;
- standards for each level of service;
- each party's responsibilities;
- escalation procedures; and
- terms for cancellation.

A company's internal customer, which could be another company, department, or site, is the subject of an internal SLA.

## 8.1.4 Plan and prioritize activities related to delivery timeline

While the severity levels of the defects are defined by the QA engineer, the priority of the faults is decided in cooperation with the manager or customer. While severity is driven by functionality, priority is driven by commercial value.

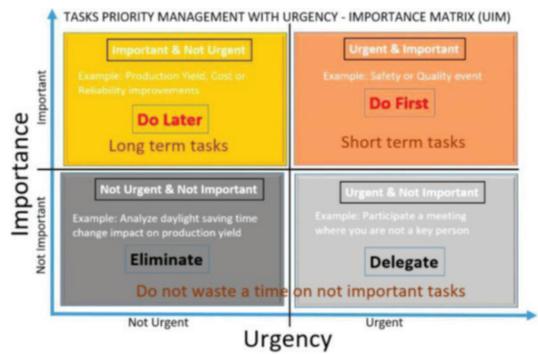
Impact gauges how a situation has affected operational procedures. We can assess the effect using a number of factors. number of impacted users and possible financial losses number of affected services lack of laws and regulations business reputation other.

The period of time it takes for a situation to significantly affect company is known as the urgency.

- A period where a system is considered as more critical
- When some systems are identified critical with a high availability level

**Priority**, which determines when activities must be taken, is based on impact and urgency.

• The allocation of a priority code determines how the incident is being taken care of by the tool and the support staff.



A priority matrix can help you sort your to-do list by things like urgency, importance, or impact.

In a four-quadrant priority matrix, your task may fall into four categories. For example, your quadrants may be:

- High impact and high effort
- High impact and low effort
- · Low impact and high effort
- Low impact and low effort

By mapping your tasks along a priority matrix, you can determine how and when to tackle each to-do.

## 8.1.5 Identify the cost of repair and verify if it is within Beyond Economic Repair (BER)

**Price standardization** refers to charging all consumers the same amount for the same mobile issue. The cost may change depending on the repaired parts, the brand and model of the equipment, etc. The standardization of prices is a crucial element that demonstrates the professionalism of the handset repair service provider.

A corporation can use information from a Beyond Economic Repair (BER) analysis to assist decide if mending a product is more cost-effective than replacing it. BER compares the cost of repairing a part or assembly with the cost of replacing it.

- Using data from a BER analysis, repair methods can be created such that, after a certain amount of time has been spent trying to fix a product unsuccessfully, it can then be replaced, using the extra time to do so rather than making additional repair attempts.
- A BER analysis begins as a prediction utilizing expected repair costs for a new product to determine how many hours are spent doing repairs before giving up and replacing the product.

Actual repair hours and the economical repair yield (the proportion of failed assemblies of each type
that are successfully and inexpensively repaired) for a product can both be recorded as individual
product units are sent back to the company for repair.

## - 8.1.6 Formation of alternating and direct Current

When an electrical current continually runs in a single direction, it is said to be in direct current. Rectifiers, batteries, generators with commutators, and fuel cells all generate direct current. A flashlight or an appliance powered by batteries, for instance, both use direct current. Electroplating is the most popular and necessary application of direct current. For normal commercial power, alternating current (AC) currents have taken the place of direct current.

A form of electrical current known as an alternating current, sometimes known as an AC current, is one in which the direction of electron flow changes periodically. The current that flows via home electrical cables and outlets is a common illustration of an AC current. Any electrical item that complies with India's standard voltage and frequency requirements of 230 Volts and 50 Hertz may be used there.

The fact that the alternating current frequency ranges from 50 to 60 Hertz distinguishes AC current from DC current. In contrast, the frequency of direct current stays zero in accordance with national standards.

Depending on the situation, the DC and AC current are frequently interconverted. A rectifier changes an alternating current into a direct current, while an inverter changes a direct current into an alternating current.

Applications for AC-DC current is numerous. While DC is mostly employed in flash lighting, electrolysis, electronic equipment, hybrid vehicles, and other applications, AC currents are used in factories, households, and enterprises.

- DC sources
  - o Battery
  - o Dynamo
  - o Fuel cell
  - Solar panels
  - Wind turbines
  - o Rectified AC
  - o Thermocouple
  - o Energy from bacteria
- AC sources
  - o Generators
  - o Alternator
  - LC Oscillator
  - Crystal oscillator
  - Inverters

Our phones require DC power to charge, but the charger's source current is AC, thus it must be converted to DC using a component known as a rectifier circuit. The charger really provides an AC supply to the phone, converting the AC to DC using converters built into the device. The charger's circuit additionally steps down the voltage using a transformer and a few minor loads.

## 8.1.7 Importance of recording customer details

These are merely documents that outline the details of your interactions with customers on a business to-business basis. These data include your clients' full name, company name, address, phone number, email address, fax number, and website, among other information. Birthdays, spending habits, employment history, and any other business data you consider appropriate may also be included.

Two difficult jobs come with maintaining client records. Creating a client database that meets your

demands is the first step. The second is continuing your commitment to regularly collecting and updating client information.

You can create a customer database to keep your customer information. For those unfamiliar with MS Excel, this client database may be challenging. If you're skilled at it, you could create a database that captures all the vital consumer data you require. There are many ways to collect information on your customers, including:

- order forms
- enquiries
- complaints
- warranty cards
- customer rewards programs
- customer satisfaction surveys
- feedback cards
- customer competitions
- your website

Keep in mind that client information is private and needs to be kept safe. Make a plan for the storage of client information and distribute it to all employees.

Only current customer information is helpful. It's crucial to constantly review the correctness of your clients' information and make any required updates.

## -8.1.8 Inspect the repair table and area for cleanliness

Cleaning up the workplace not only makes it healthier for workers, but it also typically aids businesses in becoming more productive and effective.

Desk clutter, unfinished meals, and waste paper are just a few of the most typical things that make a workstation messy.

Repairing mobile devices is a delicate art. To ensure that you can work comfortably, a table and chair of the suitable height are necessary.

Although it is true that fixing cell phones is a mentally taxing and stressful profession, this does not excuse you from exercising caution and maintaining a tidy work area. Keep all of your regular tools close at hand and in the proper location so that over time you become so familiar with the area that when the need comes for a specific item, your hand automatically reaches out to it and you do not even need to use your eyes to find it.

Because a person's character and habits are reflected in the state and settings of their workspace, it is imperative that you keep your workspace spotless and never let it get crowded.

#### Phone repair service generally includes:

- Attending to walk-in customers for any mobile phone repair queries
- Assisting customers to check and troubleshoot their mobile phones to offer any solutions (such as repairing of phones)
- Operating test equipment and/or upgrading of software
- Assisting customers with fixing on their accessories (such as screen protectors and phone covers)
- Maintaining and using repair tools and equipment.
- Ensuring tools and equipment for repairs are sufficient order tools if required

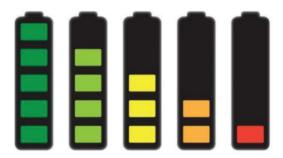
The quick flow of electricity between two electrically charged items brought on by any touch between them is known as an ESD (Electro Static Discharge). Since it varies from device to device, the intensity of this current is impossible to predict.

Your safety does not require ESD protection. The motherboard's electronic components' security is the reason.

You need to use an anti-static wrist strap for ESD protection. Any static accumulation in the body is grounded by the anti-static wrist strap.

You can also use anti-static gloves, a mat to reduce static electricity, and ESD-safe tools.

## 8.1.9 Equipment calibration process as per tablet manufacturer



Your battery and charge levels must be tracked by the Android operating system so that it can alert you when they are full or empty. The issue is that it can occasionally become corrupted and begin showing false data, leading, for instance, to the phone shutting off before it reaches 0% battery life. The ageing of the data may possibly be the reason of this disparity.

All batteries deteriorate over time, and an older battery is unable to maintain a charge as long as it once could. However, when showing the battery condition on the screen, the software that runs on your phone typically does not take this degradation into consideration.

To calibrate your Android battery, all you have to do is ask the Android OS to update this data to reflect your real battery levels once more. It's critical to realise that the battery itself is not calibrated (or enhanced) throughout this process. Additionally, battery calibration does not lengthen your phone's battery life. It will merely make the phone's battery statistics more correctly displayed.

The situations where calibrating your battery might be a good idea are listed below.

 Even though your smartphone said there was adequate battery remaining, it shuts down unexpectedly.

- If billing percentage is consistently stuck at a particular value.
- Why you believe the shown battery statistics are wrong because your smartphone is quite old.

#### Android smartphone batteries should be calibrated:

- Discharge your phone fully until it turns itself off.
- Turn it on again and let it turn itself off.
- Plug your phone into a charger and, without turning it on, let it charge until the on-screen or LED indicator says 100 percent.
- Unplug your charger.
- Turn your phone on. It's likely that the battery indicator won't say 100 percent, so plug the charger back in (leave your phone on) and continue charging until it says 100 percent on-screen as well.
- Unplug your phone and restart it. If it doesn't say 100 percent, plug the charger back in until it says 100 percent on screen.
- Repeat this cycle until it says 100 percent (or as close as you think it's going to get) when you start it up without it being plugged in.
- Now, let your battery discharge all the way down to 0 percent and let your phone turn off again.
- Fully charge the battery one more time without interruption and you should have reset the Android system's battery percentage.

#### The best way to calibrate a battery:

- For phones and tablets:
  - o Charge it to 100%, and keep charging it for at least 2 more hours.
  - o Use your device until it shuts off due to low battery.
  - o Charge it uninterrupted to 100%.
- For laptops:
  - Charge it to 100%, and keep charging it for at least two more hours.
  - Unplug your laptop and use it normally to drain the battery.
  - o Protect your work when you see the low battery warning.
  - Keep your laptop on until it goes to sleep due to low battery.
  - o Wait at least 5 hours, then charge your laptop uninterrupted to 100%.

## 2.1.10 Software version/modules and basic software commands for data

The European Telecommunications Standards Institute (ETSI) created the GSM (Global System for Mobile Communications) standard (ETSI).

On the global system for mobile communications used by the 2G and 3G cellular communication systems, General Packet Radio Service (GPRS) is a packet-oriented mobile data service (GSM).

A chip or circuit known as a GSM module or GPRS module is used to establish communication between a mobile device or computer and a GSM or GPRS system. In this case, the modem (modulator-demodulator) is essential.

These modules include a GPRS or GSM modem that is powered by a power supply circuit as well as computer connection interfaces (such as RS-232, USB 2.0, and others). A GSM modem can be a standalone modem with a serial, USB, or Bluetooth connection, or it can be a mobile phone with GSM modem functionality.



## **UNIT 8.2: Basic Electronics of a Mobile Phone**

## **Unit Objectives**



#### By the end of this unit, the participants will be able to:

1. Identify and classify various electronic components that are used in mobile handsets

## **8.2.1** Architecture of a Mobile Handset

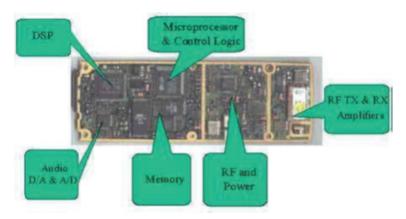


Fig. 8.2.1: A sample circuit board of a mobile handset

- EEPROMs (electronically-erasable programmable read-only memory) are used to store system data in handsets.
- Physical access to memory chips is not required by Service Providers to reprogram a phone.
- Read Only Memory (ROM), being nonvolatile memory, is used to store the phone OS.
- Subscriber identity module (SIM) cards are included as part of a handset.
- Handsets use embedded processors, examples include:
  - o BlackBerry 8700, uses Intel PXA901 chip
  - o iPhone, uses Samsung ARM 1100 chip
  - Low power use and code size are crucial
- Microprocessor vendors often package all the chip's functionality in a single chip (package on package) for maximum flexibility.
- A microprocessor and EEPROM (16 KB to 4 MB) are within a SIM card and come in two sizes. Its portability (easy move from one phone to another) makes it highly versatile. A SIM card stores:
  - o Identity of the subscriber to enable recognition by a network.
  - o Personal information, messages, information about services on offer, address books etc.
- Besides the SIM, handsets also include peripheral memory cards like:
  - o Compact Flash
  - o Multimedia Card
  - o Secure Digital (SD) Card
- Handsets synchronize with a computer. Nowadays, computers include slots of various sizes to hold these memory cards.

### 8.2.2 The Printed Circuit Board or PCB

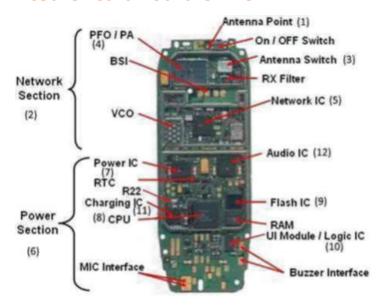


Fig. 8.2.2: The PCB of a mobile phone

#### The detailed location of various parts and sections of a mobile (refer Fig 2.2.2 for the labels below):

- Antenna Point (1) is the point where the antenna is connected.
- Network Section (2) is above the power section and just below the antenna point.
- Antenna Switch (3) is found in the network section.
- Power frequency oscillator (4)(PFO) is located adjacent to the antenna switch.
- Network IC or integrated chip (5) is adjacent to or below the antenna switch and PFO.
- Power Section (6) is below the Network Section.
- Power IC (7) is located in the Power Section and can be identified by the several capacitors (brown coloured) that are around it.
- CPU or central processing unit (8) is the largest IC located in the power section.
- Flash IC (9) is located adjacent to the CPU.
- Logic IC (10) is the IC with 20 legs.
- Charging IC (11) is the IC beside R22 in the Power Section.
- Audio IC (12) is the IC parallel to Power IC.
- SMD are electronic components (Resistor, Capacitor, Coil and Transformer) that are very compact and can be easily mounted on the PCB surface. As they save space, their use has led to significant reduction in the size of mobile phones.

#### How each section is connected and how do they get power, etc.:

- In all cell phones the Keyboard section is directly connected to the CPU.
- Display section is directly connected with the CPU to receive following signals LCD (liquid crystal display) data signal, LCD reset signal, LCD WR signal, LCD RD signal, LCD FLM signal, etc.
- SIM card section is directly connected with the CPU in most mobile cell phones.
- An 8-pin socket connects the Micro SD card to the micro card section
- MIC (microphone) interface section is directly connected with the CPU in most mobile phones.
- Ear speaker section is directly connected to the CPU.

- In most cell phones in order to obtain a loud sound, the ringer, buzzer or speaker are connected with the audio amplifier IC.
- The key backlight section contains the LED (light emitting diode) lights that are connected in parallel to get uniform voltage.
- LCD backlight section is made according to the series circuit.
- Vibrator motor section is connected to the battery positive terminal for power supply.
- The external antenna socket, antenna, RF IC, RX & TX Bandpass filter, RF Crystal FEM, PFO and the CPU comprise the Network Section.
- Battery Charging Section- It comprises of the charger and system interface connector. In most mobile phones these are integrated into the PCB itself.
- FM Radio Section- Comprises of the FM antenna, radio driver IC, signal and supply components.
- Bluetooth Section- Comprises of the antenna, RF signal filter, driver IC, supply and signal components for bluetooth frequencies.
- Power ON Section- Comprises of Flash IC, CPU, Power IC, RF-CLK, Crystal, RF-IF, etc.
- The earphone section includes hands-free MIC, speaker jack, speaker signal component and audio Amplifier.

### 8.2.3 Card Level Parts

- The front cover in the housing of a mobile phone is called the Front Fascia.
- The back cover in the housing of a mobile phone is called the Back Fascia.
- The internal skeleton of a mobile phone is called the Internal Fascia
- Ringer or loudspeaker plays loud sound and music in mobiles.

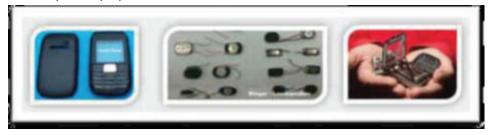


Fig. 8.2.3(i): Cover, ringer and skeleton of a mobile

- Speaker also called earpiece helps in hearing the sound from sender.
- Microphone is a transducer and converts a speaker's sound in a phone call to electrical signals that can then be transmitted.
- Vibrator creates vibration when vibration mode is activated in a cell.



Fig. 2.2.3(iii): LED, charging connector and earphone of a mobile

- Light Emitting Diode (LED) produces light in a mobile phone.
- Charging connector is mounted on the PCB and helps to connect the charger of a mobile phone to the battery in order to charge it.
- Headphone/earphone connector helps to connect, headphone to the mobile phone via jack.



- Data Cable Connector enables interconnecting the mobile to another device such as a computer and helps in interchange of stored data.
- A Battery is the source of DC supply to the mobile phone.
- A battery connector connects the battery to the internal wirings of a PCB of the cell phone.
- SIM Card or Subscriber Identification Module Card is a small rectangular chip with circuit and
- information of user of the card.
- SIM Card Connector holds the SIM card connecting it to the PCB of a mobile phone.
- Memory Card stores user data like documents, images, videos, music etc.
- The Memory Card (MC) Connector interconnects the PCB of a mobile phone to the memory card.
- Camera captures still images and also records videos.
- Camera Connector interconnects the PCB of the mobile phone and the camera.

## 8.2.4 The Big Parts & Functions

- Antenna Switch is found in the Network Section of a mobile phone. It searches network and passes forward after tuning.
- The power frequency oscillator (PFO) is found near the antenna switch. It filters and amplifies network frequency and selects the home network.51

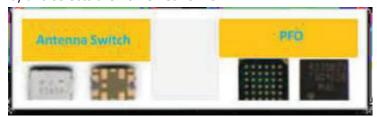


Fig. 8.2.4(i): Antenna switch and PFO of a mobile

- RF (radio frequency) IC / Network IC is found near the PFO and works as transmitter and receiver of audio and radio waves, as per instructions from the CPU.
- 26 MHz Crystal Oscillator is found near the PFO and creates frequency during outgoing calls.



Fig. 8.2.4(ii): Network IC and 26 MHz crystal oscillator of a mobile

- VCO (voltage-controlled oscillator) is found near the Network IC and sends time, date and voltage to the RF IC and the CPU.
- RX Filter is found in the Network Section of a mobile phone and filters frequency during incoming calls.

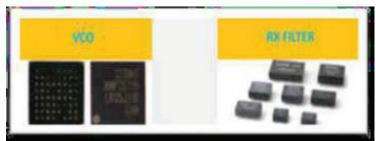


Fig. 8.2.4(iii): VCO and RX Filter of a mobile



Fig. 8.2.4(iv): TX filter, RAM, ROM and flash IC of a mobile

- TX Filter is found in the Network Section of a Mobile Phone and filters frequency during outgoing calls.
- ROM is found in the Power Section of a Mobile Phone and loads current operating program in a Mobile Phone.
- RAM is found in the Power Section of a Mobile Phone sends and receives commands of the operating program in a mobile phone.
- Flash IC is found in the Power Section of a Mobile Phone. Mobile phone software is installed in the Flash IC.
- Power IC, found in the Power Section, reduce the space requirement. It takes power from the battery and carries out power management as it supplies power to all sections of a cell phone.
- Charging IC is found in the Power Section near R22. It regulates charging of the battery when a charger is connected to a mobile phone.



Fig. 8.2.4(v): Power & charging IC, RTC, CPU and logic & audio IC of a mobile

- RTC (real time clock) is found in the Power Section near Power IC. It helps to run date and time in a mobile phone.
- CPU is found in the Power Section and controls all sections of a mobile phone.
- Logic IC / UI IC is found in any section of a mobile phone and controls the Ringer, Vibrator and LED.
- Audio IC is found in Power Section of a mobile phone and controls Speaker and Microphone of a mobile phone.

### 8.2.5 Small Parts & Functions

- Coils in a mobile phone:
  - o Coil is found in any section of a mobile phone filters & decreases Current, Voltage.
  - o Boost Coil is a little bigger than coil, its function is to increase current.
  - o Coupler is found in the Network Section of a Mobile Phone & filters network.

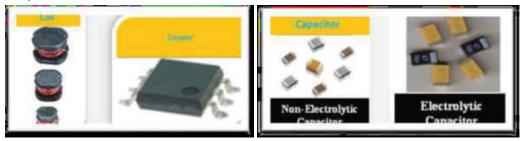


Fig. 8.2.5(i): Coil, coupler and capacitor of a mobile

- Capacitors in a mobile phone are of 3 types:
  - o Non-Electrolytic Capacitor is found in any section of a mobile phone and filters DC current.
  - o Electrolytic Capacitor is found in any section of a mobile phone & filters and stores current.
  - o Network Capacitor is found in any section of a mobile phone.
- Diodes in a mobile phone are of 4 types:
  - o Rectifier Diode is found in black color and converts AC Current to DC Current.
  - o LED is found in white or light-yellow color and emits light.
  - o Zener Diode is found in charging section and acts as voltage regulator.
  - o Photo Diode is used for Infrared.

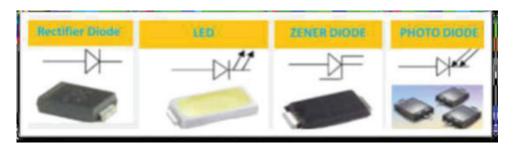


Fig. 8.2.5(ii): Various diodes and LED of a mobile

- Resistances on a mobile PCB are of 2 types:
  - o Chip Resistance is found in any section of a mobile phone. It decreases current & passes forward.
  - o Network Resistance can be found in any section of a mobile phone.



Fig. 8.2.5(iii): Resistor of a mobile

- Regulator component:
  - Regulator component is found in any section of a mobile phone. It filters current and regulates voltage.
  - o Transistor an electronic component is found in any section of a mobile phone and does the work of switching.

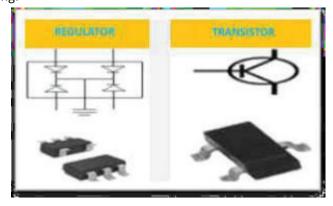


Fig. 8.2.5(iv): Regulator and transistor of a mobile

## 8.2.6 Electric Circuit and its Types

The path taken by the current as it flows consuming electricity is called an electric circuit. There are typically five types of electric circuits:

**Close circuit:** When the circuit loop is complete and load performs its function, the circuit is said to be a closed circuit.

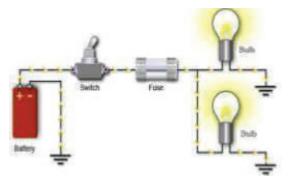


Fig. 8.2.6(i): A close circuit

**Open circuit:** When there is a break in the circuit either because it is switched OFF or a wire is broken or some other component is faulty and not allowing the current to flow, the circuit is called open circuit.

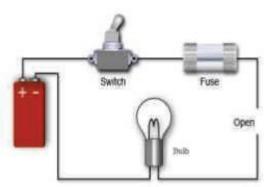


Fig. 8.2.6(ii): An open circuit

**Short Circuit:** When the two terminals of voltage source get interconnected without any load inbetween, a very large current flows and it is called short circuit.

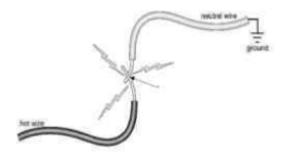


Fig. 8.2.6(iii): A short circuit

**Series Circuit:** When two or more loads are connected one after another in such a manner that the positive terminal of one device is connected to a negative terminal of another device, it is called a series connection.

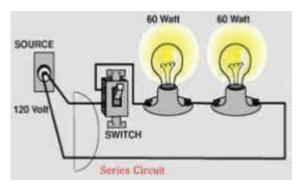


Fig. 8.2.6(iv): A series circuit

**Parallel Circuit:** When two or more loads are interconnected in such a manner that one common terminal of all the loads is connected to one terminal (Positive or negative) of the input supply and the other end of the load to the other terminal of the input supply, the circuit is called parallel circuit.

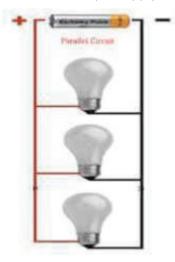


Fig. 8.2.6(v): A parallel circuit

## 8.2.7 SMD (Surface Mounted Device) Resistor

**Resistance** is the obstruction to the flow of electric current in any material. Unit of resistance is Ohm and its power rating Watt. Fig 2.1.7 shows a few SMD resistors.

- Importance things to remember:
  - o A resistor can never get shorted.
  - o Resistor can get open, that is have a break thus preventing any current flow.
  - o Value of resistor can vary from a few ohms to a very high figure.
  - o Resistor may or may not come with a code (mostly without code in mobile phones).



Fig. 8.2.7(i): SMD resistors

#### **Resistor Rating**

Resistances rating are marked and interpreted in the following manner:

- < 1000 ohms or 1K with an "R" indicates a decimal point "'":
  - $o 5'6 = 5.6\Omega$
  - o 8'8 = 8.8Ω
- It is also rated and interpreted in the following manner:
  - o  $200\Omega = 200 \text{ ohms}$
  - o  $320\Omega = 300 \text{ ohms}$
  - o 4.7K = 4.7 kilo ohms
- Resistors have a three-digit code marked, the first two represent two significant digits and the third digit represents power of 10, e.g.:
  - o  $564 = 56 \times 10,000 \Omega = 560 k\Omega$
  - o  $422 = 42 \times 100 \Omega = 4.2 \text{ k}\Omega$
  - o  $473 = 47 \times 1,000 \Omega = 47 kΩ$
  - $\circ$  205 = 20 × 100,000  $\Omega$  = 2 M $\Omega$
- "000" and "0000" are sometimes marked on surface-mount zero-ohm links, to signify that they have (approximately) zero resistance
- Resistances less than 100 ohms are written: 100, 220, 470. The final zero represents ten to the power zero, which is, e.g.:
  - o  $200 = 10 \times 1 \Omega = 10 \Omega$
  - o  $320 = 22 \times 1 \Omega = 22 \Omega$
- Resistances < 10 ohms use the symbol 'R' to indicate decimal point's position, e.g.:</li>
  - o  $5'6 = 5.6 \Omega$
  - $0'32 = 0.32 \Omega$
  - o  $0'01 = 0.01 \Omega$
- Precision resistors use a four-digit code, with the first three digits representing significant digits and fourth is the power of 10, e.g.:
  - o  $2001 = 200 \times 10 \text{ ohms} = 1 \text{ k}\Omega$
  - o  $3992 = 399 \times 100 \text{ ohms} = 39.9 \text{ k}\Omega$
  - o  $4000 = 400 \times 1 \text{ ohm} = 400 \Omega$

## 8.2.8 SMD Capacitor

A **capacitor** is a passive electronic device used to store electrical energy (charge). It is made up of two conductors separated by an insulator. Air, paper, mica and electrolyte capacitors are the most commonly used SMD capacitors. Fig 2.1.8 shows a capacitor.

- Its main function is to store the electrical energy and re-supply.
- Unit of 'Capacitor' is Farad.
- They are polarised and non-polarised type.

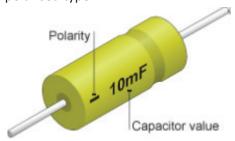


Fig. 8.2.8: An axially (on its side) mounted capacitor

- Polarised capacitors are used in DC circuits with following characteristics:
  - o Values range from 0.1uF to 470uF.
  - o They are used to smoothen large voltage variations, such as in DC line filtering to reduce the ripple (voltage variation) seen after rectification from AC source to DC.
  - o Commonly capacity is measured in microfarads. Connecting with correct Polarity, that is + & marking of plates is essential for correct functioning.
  - o Both, capacity (farad marking) and max voltage rating (usually double the circuit voltage used), is specified on a capacitor body.
- Non-Polarised capacitors are used in DC circuits with following characteristics:
  - o Similar metal conductor plates (Unlike in polarised caps) are used in Non-polarised caps.
  - o Typically used in AC and DC circuits where low voltages exist.
  - o Polarity of the plates is not critical in their functioning.
  - Typically, capacity is in pico farads (10 -9 farad)

## **8.2.9 Integrated Circuit or IC**

- An IC is an electronic component made up of combination of several other electronic components like resistor, capacitor, transistor etc. It is mainly of two types:
  - o Leg-Type IC: This type of IC has legs or pins.
  - o Ball-Type IC: This type of IC has BGA (Ball Grid Array) underneath the IC.
  - o Counting of leg-type IC starts in numerical digit in anticlockwise direction starting from the Nose Point or Cut Point

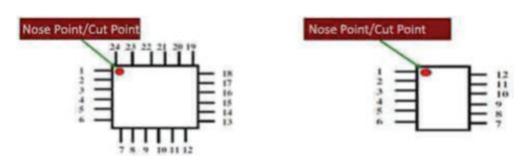


Fig. 8.2.9(i): Counting of Leg-type IC

- Counting of Ball-type IC is done in both clockwise and anti-clockwise direction as shown in Fig 8.1.9(ii). 'ows are counted in digits (1, 2, 3,...) clockwise and columns in alphabet (A, B, C, D...) anticlockwise.
- When counting Columns, "I" and "O" are omitted because they look like "1" and "0".

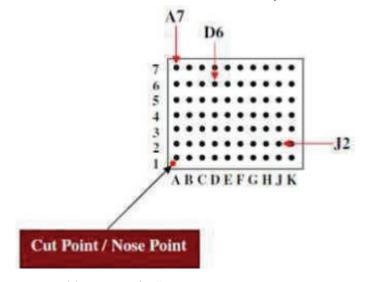


Fig. 8.2.9(ii): Counting of Ball-type IC62

## **8.2.10** Filters

Filters are analog circuits that can reject unwanted signal frequency componebts, allow wanted frequencies to pass through and also, in some cases, enhance them. Mobile handsets normally use four types of filters:

- **Low-Pass Filter** allows all frequencies below a threshold to pass through. All frequencies above this threshold are stopped or rejected.
- **High-Pass Filter** is opposite of a low pass filter. It allows all frequencies above a threshold to pass through while stopping or rejecting all frequencies below it.

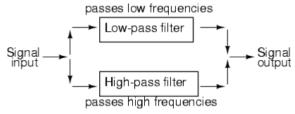


Fig. 8.2.10(i): A representation of low- and high-pass filters

- Band-Pass-Filter allows only a designed frequency band to pass through. Frequencies above or below this band are stopped or rejected by the filter.
- **Band-Stop Filter** is opposite of a Band-Pass Filter. It stops or rejects a designed frequency band to pass through but allows all other higher or lower frequencies to pass through.

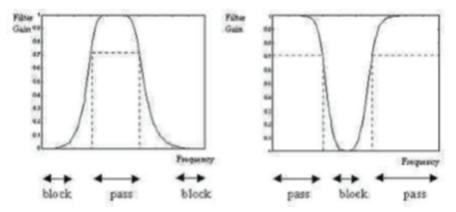


Fig. 8.2.10(ii): A representation of band-pass and -stop filters

## -8.2.11 Identifying Circuit Symbols

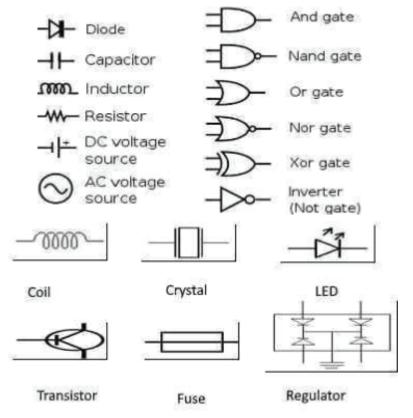


Fig. 8.2.11: Common circuit symbols

## 8.2.12 Electric Power and Earthing

**Electric Power** is the capacity to do work. It is the rate of transfer of electrical energy in a circuit. It is the product of voltage (in volts) and current (measured in amperes). The unit of measure of power is Watts (W). In other words, Power is given by

$$P = V * I$$

Three-pin plugs as shown in Fig 2.1.13 are used in electrical appliances such as computers, mobile phones, and AC. Two pins are used for phase (Red wire) and neutral (Black wire), the third pin (middle top centre - green wire) is used for earthing. Earthing pin is used to protect the operator, as also the connected device, as it sends any leakage current into the earth.

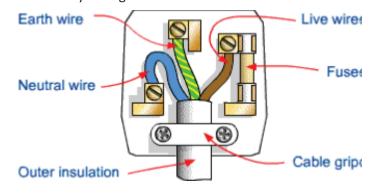


Fig. 8.2.12: Inside a typical 3-pin plug

# 8.2.13 Diode-Function, Symbol, Denoting letter, Identification of Solid Transistor-Basics, Types, Symbol, PNP and NPN

Diode:



A polarised device having two terminals, a diode is represented by the letter D. One terminal of a diode is positive (anode), and the other is negative (cathode). An anode is the base of a triangle, while the closed side is its cathode.

A horizontal isosceles triangle pressed up against a line connecting two terminals forms the shape of a diode. The diode operates in the forward bias situation, or we may say that the diode will permit current flow in this circumstance. It is crucial to remember that the diode's positive terminal (anode) connects to the positive pole of the battery and its negative terminal (cathode) connects to the negative terminal.

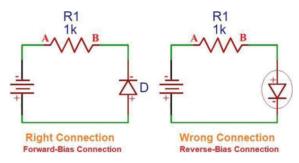


Fig. 8.2.13(ii) Diode Connections

Other diodes with more detailed characteristics and features are described below. Check the functioning of several diodes here as well.

#### **Light Emitting Diode (LED):**



Fig. 8.2.13(iii) Light Emitting Diode

Light-emitting diode is what it stands for. With more arrows, the LED symbol resembles the diode symbol. These arrows appear to radiate out from the triangle and point in the opposite direction. Anode and cathode connections are found on polarised components like LEDs.

#### **Photodiode:**

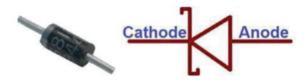


Fig. 8.2.13(iv) Photodiode

In contrast to the LED Symbol, the photodiode's symbol features arrows striking the diode. Photons, or light, are represented by arrows that hit the diode. Anode and cathode are the names of the two terminals on the photodiode. Light is converted into electrical current using a photodiode.

#### **Zener Diode:**

It functions similarly to a standard forward diode and, when the applied voltage reaches the breakdown voltage, also permits reverse current. When a specific voltage is attained, the diode's unique, severely doped P-N junction is programmed to work in the other manner.



As a result, electrons are unable to get across the Schottky barrier. An electron on the N side is given additional energy to pass the barrier and enter the metal under the forward biassed situation. Consequently, the diode is referred to as a hot carrier diode. The electrons are also referred to as hot charge carriers as a result.

#### Types of Diode in Mobile Phone and their Function:

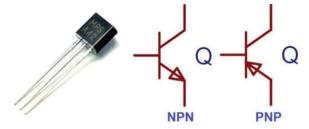
- 1. Signal Diode: This kind of diode is utilized for signal detection. Glass is used to create these diodes. The cathode of the terminal is indicated by a red ring. The following numbers for these diodes are available: IN4 148, IN34, OA79, etc. SMD signal diodes are also offered in black.
- **2. Zener Diode:** This particular silicon-based diode is utilized to maintain the stability of the output supply. In order to stabilize voltage, Zener diodes are utilized. "Z" is used to signify it. Zener diode is recognized by its "Zener Volt" like 3.0VZ, 3.9VZ, 5.1VZ, 6.2VZ etc.
- **3. Varacter Diode:** This diode has a changeable capacitance and works similarly to a variable capacitor. These diodes operate within a specific capacity range. Varactor diodes come in capacitance ranges of 1 to 500 pf and 10 to 100 V. These are employed in the circuits for transmitting signals.
- **4. Tunnel Diode:** These diodes are employed for switching at microwave frequency levels and for processing the characteristics of negative resistance.

## **LED or Light Emitting Diode:**

These are diodes that after getting forward biasing start to emit light. They are utilized in mobile phones to illuminate the display or keypad.

**Transistors:** Different transistors, such as BJTs or MOSFETs, are available in schematics. The transistor is a three terminal electronic component that switches or amplifies electrical power and electronic impulses.

**Bipolar Junction Transistor (BJT):** A BJT is a bipolar transistor with emitter (E), base (B), and collector connections (C). The emitter and collector are lined up for the BJT symbol, while the base is positioned vertically. There are two types of BJTs: NPN and PNP.



In the BJT symbol, the emitter has an arrow and the arrow's direction tells whether it's a PNP or NPN transistor. If the arrow points inward, it is a PNP, and if the arrow points outward, it is an NPN. To remember the configuration you can learn it like this- "NPN: Not Pointing In" MOSFET: Metal Oxide Field Effect Transistor (MOSFET) terminals have three terminals: Source (S), Drain (D), and Gate (G). There are two different MOSFET symbol types: n-channel and p-channel MOSFET. Learn more about the many MOSFET kinds available here.

Just like BJT, in MOSFET, the direction of the arrow is used to distinguish between n-channel and pchannel MOSFET. If the arrow at the center of the symbol is pointing IN, it is an n-channel MOSFET and if the arrow is pointing OUT, it is a p-channel MOSFET.

You can remember the configuration like this. "n is  $\ensuremath{\mathsf{IN}}$ "

## **UNIT 8.3: Resetting a Phone**

# - Unit Objectives



## By the end of this unit, the participants will be able to:

- 1. Recall and demonstrate steps to reset a phone to its original factory settings
- 2. Recall and demonstrate steps to download apps and set-up email accounts on a handset

## 8.3.1 The Need to Reset a Mobile Phone

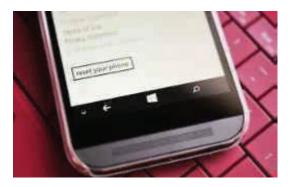


Fig. 8.3.1 Sometimes resetting a phone is the only option

- You may need to reset cell phone to correct malfunctions e.g., freezing, slowness, etc., to restore the phone to its original state.
- Steps for resetting a mobile will vary based on the make and model of the mobile.
- All personal data will invariably be removed if a mobile is reset.
- It will restore the phone back to its original factory settings.

## 8.3.2 Steps: How to Reset Phones?

#### 1. Apple iPhone

- **Step 1:** At the home screen tap on "settings".
- **Step 2:** Tap "General Settings" from the list of options.
- **Step 3:** Tap on "Reset". Your iPhone will take several minutes to restore depending on the memory capacity of your device.

#### 2. Android Phone

- **Step 1:** Select "Settings" from your application menu.
- **Step 2:** Access the option for "Factory Data Reset" based on the make & model of your Android device, this option will be located in either the folder labelled "Privacy" or ""D & Phone "Storage".
- Step 3: "Select "'Reset Phone".
- **Step 4:** Select "Erase Everything" when shown the warning that a reset will erase all personal data from your device.

#### 3. Blackberry Phone

- **Step 1:** Select "Options" from your Blackberry's main menu.
- Step 2: Select the icon labelled "Security" or "Security Options".
- Step 3: Choose either "Wipe Handheld" or "Security Wipe" from the options provided.
- **Step 4:** Select the appropriate option to confirm the reset process; Enter "blackberry" when prompted for reset password.

#### 4. Windows iPhone

- **Step 1:** Access "Settings" from the Start menu or programs list of your Windows mobile device.
- **Step 2:** Select "Clear Storage" or "Hard Reset" from the options provided. On some Windows mobile phones, you may need to access these options from the "System" folder.
- **Step 3:** Type "1234" when prompted to enter a password for the reset.
- **Step 4:** Answer "Yes" when prompted to confirm that you want to reset your Windows mobile cell phone.

#### 5. LG Phone

- Step 1: Remove the SIM card from the mobile.
- Step 2: Type 2945#\*#.
- Step 3: "elect the "'E"ET" option.

#### 6. Motorola Phone

- **Step 1:** Remove the SIM card from the mobile.
- **Step 2:** Type \*#\*\*367628# and call.
- Step 3: After one minute type \*#\*\*778337#.

## 7. Nokia Phone

- **Step 1:** For soft formatting type \*#7370# followed by 12345.
- Step 2: For hard formatting type \*#7780# followed by 12345.

## 8.3.3 Steps: How to Install Apps?

A phone reset takes a mobile handset to its original settings with a fixed set of apps. All user apps and email accounts are to be set up again.

## Installing mobile Apps on popular platforms-

#### 1. Android

- Step 1: On the Home screen tap the Play Store (also Android Market or Google Play).
- **Step 2:** If this is the first time then you'll be asked to accept the terms of service.
- **Step 3:** Type Mobile APP's name in the search above. A list pops up as you write. Select the one you want and tap Install.

**Step 4:** Tap on the desired APP's icon in your App list. Log in with your details.

#### 2. Blackberry

- Step 1: Scroll to BlackBerry App World and click.
- Step 2: Tap on the search Icon and type in mobile App's name.
- **Step 3:** Select the desired App from the list below.
- Step 4: Tap Download. Provide the Blackberry ID and password once prompted.
- Step 5: Tap Ok.
- **Step 6:** Tap on the desired icon in your App list. Log in with your details.

#### 3. iPhone

- **Step 1:** Make sure you've an Apple ID before the installation.
- Step 2: Tap App Store.
- **Step 3:** Tap Search and type in mobile App's name.
- **Step 4:** Tap App's name. Tap Free. Tap Install. You may be prompted to put in the password for your Apple ID.
- **Step 5:** Tap on the desired icon in your App list. Log in with your details.

#### 4. Windows Mobile

- **Step 1:** Scroll the Home screen to go to the second screen.
- Step 2: Tap on Store.
- **Step 3:** Tap on the search icon and type Mobile APP's name in the search bar.
- **Step 4:** Select the one you want and tap Install.
- **Step 5:** Tap Allow to give the application access to location.
- Step 6: Tap on desired icon in your App list. Log in with your details.

## 8.3.4 Steps: How to Set-up Emails?

#### 1. On Android Phones

- Step 1: Tap Email.
- Step 2: Tap Add account.
- Step 3: Type your email and password.
- **Step 4:** Select the account type.
- **Step 5:** Type your full email address in the Username field, related password in the Password field, for POP3 type in pop.<your domain>.com into the POP3 server field and for IMAP type in imap.<your domain>.com into the IMAP server field.
- **Step 6:** Type smtp.<your domain>.com in the SMTP Server field, check 'Require sign-in' box, fill in your full email address in the Username field and password, in the Password field.
- **Step 7:** Select the email checking frequency settings.

- **Step 8:** Check 'Send email from this account by default' if you want to use this email account as default for sending emails.
- Step 9: Fill in a name for the email account and your name that will appear on outgoing emails.

#### 2. On Blackberry

- **Step 1:** Go to Home menu and select setup.
- **Step 2:** Select email settings.
- **Step 3:** Enter your Blackberry Service username and password as provided by your mobile network provider.
- **Step 4:** Enter your Blackberry Service username and password as provided by your mobile network provider.
- Step 5: "elect 'Add My Existing Email Account'.
- **Step 6:** Select your mail service provider and type in your relevant account details, select Other to set up the email manually.

#### 3. On iPhone

- Step 1: Tap Settings.
- Step 2: Scroll down and tap Mail, Contacts, Calendars.
- Step 3: Tap Add Account.
- **Step 4:** Select your Email provider. If not present then select 'Other'. Follow the instructions and provide the necessary information to configure your Email account.

## 4. On Windows Phones

- Step 1: In the App List tap settings.
- **Step 2:** Tap Email + accounts.
- Step 3: Tap Add an account.
- **Step 4:** Select your Email provider. If not present then select 'Other Account'. Follow instruction and provide the necessary information to configure your Email account. If you are adding an account manually then select 'Advanced setup'.
- **Step 5:** Enter your email address and password.
- Step 6: Tap Internet email.

#### 5. Do the following in case you are unable to send/receive mails:

- Step 1: Verify if the Phone is connected to a data or Wi-Fi network using the mobile browser.
- **Step 2:** If network present then verify the email address and password again. You may need to reenter the password if it was changed recently.
- **Step 3:** Check mail account server settings if Step 2 fails.
- **Step 4:** If nothing works then delete the mail account and set it up again.

## **UNIT 8.4: Fixing the Firmware Participant**

## - Unit Objectives



## By the end of this unit, the participants will be able to:

- 1. Outline and explain the role of firmware in a handset
- 2. Recall and demonstrate steps to install a new firmware

## 8.4.1 Understanding Firmware and How to Fix it

**Firmware** is a software that controls individual parts of the phone. Each mobile phones has a unique firmware version and a specific software is used to access it. Sometimes the mobile phone does not power on, hangs frequently, or keep restarting. In such cases the phone's Firmware could have been damaged and needs to be installed.

Flashing or installing a new firmware to a cell phone flash memory requires the following:

- A computer to run the software program, with a USB port.
- A flashing device that synchronizes mobile phone and computer.
- Flashing software.
- A USB cable, a flashing cable, which connects a mobile phone to the flashing device that also connects to the computer.
- Flash files and firmware collection. Programmed data used in phones.

## 8.4.2 Steps: How to Flash a Mobile Phone?



Fig. 8.4.2: Flashing a mobile phone

**Step 1:** Search and download the flashing program for your phone onto your computer.

**Step 2:** Unzip the files and read the instructions carefully, make sure your phone is updated and has all the latest drivers.

**Step 3:** Be ready with answers about your original carrier, what you're flashing to, and your phone's make and model. The software will also prompt you to choose between a "half flash" and a "full flash." A "half flash" is just talk and text.

- **Step 4:** Know your MEID (mobile equipment identifier) and ESN (electronic serial number). This information can be found underneath your phone's battery. The program you are using to flash can also give you all this information. The MEID will be 18 digits (starting with 2) if it is MEID Dec or 15 numbers and letters if it is MEID Hex. The ESN will be 8 numbers long and possibly labelled PESN.
- **Step 5:** Detect your phone using the software. It will determine the COM port for you. In case there is a problem, you can manually find the port through Device Manager.
- **Step 6:** Select "write" and confirm. On selecting "yes", phone will get flashed and automatically reboot when successful.

## **UNIT 8.5: Hardware Repair Tools**

# **Unit Objectives**



## By the end of this unit, the participants will be able to:

1. Identify and make use of common mobile handsets repair tool

## **8.5.1 List of Common Repair Tools**

## Following are the popular repair tools:

- Soldering Iron, Soldering Station, Solder Wire.
- PCB Cleaner, Jumper Wire, Blade Cutter, Point Cutter, Nose Cutter.
- Precision screwdriver, Tweezers, Brush, Multi-meter, Battery Booster, Ultrasonic Cleaner.
- Magnifying Lamp, Mobile Opener, DC Power Supply, Liquid Flux & Paste Flux, Solder Paste.
- Cleaning Sponge, De-soldering Wire, Screwdriver Kit, LCD Tester, Microscope, Test JIG Box.
- Wrist Strap, antistatic Hand Gloves, Antistatic Mat & Apron, Smoke Absorber, Battery tester.

## 8.5.2 Soldering Iron

A soldering iron is used to fix passive components like resistor, capacitor as also active components like diode, transistor, microphone, speaker, regulator, speaker, display, etc. to the PCB. For most mobile phone repairs a 50 watt soldering iron is adequate.

## 8.5.3 Use of lead-free soldering tools

The power of Soldering Stations is always sufficient to melt through thick solder layers. Do not allow your patience to be melted by a subpar soldering station. Lead-free, infrared, and hot air gun soldering stations are the three different types of soldering stations.

When purchasing a soldering station, additional factors to take into account include digital or analogue, wattage rating, variable temperature, replaceable Soldering Iron Tip, and accessories. Lead-Free Soldering Stations:



Lead's detrimental health effects, such as anaemia, weakness, kidney, and brain damage, have sparked a movement in the electronic industry to develop lead-free solders.

Lead-free solder may not melt at a high enough temperature in standard leaded machines, or if it does, the tips will frequently burn out soon.

The soldering iron head's temperature can climb in just two seconds thanks to the single-chip microcomputer control system. The C210 Iron Handle will be in a sleeping mode while it is positioned on its holder, which can increase the heating element's lifespan.

The temperature of each of the three memory channels—CH1, CH2, and CH3—can be independently controlled for both storage and recall.

#### **Infrared Soldering Stations:**

By directing the laser directly at the component, you may heat the component rather than the joint. Additionally, since the laser doesn't blow components around like a hot air soldering machine can, there is less possibility of incorrect soldering.



A speedier method, both in setup and heating, an infrared station uses a laser to heat the joint. Therefore, infrared stations are typically more expensive.

**Hot Air Gun Soldering Station:** Similar to infrared soldering stations, hot air soldering stations function by having the user pour a soldering mixture between the junction and then heating it to form a connection.



#### **Soldering**

Soldering is a process of permanently joining two or more metals (generally wires) by melting a relatively lower melting point filler metal into the joint of the two metals. The filler metal on cooling makes the joint permanent.

**Step 1:** Ensure the tip of the soldering iron tip is absolutely clean. If it is not shining clean, melt solder on the solder tip and wipe it clean using a damp cloth or sponge till it starts shining.

**Step 2:** Heat the connector pins and the circuit board trace evenly for a few seconds ensuring that the soldering iron tip touches them together.

**Step 3:** Get the solder wire to touch the heated connection quickly in order to melt it and let it flow onto the joint. The solder wire should not directly touch the soldering iron.

**Step 4:** Let the connection cool, blowing on it if faster cooling is desired.

**Step 5:** Excess flux or residue at the joint soldered should be removed using a solvent and a non-metallic brush.

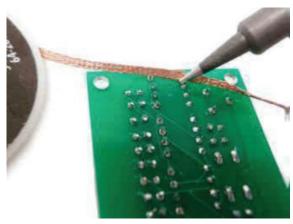
#### **Desold**

Desoldering is the opposite of soldering. It involves removing of the solder so as to remove the components from a printed circuit board for troubleshooting or replacement. It is done in the following steps:

**Step 1:** Clean the soldering iron as in case of soldering. Now heat it for a few seconds and then touch the joint to be de-soldered until the solder melts.

**Step 2:** Use a solder pump or a wick (finely braided copper) to remove the excess solder from the joint on the PCB

**Note:** Ensure only the joint to be de-soldered on the solder side of the PCB is touched and the component side of the PCB does not come in contact with the soldering iron.



## 8.5.4 Access, Cutting and Cleaning Tools

A PCB (Printed Circuit Board) Holder as shown in Fig is used to hold the PCB of a mobile phone while soldering or repairing.

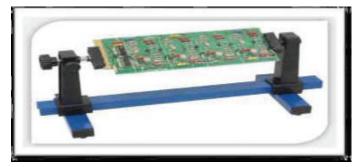
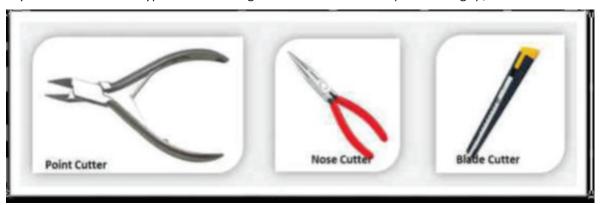


Fig.: PCB holder

Blade Cutter is mostly used to expose the wire by removing the insulation from a jumper wire (refer Fig 2.5.5(ii)). Point Cutter (refer Fig 2.5.5(ii)) and a Nose Cutter (refer Fig 2.5.5(ii)) are used to cut a wire. They can be of different types and are designed to access awkward places and grip, bend or turn wires.



## 8.5.5 Multimeter

Multimeter is a combination of a voltmeter, ammeter and an ohm-meter. It can measure voltage, current and resistance by changing a switch. Various parts and components of a cell phone are checked using a multimeter. All multimeters have two wires called probes as shown in Fig 2.2.4. The red probe is positive (+), while the black probe is negative (-), a standard convention in electronics

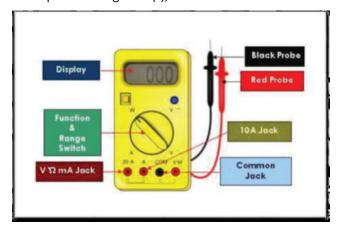


Fig.: A typical multimeter

- Following precautions must be taken while measuring multimeter:
- If the multimeter is showing faulty readings check the battery, probes and the fuse.
- Voltage is always measured between two points of a circuit. To obtain an accurate reading, ensure the multimeter is properly connected across two points in a circuit.
- While measuring voltage ensure you do not touch the probe tips together as this will result in a short-circuit.
- The resistance (impedance) of a circuit changes when energized. Therefore, for Continuity testing (or finding circuit resistance) with a multimeter ensure the circuit is NOT energized.

#### In case the phone is not powering on or the battery drains quickly.

**Step 1:** Remove the battery of the cell phone after ensuring it is switched off.

**Step 2:** Note the battery voltage as given in its label. Generally, cell phone and tablet batteries are of 3.7V or 3.8V.

**Step 3:** Place the battery in such a way that the terminals are easily accessible to you.

**Step 4:** Set the multimeter to read DC Volts. The switch position would point to DCV or just V with a straight line and 3 dots below it. Depending on the range, there will be settings varying from few mV (milli Volts) to 1000 V. The multimeter switch setting should be on a number that is above the battery voltage noted by you in Step 1. Mostly, setting of 10V or 20V is adequate.

**Step 5:** Place the red probe tip on the positive (+) terminal of the battery and black probe tip on the negative (-) terminal as shown in Fig 2.2.4.1.

**Step 6:** Keep the probes firmly pressed on both the terminals till the reading on the multimeter display is stable. The following can be inferred from the voltage reading for a battery of 3.7V: -

- Reading 3.7V or more Battery Fully Charged
- Reading OV or < 3.7V Battery to be Charged

If there is no change in the voltage reading even after charging for a long time, then the battery is dead and needs to be replaced with a new one. Batteries cannot be repaired.

#### **Measuring DC Current**

Step 1: Place BLACK probe in the COM (common) plug and RED (+) probe in mÃ/Ã plug.

**Step 2:** Set the rotary selector switch for reading current in DCA range.

**Step 3:** De-energize the circuit by switching OFF the power supply.

**Step 4:** Connect the probe tips of the multimeter with the circuit in series (Red to positive and Black to negative of the circuit.

**Step 5:** Switch ON the power supply and read the display for the ampere value.

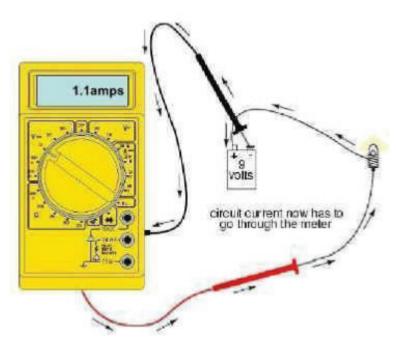


Fig.: Measuring current with multimeter

## **Check Shorting problems**

#### In case of a dead mobile phone.

**Step 1:** Set the multimeter rotary switch on continuity (also called diode setting).

**Step 2:** Place the PCB in such a way that the battery connector is easily accessible. The positive terminal will have a (+) mark called vBat (Battery Voltage) pin. The negative terminal will have (-) mark called GND (Ground) pin. Correctly identify the battery connectors.

**Step 3:** Place the red (+) and Black (-) probe of the multimeter on the vBat and GND pins of the battery connector firmly.

**Step 4:** If there is a continuous beep sound that is heard or there is some reading in the multimeter, then the motherboard (i.e., the mobile phone) is short. Otherwise, in the absence of either of these i.e., no multimeter reading nor a continuous beep sound, the board is not short.

**Note:** In case of an analog multimeter, short can be identified by measuring the resistance. The rotary selector switch should be set to ohms (x10) position. If the needle moves even slightly then the motherboard (or cell phone) is short.



# 8.5.6 Concepts of Embedded Multimedia Card (EMMC) chip off, Re-balling and Soldering Handheld Devices (Handset & Tablet) Technician

Embedded Multimedia Card, sometimes known as eMMC, is a type of flash memory used by mobile applications.

Flash memory is almost often used to store content in embedded applications such as digital cameras, smartphones, and tablets nowadays.

The non-volatile storage found in smartphones, tablets, and mini PCs is called eMMC. Usually, it might be 8 GB, 16 GB, 32 GB, or even 64 GB.

It typically resides in a tiny integrated circuit that is directly soldered to the motherboards of the devices.

This memory houses the operating system, any downloaded apps, settings, and data including contacts, text messages, pictures, music, and videos, among other things. Although many phones allow you to install a micro-SD card, some phones may also allow you to store some apps on this card in addition to music, photographs, and videos.

Additionally, the phone will feature volatile memory (RAM), which is used to store temporary data that will be lost when the phone is turned off.

The emmc chip at least found in a samsung is a 14 by 14 pins which only about 1/3 of it's pins are critical, the respite are dummy and do not worry if they eventually get removed, while removing the chip or cleaning the board after desoldering prior installing the new chip.

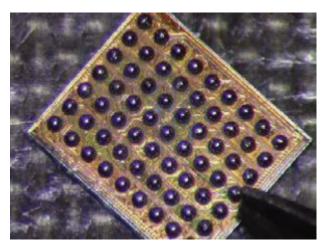
Some tips on reworking:

- Always cover important glued components, such as the baseband processor, which is typically XGOLD found in Samsung and the CPU + POP (package on package) RAM.
- Before attempting to remove the chip glue, clean the area around it by heating it to about 250C and using a needle to scrape the adhesive.

To avoid further harm to the motherboard's built-in tracks, do not remove the real chip at temperatures above 350C.

#### The BGA Reballing Procedure and Supplies:

Reballing requires a number of tools, as well as significant knowledge and technical skill, which is why BGA reballing is typically done by professionals. However, BGA rework equipment and kits are offered for sale on the market.



You will need a soldering iron to reball a BGA. A hand-held tool called a soldering iron is created specifically for soldering projects. The solder metal will get heat in order to melt and improve flow into the damaged junctions between the electronic component and the PCB. Each soldering iron is made with a properly insulated handle and a metal tip that has been heated to the proper temperature.

Soldering paste or wire will also be needed and is used to affix circuit board pads to surface mounted components. It is frequently used by manufacturers in order to manufacture various printed circuit boards and is very useful for attaching solder balls or electronic components onto the mounting area.

Desoldering wire, which can be used to desolder or solder wick, is also necessary. It is available on the market in roll form and is typically braided with copper wire that is 18 to 42 AWG and is insulated with leading-edge rosin flux. By soaking the metal solder in the desoldering wire, the solder is intended to be removed from the joint.

Reballed chips will also need a holding stand, which you can get on the market for a reasonable price in a BGA chip container. A chip stencil, which is essentially a metal sheet with several holes so that solder balls may be inserted, is also necessary. Made with very high-quality steel, it can be heated either with the BGA machine itself or a hot air gun if desired. Regardless of which option you go with, the end result is that the ball soldering process will be both quick and easy.

Solder balls will also be needed, and consist of small balls of solder that are strewn about the SMT board surface in an arbitrary manner. The purpose of solder balls is to provide a point of contact between the multichip modules and the stacked packages, as well as between the PCB and the chip package.

Finally, a top-of-the-line BGA reworking machine that can produce a lot of heat will be required to complete the BGA reballing operation. Additionally, it can be applied to attach or remove BGA chips.

## **UNIT 8.6: Basic Troubleshooting**

## - Unit Objectives



## By the end of this unit, the participants will be able to:

- 1. Open up or disassemble a mobile phone using the common hardware repair tools
- 2. Identify and troubleshoot common handset problems
- 3. Identify and troubleshoot common software related issues in phones
- 4. Create back up data from the handset

## 8.6.1 Disassembling a Mobile Phone

The process of taking a cell phone apart is basically the same but can vary slightly depending on the type and model of phone that you have.

Tools required

- 1. A mobile opener
- 2. A screwdriver



Fig. 8.6.1: Tools required to dismantle a mobile phone

#### Disassemble a phone

**Step 1:** Using a mobile opener, first remove the back cover of the mobile. Thereafter remove the exposed battery, SIM card and the memory card. Remove the Screws (circled in the figure) next.

**Step 2:** Pull off the battery compartment. The camera and volume buttons will also loosen and the circled screws can now be removed.

**Step 3:** The lock (left circle) button and volume (right circle) button micro switches should be peeled away carefully from the phone side ensuring they remain attached to the circuit board.

**Step 4:** The exposed circuit board should now be pulled towards yourself making the ribbon connector (circled in figure below) visible. To make the circuit board free unplug the ribbon connector by levering it upwards, away from the mobile.

- **Step 5:** The three ribbons circled in green and red in the figure below are to be detached. The red circled ribbons can be levered up to be unplugged. The green circled part is attached by a double sided tape to the phone housing on one side and the circuit board on the other. To release carefully lever it up.
- **Step 6:** The circuit board is now lifted away from the phone and removed. At this stage another ribbon connector, circled in green on the figure below, will be disconnected. Now unscrew the blue circled screw in the figure. Remove the antenna by prying along the dotted line in the figure. Another connector (red circle in figure) is then removed by levering it upwards.
- **Step 7:** The identification sticker is now to be peeled off carefully. To release the keypad on the other side, push a screwdriver into the points circled in the figure below.
- **Step 8:** Another ribbon connector circled below gets exposed. To remove this connector flick the black latch up in a direction opposite to the side of the socket into which the ribbon enters. The ribbon will now be loose. To separate the cover from the black metal plate (shown by dotted line in the below figure) pull the front cover along the direction of the arrows.
- **Step 9:** Carefully peel the identification sticker off and push your screwdriver into the circled points. This will release the keypad on the other side.
- **Step 10:** The connector circled below connects in a slightly different way. Just flick the black latch up, opposite to the side the ribbon enters its socket. The ribbon will now be loose. Now pull the front cover in the direction shown by the arrows so that the front cover separates from the black metal plate, indicated by the dotted line.
- **Step 11:** Now release the LCD screen by sliding a mobile opener tool under it. Remove the LCD screen therafter.

## **8.6.2 Steps: Solution to Battery Related Problems**

In case of battery complaints of it not charging, low back up time, fast draining or low battery the following steps can be tried: -

- **Step 1:** Check the charger plug point and the battery connector for any fault.
- **Step 2:** Check for corrosion in the battery connector, any broken pin and dust particles. All these points should be cleaned using cleaning swabs.
- **Step 3:** Check the interface connector for any dust and clean it if dust exists. Replacement of the the interface connector can also be done.
- **Step 4:** If the problem persists, upgrade to the latest version the system software and the operating system.
- **Step 5:** If the above steps do not solve the problem then check the current being consumed by the phone.
- **Step 6:** Check for any short-circuit.
- **Step 7:** If there is a board level problem, it is desirable to replace the complete logic-board.

## **8.6.3 Steps: Solution to Network Not Working**

For signal related problems in a mobile like weak signal, signal present intermittently or no network the following steps can be tried: -

- **Step 1:** Search for the network manually. If the 'no network' indication continues, then there the antenna switch is faulty and needs to be repaired or replaced.
- **Step 2:** After the manual searc, if the network is visible but the home network is not getting selected, then the PFO has gone faulty and needs to be repaired or changed.
- **Step 3:** If the problem pertains to network disconnection when a phone call is in progress, the the network IC is faulty and should be repaired or changed.
- Step 4: Clean the antenna tips and point.
- Step 5: Change the 26MHz crystal oscillator if the problem has not yet been addressed.
- **Step 6:** Change the antenna switch thereafter. If the antenna switch is not available carry out jumpering.
- **Step 7:** If the problem persists, heat, change or jumper the PFO. network IC, power IC and finally the CPU in that order if the problem still persists.
- **Step 8:** Heat, re-ball or change the network IC, power IC and finally the CPU in that order : if the problem still persists.

## 8.6.4 Steps: Solution to Network Signal and Call Drops

In case of network problems and call drops the following steps can be tried: -

- Step 1: Remove the SIM card and insert it into another cell phone to see if the problem persists.
- **Step 2:** You can also try to put the some other serviceable SIM card inside the mobile phone that has reported the to rule out a problem with the mobile.
- **Step 3:** Change the SIM card if the source of the problem is not the mobile phone.
- Step 4: Upgrade to the latest version of the operating system if no other problem is identified.
- **Step 5:** Change the mobile phone if none of the above steps work.

## 8.6.5 Steps: Solution to Mobile Phone Overheating

In case there is a report a mobile overheating either indide or outside the body, run the trouble shooting software.

If the software troubleshooting fails to resolve the issue, then change the PCB or logic-board as there is some internal circuitry problem.

## **8.6.6 Steps: Solution to Earpiece Problem**

The following steps can be tried in case there is a report on no sound being heard during a phone call. Low volume or sound 0r speech has interuptions.:

- **Step 1:** The speaker volume should be first checked when a call is in progress.
- **Step 2:** If there is no problem with the speaker volume, then check the earpiece by keeping the multimeter in buzzer mode with resistance setting as 25~35 Ohm. Change the earpiece if the resistance reading is not between 25 to 35 Ohm.

- Step 3: Thereafter, test the circuit track of the earpiece section. Jumper as and when necessary.
- Step 4: Heat, reball or change the UEM/Audio IC if the problem persists.
- **Step 5:** The last thing left if all others fail is to heat, reball or change the CPU.

## 8.6.7 Steps: Solution to Ringer Problem

The faults reported for a faulty ringer could be that it does not ring, it gives a low sound, interrupted sound or it lacks clarity. The following steps can be tried to rectify a faulty ringer:

- **Step 1:** Examine the phone settings for the ringer. Ringer volume and silent mode setting be verified. In case the fault is a setting problem, adjust the volume or the mode as applicable.
- Step 2: Open the cell phone, access the ringer and clean the ringer point and connector.
- **Step 3:** Check the ringer for serviceability using the multimeter. Put it in buzzer mode with the resistance set between 8 to 10 Ohm. The ringer is OK if the reading is between 8 to 10 Ohms. If it is outside this range, change the Ringer.
- **Step 4:** Check track of the ringer section if the problem is not resolved.. Jumper wherever found to be necessary.
- **Step 5:** Check the ringer IC for serviceability. Heat or change the ringer IC if found to be unserviceable.
- **Step 6:** If the fault persists heat, reball or change the UEM / Logic IC and finally the CPU if the fault has still not been solved.

## **8.6.8 Steps: Solution to Vibrator Problem**

The faults reported for a faulty vibrator could be that it does notwork, works with interruption it hangs. The following steps can be tried to rectify the vibrator:

- **Step 1:** Examine the phone settings for the vibrator and confirm that the "On-Off" setting is set to ON.
- Step 2: Open the cell phone, access the vibrator and clean the vibrator point and connector.
- **Step 3:** Check the vibrator for serviceability using the multimeter. Put it in buzzer mode with the resistance set between 8 to 16 Ohm. The vibrator is OK if the reading is between 8 to 16 Ohms. If it is outside this range, change the vibrator or motor.
- **Step 4:** Check track of the vibrator section if the problem is not resolved. Jumper wherever found to be necessary.
- Step 5: Check if the fault persists. If it does heat, reball or change the UEM / Logic IC / Power IC
- Step 6: Finally, if the fault persists, heat, reball or change the CPU.

## 8.6.9 Steps: Solution to Microphone Problem

- Step 1: Examine the phone settings for the microphone and confirm that they are normal.
- **Step 2:** Open the cell phone if settings are ok, access the mic and clean the mic point and connector.
- **Step 3:** Check the mic for serviceability using the multimeter. Put it in buzzer mode with the resistance set between 600 to 1800 Ohm. The microphone is OK if the reading is between 600 to 1800 Ohms. If it is outside this range, change the microphone. Only one side of the microphone will give value

- **Step 4:** Check track of the microphone section if the problem is not resolved. Jumper wherever found to be necessary
- **Step 5:** Check if the fault has been rectified else heat or change the IC.
- Step 6: Check if the fault persists. If it does heat, reball or change the UEM / Logic IC / Power IC
- **Step 7:** Finally, if the fault persists, heat, reball or change the CPU.

## 8.6.10 Steps: Solution to Display Problem

The following faults can be reported in case of displays:

- Display is blank or white or working improperly.
- Only partial portion of the display is proper.
- Inverted display.
- Display is broken.
- On switching ON the cell phone, after initially the logo is visible but thereafter the display disappears.

## Carry out the following steps to rectify the problems:

- Step 1: Open the cell phone, access the display and clean the display tips and connector.
- **Step 2:** If not resolved, solder the display connector.
- **Step 3:** Check if display functional, else change the display.
- **Step 4:** If problem persists, the display track should be checked.
- **Step 5:** If there is no change in status solder or replace the display IC.
- **Step 6:** Finally if everything fails, heat, reball or change the CPU.

## 8.6.11 Steps: Solution to LED Problem

The following LED related faults may be reported by the customer:

- No LED is glowing.
- Only the keyboard or display LED is glowing.
- Partial functioning / non functioning of the lights.

#### Carry out the following steps to rectify the above problems.

- **Step 1:** Check the phone settings for light display and check all OK.
- **Step 2:** If all OK in the settings resolder all the LEDs.
- Step 3: Change the screen or the display if the problem persists
- **Step 4:** Set "buzzer mode" in the multimeter and test all LEDs. The serviceable LEDs will glow and the faulty ones will not.
- **Step 5:** Jumper or replace the faulty LEDs that have been identified above.
- **Step 6:** If the fault persists verify the track of the light section and jumper if required.
- **Step 7:** If no fault is detected till this stage, the boosting coil should be checked and replaced if necessary.

- **Step 8:** Heat or replace the Light IC if the above steps do not solve the problem.
- Step 9: Finally, if every thing else fails then heat, reball or replace the Power IC.

## **8.6.12 Steps: Solution to Touchscreen Problem**

The following touchscreen related faults may be reported by the customer:

- Touch does not have any effect.
- Half touchscreen only functional.
- Wrong key displayed on pressing some keys.

## Carry out the following steps to rectify the above problems.

- **Step 1:** If the cell phone also has a keypad besides the touchscreen, verify the phone settings for correctness.
- **Step 2:** If settings are in order, open the cell phone clean PDA Tips and connector and resolder them if required.
- **Step 3:** If the fault persists, replace the PDA.
- **Step 4:** If the fault persists verify the track of the PDA section and jumper if necessary (refer Fig 2.3.12).
- **Step 5:** If the above steps do not resolve the fault, Heat or replace the PDA IC.
- **Step 6:** Finally if everything fails, heat, reball or replace the CPU.

# In case the touchscreen have excessive scratches that require its replacements or the touchscreen is broken, the following steps can be tried:

- **Step 1:** Open up the mobile cover and remove the battery, all SIM cards and the SD cards.
- **Step 2:** To access the touchscreen the screws at the base around the battery cover are removed. Photograph the device as a reference whenever in doubt.
- **Step 3:** Take the pry tool and pry open the back cover. Starting from the corner take the tool under the edge carefully. Pop out the clips once the tool reaches the edge and lift the cover. In the particular model shown above, only the top cover of the camera needs the pry tool.
- **Step 4:** Unclip any other visible connections and any screws that are visible.
- **Step 5:** The main device is now carefully "pushed" without using any excessive force such that it is detached from the metal chassis. Be careful to bend up the lower PCB, lest it gets caught in the rear of the chassis.
- **Step 6:** From the top or bottom unscrew any additional screws that are visible. Simply lift the plastic bracket that now gets released.
- **Step 7:** The display elements have to be separated from the motherboard of the mobile. The digitiser and display connections would vary from model to model. In the model here these connections are seen as two ribbon cables coming in to the side of the model. Remove and save the tape using the pry tool. Remove the ribbons using a suitable screw driver after lifting the locking element (white coloured).
- **Step 8:** Using a pry tool work carefully around the edges of the exposed parts to separate the display and the motherboard that are invariably glued together.
- **Step 9:** To gain access to the display section and the motherboard section, fold open the mobile carefully and disconnect the last of the two connecting elements.

**Step 10:** The digitiser is bound to the display chassis by an adhesive gasket. Using a hot-air gun, set at the lowest temperature, heat the joint continuously moving the gun to loosen the adhesive. Thereafter separate the digitiser from the display by using a pry tool.

**Step 11:** The screen should be removed a part at a time. Start from the least broken portion or from the the bottom edge. Test the "stickiness" of the adhesive using a pry tool and heat it again. Repeat the process until they start separating. Continue the entire process small section at a time till the entire digitiser can be lifted out. Save the adhesive gasket as far as possible.

**Step 12:** Be very careful in the entire process because if any portion of the digitiser comes in contact with the display or chassis it will short and false-positive touches will be encountered. If you have damaged the adhesive gasket, replace it with 1mm or 2mm adhesive tape designed for phones.

**Step 13:** Remove any protective film on either side, feed the new digitiser's ribbon through the lower hole and carefully from the base, angle it back into place firmly pushing it down to make sure the adhesive holds well. Feed the ribbon along the back of the display and reverse this process to carefully rebuild your phone.

**Step 14:** Check the mobile by powering it on and test that the faults reported have been addressed.

## 8.6.13 Steps: Solution to Keypad Problem

## The following keypad faults can be reported by a customer:

- Certain keys not functional.
- More pressure is required to be applied on some or all keys.
- Some key works continuously when pressed.
- Another key functions when some other key is pressed.
- Simultaneous working of a key when some other key is pressed.

#### Carry out the following steps to rectify the above problems.

- **Step 1:** Physically inspect the face of the keypad.
- **Step 2:** The keypad and its contact points (refer Fig 2.3.13.) are cleaned using a cleansing liquid.
- **Step 3:** If the problem is not resolved, set the multimeter's rotary switch in buzzer Mode and check for continuity the rows and columns of the Keypad. The keypad is functioning properly if a beeping sound is heard.
- **Step 4:** Heat or replace the Keypad / interface IC if the problem persists.
- **Step 5:** Finally, if the problem persists heat, reball or replace the CPU.

## 8.6.14 Steps: Solution to SIM Problem

## The following steps can be tried in case:

- SIM is inserted but the message says "Insert "IM".
- The mobile phone goes OFFLINE when the SIM card is inserted.
- The SIM works for some time and then stops working.
- There is a message that says "Invalid "IM".

#### Carry out the following steps to rectify the above problems.

- **Step 1:** Check settings and see if the mobile phone is in Flight Mode. If it is in 'Flight Mode' then change it to Normal mode.
- **Step 2:** Clean the SIM card tips and SIM connector.
- **Step 3:** If the problem is not solved then change the SIM card and check.
- **Step 4:** If the problem remains then change the SIM connector.
- Step 5: If you still do not find a solution to the problem, check the track of the SIM section.
- Step 6: If the problem is still not solved then heat or change the SIM IC.
- Step 7: Finally, if there is no change, heat, reball or change the Power IC.

## **8.6.15 Common Software Problems and Solutions**

#### **Battery** issues

Sometimes resource hungry apps drain the mobile battery and also cause the phone to become slow. Search and locate such apps and delete if not important.

#### **Bluetooth issues**

Try switching the phone off and on. If it doesn't work, go to Settings > Apps > Scroll over to All > Select Bluetooth Share > Clear Cache (Android phones)

#### **Cellular Data Issues**

This is a common problem amongst Android phones. To fix this problem, simply go to Settings- > More- > Cellular networks. Turn it back on after 30 seconds or so and see if the connection is back. If it is not, try rebooting your smartphone.

#### **Camera Glitches**

Try to reset your device and make sure the OS is up to date. Rebooting the device may fix the problem and the camera might start functioning again.

## **8.6.16 Steps: Updating a smartphone**

It is a good practice to back up your data such as contacts and photos before a phone upgrade.

#### **Android**

- **Step 1:** Go to and select the Settings menu of the mobile.
- **Step 2:** Scroll down and click on 'About Phone'. In case of a tabbed settings menu this will be found in the 'general' section.
- **Step 3:** Select 'Software Update' or a similar option.
- **Step 4:** The mobile software is programmed to automatically search the company web site for an update. Some applications may take you to another menu and display the updates and expect you to check a button displayed in front of the software name. A confirmation will be taken before downloading the update, if available. On confirmation the update is downloaded, installed and the mobile rebooted.

#### **iPhone**

From the phone directly

- **Step 1:** Plug your phone in to power and connect to the Internet with Wi-Fi.
- **Step 2:** Tap Settings > General > Software Update.
- Step 3: Tap Download and Install.
- **Step 4:** To update now, tap Install.
- **Step 5:** If prompted, enter your passcode.

#### **Through iTunes**

- **Step 1:** The latest version of iTunes is first installed on a PC.
- **Step 2:** Connect the phone to your computer.
- Step 3: Open iTunes and select your iPhone.
- **Step 4:** Click "ummary, then click 'Check for Update'.
- Step 5: Click Download and Update.

#### Windows

- Step 1: Tap Settings.
- **Step 2:** Tap 'phone update'.
- **Step 3:** Tap the button 'check for updates'.
- **Step 4:** You can choose to install the update immediately or postpone the update for a more convenient time.

#### **Blackberry**

- **Step 1:** Visit the http://www.blackberry.com/update web site.
- Step 2: Click 'Check for Updates'.
- **Step 3:** Follow the on-screen instructions to reload the software.

## 8.6.17 Steps: Mobile Data Transfer

## **Using USB Cable**

- **Step 1:** Use the USB cable provided along with the mobile to connect the mobile and your computer.
- **Step 2:** Find the icon of a removable drive (your mobile) on your computer under My Computer or Finder if a pop-up window does not open.
- **Step 3:** Drag and drop the relevant files you want to copy from the cell phone to the PC (or vice versa).
- **Step 4:** When you are finished, close the window and disconnect the USB cable.

#### **Using Bluetooth**

- **Step 1:** Turn Bluetooth on in both the mobile and your PC. You can activate it in your phone by looking under Settings or Controls. In case of a Mac, the Bluetooth symbol (a white B on a blue background) is seen on the right side of the upper toolbar left of where the Date and Time is displayed click on it to turn bluetooth on. In Windows it should be under the Control Panel.
- **Step 2:** Make sure that the phone is not too far away from the computer.
- **Step 3:** Find and select the file (phone) that you want to transfer.
- **Step 4:** Select Copy or Send in the menu.
- **Step 5:** Choose the Bluetooth option.
- Step 6: Select the "Look for Devices" or a similar option in the Bluetooth menu that pops up.
- Step 7: Select your device (computer).
- **Step 8:** Request would be sent to the device to accept the file.
- **Step 9:** Accept request & data will be sent from mobile to computer and vice-versa.

#### **Using Memory Card Reader**

- **Step 1:** Plug in your memory card into a memory card reader. If it's a micro SD card then insert into an adapter and then insert the adapter into the reader.
- Step 2: Insert the card reader into the USB port of your PC if it does not have a built in card reader.
- **Step 3:** Look for the card as a removable device on your computer under My Computer or Finder if a pop-up window does not open. Drag and drop the data you want to copy on your local drive. In case of a Mac, open iPhoto, select Import to library option under file menu option & select the desired photos from memory Card.

#### **Using iTunes**

- **Step 1:** Connect iPhone to computer using a USB cable. iTunes should open automatically, if not go to the applications folder and open it from the Start Menu.
- Step 2: Select your iPhone from the list under Devices button (upper right corner of iTunes window).
- **Step 3:** Choose the media (Apps, Music, Movies, etc.) that you want to sync. Select the "Sync" checkbox and click on individual tab to be added to your device. You can also choose to sync all media of that type, or just specific files.

## **UNIT 8.7: Safety Guidelines**

# **Unit Objectives**



## By the end of this unit, the participants will be able to:

- 1. Understand and follow standard safety precautions while repairing a handset
- 2. Understand and follow radiation compliance standards for mobile phones in India

## **8.7.1 Safety Tips and Precautions**

- Repairing of any mobile handset must always be done on an ESD-Safe Mat.
- The person doing the repairing job should also be wearing
- ESD-Safe Clothing like ESD-Safe Apron, ESD-Safe Slippers, ESD-Safe Hand Gloves and Anti-static wrist strap. This prevents the gadget or mobile phone from any potential damage to sensitive electronic components mainly SMD due to static electricity.
- The workstations should be well equipped so that all your tools of regular use are within your arms reach and at appropriate place.
- Use only dedicated tools for particular device you want to repair and fix.
- Make sure the LCD does not get any scratches. Handle connectors and connecting cables carefully
  as they are very delicate.
- Hot air machine and soldering iron or soldering station must be used and handled carefully. They
  can damage the gadget and even harm you. Hot air machine produces hot air with very high
  temperature. Make sure the direction of the nozzle is where it should be. Switch it OFF when not
  in use.
- Use a Solder with care. Always place the iron in an iron stand and do not put it on the table.
- In case you have to perform a factory reset in a mobile phone, make sure to backup all data first.
- Software troubleshooting of any mobile handset must always be done on an ESD-Safe Mat.

The person doing the repairing job should also be wearing ESD-Safe Clothing like ESD- Safe apron, ESD-Safe Slippers, ESD-Safe Hand Gloves and Anti-static wrist strap. This prevents the gadget or mobile phone from any potential damage to sensitive electronic components mainly SMD due to static electricity.

- The workstations should be well equipped so that all your tools of regular use are within your arms reach and at appropriate place.
- Make sure the LCD does not get any scratches. Handle connectors and connecting cables carefully as they are very delicate.
- In case you have to reinstall the operating system in a mobile phone, make sure to backup all data first.

## **8.7.2** Radiation Compliance for Mobile Handsets

The measures taken by the Department of Telecommunications, Government of India, against Electro Magnetic Field (EMF) exposure are:

- Stringent international norms for mobile handsets have been notified by India.
- The maximum level allowed by the FCC is 1.6 watts per one kilogram of bodyweight.
- The earlier versions of mobile handsets that complied with the earlier standard of 2.0 W/kg averaged over 10 gram of human tissue have been discontinued from 1st Sept. 2013.
- As in case of the International Mobile Equipment Identity (IMEI) display the SAR value is also required to be displayed in all mobiles. SAR values related information is also to be made available at the point of sale to all consumers.
- Mobile hand set manufactured and sold in India or imported from other countries are checked on random basis for compliance of SAR limit at the TEC SAR Laboratory.
- All cell phones available in India have to comply with laid down standards and are compulsorily to be available in hand free mode.

# **UNIT 8.8: Report and Document Daily Activities**

# - Unit Objectives 🌀



By the end of this unit, the participants will be able to:

1. Identify and fill up a job-card, a daily activity report, and a customer feedback form

## 8.8.1 A Repair Job-Card

A job-card is an important piece of document that the Handheld Devices(Handset & Tablet) Technician needs to fill. It records all information related to a repair work viz., customer details, product details and the problem needing a fix.

2	Customer Name Perchase On		ler Number:	Phone:	Fax:	
HE SHE	Mail Address:	Street.		City	State:	Pin
21	Customer Name Attention/Tag				Phone:	Fax:
SHIP TO	Mail Address: Street City:				State	Pin
-	Company Name: Contact Name			Email Address:		
CONTACT	Mail Address: Street			Cay	State:	Pin
	Product Model Number			Description:	Approval Method:    Francoproved Rg.     Guide Behav Approval	
5	Series:	Serial Number / Lot Code:		Quantity:	Return Via	
ITEM #1	Repair Description /	Comments:	Repair Service Requested:   Standard (10 business (lays)   Ruch (3-5 business days, +10%)   Emergency (rest dutiness day, +25%)			
Г	Product Model Number			Description:	Approved Method:    Presponsed Rs.   Quate Seting Approve	
45	Series:	Serial Number / Lot Code:		Quantity:	Return Visc	
ITEM #2	Repair Description	/ Comments:	Repair Service Requested:    Standard (10 business days.)     Rush (3-5 business days. +10%)     Emergency (next business day. +25%)			

## **8.8.2** Daily Activity Report

The daily activity report is used the record the tasks undertaken by the Handheld Devices(Handset & Tablet) Technician on a daily basis. It helps the management monitor the overall process.



## 8.8.3 Customer Feedback Form

A customer feedback form gets customer's response on the service offered by the Handheld Devices(Handset & Tablet) Technician. It's a good indicator on the quality of work performed by them.

# **Exercise**

## **Multiple Choice Questions**

- 1. What identifies a mobile subscriber to a network:
  - a. SIM Card b. Memory card
  - c. Processor d. All of the above
- 2. SIM card does the following:
  - a. Stores service-related information.
  - b. Identifies the subscriber to the network.
  - c. Stores personal information, address books, messages
  - d. All of the above
- 3. Compact Flash, Multimedia Card, Secure Digital are types of:
  - a. Memory card b. PCMCIA Card
  - c. Graphic Card d. None of the above
- 4. Earthing pin, connected with the body of the equipment:
  - a. Passes current leakage to the earth
  - b. Protects people from accidents caused by electrical shock.
  - c. Both a & b
  - d. None of the above
- 5. Which of the following is antistatic clothing:
  - a. ESD-Safe Apron b. ESD-Safe Slippers
  - c. ESD-Safe Hand Gloves d. All of the above
- 6. Please identify the right statement:
  - a. A resistor never gets short b. Resistor can be open
  - c. Value of resistor can be high d. All of the above
- 7. Which of the following is not an electric circuit:
  - a. Close circuit b. Short circuit
  - c. Blocked circuit d. Series circuit
- 8. If the mobile phone overheats, change:
  - a. PCB or logic-board b. ringer
  - c. microphone d. Keypad

9.	Removal of solder and components from a PCB is kn						
	a. Soldering	b. Shorting					
	c. Desoldering	d. None of the above					
10	the Multimeter is showing faulty reading what all should you check?						
	a. Battery	b. Probes					
	c. Fuse	d. All of the above					
11	L. You may need to reset cell phone to:						
	a. Correct malfunctions	b. Stop freezing, slowness, etc.					
	c. To restore the phone to its original state	d. All of the above					
1-	2. Resetting a cell phone:						
12	a. Is a tedious and an unnecessary process						
	b. May often remove and erase all of your personal data from the device						
	c. Will restore the phone to its original state						
d. Both b & c							
13	3. One of the most important precautions that we shou	uld undertake while resetting a					
	mobile phone is:						
	a. That we should do it when we have time						
	b. We should do it after plugging out the charger						
	c. Take a back-up of the data (mandatory) to avoid losing it						
	d. None of the above						
14	1. What all medium can you use to transfer data betwe	·					
	a. USB cable	b. Bluetooth					
	c. Memory card reader	d. All of the above					
13	<ol><li>A damaged firmware in a mobile phone means it wil a. Not power on</li></ol>	b. Hang frequently					
	·	d. All of the above					
	c. Keep restarting	ע. און טו נווכ מטטעפ					
16	16. "Half Flash" & "Full Flash" are terms related to:						
	a. Flashing:	b. Data Transfer					
	c. Email	d. Social networking					

- 17. Steps to reset iPhone are:
  - a. Tap on "Settings" from home screen->Tap "General Settings" from options listed->Tap on "Reset"
  - b. Tap on "Settings" from home screen->Tap on "Reset"
  - c. Tap "General Settings" from options listed->Tap on "Reset"
  - d. Both b & c
- 18. Which of the following is antistatic clothing:
  - a. ESD-Safe Apron b. ESD-Safe Slippers
  - c. ESD-Safe Hand Gloves d. All of the above
- 19. For Soft Formatting of your Nokia Mobile type:
  - a. \*#7370# followed by 12345 b. \*#7370# followed by 12346
  - c. \*#73 followed by "password" d. None of the above
- 20. For Hard Formatting of your Nokia Mobile type:
  - a. \*#7780# followed by 12345 b. \*#7370# followed by 12345
  - c. \*#73 followed by "password" d. \*#7780# followed by "password"
- 21. Reporting helps:
  - a. Supervisor get a detailed status of a Handheld devices (Handset & Tablet) Technician (HRE) work
  - b. HRE to solve installation related problems
  - c. organisation to make more money
  - d. Both a & b
- 22. Reporting is a:
  - a. A formal accounting of the procedures and transactions
  - b. Software
  - c. Hardware tool
  - d. Repair process

#### **Descriptive Questions:**

- 1. Mention a few parts on a mobile phone PCB.
- 2. What all constitutes a hands-free section?
- 3. Briefly explain the soldering process.
- 4. What steps are involved in checking a faulty ringer with a multimeter?
- 5. What is a PFO?
- 6. What is the role of an RX Filter?
- 7. What is a Power IC?

- 8. What is the difference between low-pass filter and high-pass filter?
- 9. List steps to reset an iPhone.
- 10. List steps to reset a Windows phone.
- 11. What steps are involved to install apps on a Blackberry?
- 12. List steps to update an Android phone.

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Scan the QR codes or click on the link to watch the related videos



https://youtu.be/DBqedi6Bm3s?si=DvMtTJjj6EleM8y9

Service Level Agreements











# 9. Grameen Udhyami Initiative and Entrepreneurial Activities

Unit 9.1 - Business Planning and Infrastructure Setup

Unit 9.2 - Digital Literacy and Service Offerings

Unit 9.3 - Introduction to UPS Installation and Maintenance

Unit 9.4 - Technology Setup and Consultation



# **Key Learning Outcomes**



#### By the end of this module, the participants will be able to:

- 1. Assess the specific technology needs of a village to create tailored telecom and hardware solutions.
- 2. Develop a comprehensive business plan, encompassing services, target markets, finances, and marketing strategies for a techpreneurial business.
- 3. Identify suitable locations and define necessary infrastructure requirements for establishing a techpreneurial business.
- 4. Explain the process of obtaining permits and licenses necessary to operate a technology business in the village.
- 5. Define the purpose and benefits of organizing workshops to promote digital literacy in the community.
- 6. List services related to comprehensive telecom solutions, such as SIM card sales, mobile recharge, top-up, and post-paid bill payment.
- 7. Explain the concept of internet connectivity solutions, including broadband and wireless connections for both residential and business use.
- 8. Elaborate on setting up public Wi-Fi hotspots in central locations, focusing on proper installation and network security.
- 9. Describe the importance of expert hardware and software repair and troubleshooting services for various devices.
- 10. Identify strategies for collaborating with government officials and NGOs to establish a village information center with computer setups and internet connectivity.
- 11. Explain how to coordinate with healthcare providers to set up and manage telemedicine centers, ensuring proper equipment and connectivity.
- 12. Discuss installing and maintaining security measures like CCTV cameras, emphasizing proper functioning and coverage.
- 13. Demonstrate the correct procedures for installing and configuring internet connectivity solutions for residential and business users, such as broadband or wireless connections.
- 14. Illustrate the process of setting up and providing support for local area networks (LANs) in offices and homes, enabling file sharing and communication.
- 15. Provide guidance and consultation services to individuals and businesses on technology-related matters, addressing their specific needs and helping them make informed decisions.

# **UNIT 9.1: Business Planning and Infrastructure Setup**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Analyze the specific needs and demands for telecom and hardware solutions in a village
- 2. Develop a comprehensive business plan, including services, target market, finances, and marketing strategies
- 3. Identify the suitable location and describe the necessary infrastructure required to set up a techpreneurial business
- 4. Explain the process of obtaining necessary permits and licenses for the business

# 9.1.1 Rural Tech Needs Assessment and Solutions Analysis

Analyzing the specific needs and demands for telecom and hardware solutions in a village is a foundational step for the success of your venture as a Telecom Grameen Udhyami, focusing on serving rural small entrepreneurs.

To ensure a comprehensive and effective analysis, Telecom Grameen Udhyami should follow a detailed process:

#### • Market Research and Surveys:

- o Initiate a thorough market research effort by employing skilled researchers specialising in rural environments.
- o Conduct surveys and interviews with local residents, business owners, and community leaders. Develop questionnaires that encompass technology preferences, challenges, and aspirations.
- o Collect data on the existing telecom services, including network coverage, internet speed, and service reliability.
- o Explore the hardware requirements by examining the prevalence of smartphones, computers, and other devices.

#### Demographics Analysis:

- o Understand the demographic makeup of the village, including population size, age groups, income levels, and education.
- o Identify the primary language spoken within the community, as this is crucial for tailoring services and communication strategies.

#### • Infrastructure Assessment:

- o Evaluate the state of existing telecom infrastructure, such as the availability of mobile networks, landlines, and internet connectivity.
- Gauge the quality and coverage of these services. Identify areas with connectivity issues and signal dead zones.

#### Local Business and Service Needs:

- o Identify local businesses and services within the village and surrounding areas that may benefit from enhanced telecom and hardware solutions.
- o Consider the specific technology needs of various sectors, such as agriculture, trade, or education.

#### Accessibility and Affordability:

- o Examine the affordability of technology solutions for the local population. Assess the pricing structure and ensure it aligns with the income levels of the villagers.
- o Explore potential subsidies or financial assistance programs to bridge affordability gaps.

#### • Educational and Healthcare Needs:

- o Investigate the educational and healthcare requirements within the village.
- Assess the potential demand for online education, telemedicine services, and digital literacy programs.

#### • Local Challenges and Constraints:

- o Recognize any unique challenges, such as geographical obstacles (e.g., difficult terrain), power supply issues, and language barriers.
- o Develop strategies to overcome these challenges and ensure uninterrupted service delivery.

#### • Competitive Landscape:

- o Analyze the existing competitors, if any, in the region. Understand their strengths and weaknesses.
- o Differentiate your offerings by addressing market gaps or providing superior customer service.

#### Technology Trends and Innovations:

- Stay updated on the latest technology trends and innovations that can enhance the quality and efficiency of your services.
- o Consider emerging hardware and software solutions that may be relevant to your target market.

#### Regulatory and Legal Considerations:

- o Investigate local regulations and government policies that may impact the deployment of telecom and hardware solutions in the area.
- o Ensure compliance with all legal requirements and obtain necessary permits and licenses.

#### • Environmental Considerations:

o Assess any environmental factors impacting technology deployment, such as extreme weather conditions. Develop robust solutions to withstand these challenges.

#### • Community Engagement:

- o Engage with the local community through meetings, workshops, and information sessions to build trust and gather insights into their needs and preferences.
- Create a feedback mechanism for ongoing community involvement.

#### Data Analysis:

o Compile and analyze the data collected. Look for patterns, trends, and common needs that can be addressed with your telecom and hardware solutions.

#### Needs Prioritization:

 Prioritize the identified needs and demands based on their significance and feasibility. Identify those that require immediate attention, while others can be addressed in subsequent phases of your business.

#### • Customized Solutions:

- o Tailor your telecom and hardware solutions to meet the specific needs and demands identified in the village.
- o Ensure that your offerings align with local requirements and preferences to maximize adoption and impact.

#### • Continuous Feedback Loop:

- o Establish a robust system for ongoing feedback collection and assessment.
- o Adapt to evolving needs and preferences within the village, demonstrating your commitment to serving the community effectively.

# 9.1.2 Innovative Telecom and Hardware Solutions for Rural Communities

Some specific telecom and hardware solutions that may be in demand in a village include:

- Mobile Connectivity: Ensuring reliable mobile phone coverage to keep villagers connected locally
  and beyond, achieved through cell tower installation or strategic partnerships with mobile network
  operators.
- **Village Wi-Fi Access:** Providing essential internet access to villagers through establishing Wi-Fi hotspots or collaborations with internet service providers.
- **Digital Device Provision:** Making computers and smartphones accessible to villagers at affordable rates or via innovative rental programs, empowering them with essential tools for communication and information.
- Tech Literacy Training: Offering tailored training programs to empower villagers with the skills to
  effectively use smartphones, computers, and other devices, maximizing the benefits of available
  telecom and hardware solutions.
- **Telehealth Services:** Facilitating access to healthcare in remote areas through telemedicine, connecting villagers with qualified medical professionals, and promoting better health outcomes.
- **Remote Education:** Extending educational opportunities to remote areas through distance learning programs, enabling villagers to pursue learning and skill development from their homes.
- **E-Governance Solutions:** Enhancing access to government services by establishing online e-governance platforms, simplifying administrative processes and improving citizen services.

## 9.1.3 Developing a Comprehensive Business Plan

To develop a comprehensive business plan for a Telecom Grameen Udhyami, it is important to consider the following factors:

#### **Services**

The first step is to identify the specific telecom and hardware services that will be offered. These services may include:

- Mobile phone coverage
- Internet access
- Computers and smartphones
- Training on how to use smartphones, computers, and other devices
- Telemedicine
- Distance learning
- E-governance

Selecting services relevant to the village's specific needs and demands is important.

#### **Target market**

The next step is to identify the target market for the Telecom Grameen Udhyami's services. This may include individuals, households, businesses, and government agencies.

It is important to understand the needs and demands of the target market in order to develop effective marketing and sales strategies.

#### **Finances**

The Telecom Grameen Udhyami will need to develop a financial plan that includes the following:

- Startup costs: This includes the cost of equipment, infrastructure, and marketing.
- Operating costs: This includes the cost of rent, salaries, and maintenance.
- Revenue projections: This includes the projected revenue from the sale of services and products.

It is important to develop a financial plan that is realistic and achievable.

#### **Marketing strategies**

The Telecom Grameen Udhyami must develop marketing strategies to reach the target market and promote its services. These strategies may include:

- Creating a website and social media presence
- Running advertising campaigns in local media
- · Partnering with local businesses and organizations
- Offering discounts and promotions

It is important to develop marketing strategies that are tailored to the specific target market.

Here are some additional tips for developing a comprehensive business plan for `Telecom Grameen Udhyami:

- **Conduct market research:** This will help you understand the needs and demands of the village and the competitive landscape.
- **Develop a unique selling proposition (USP):** This is what will make your Telecom Grameen Udhyami stand out from the competition.
- Set realistic goals: It is important to set achievable and measurable goals.
- **Track your progress:** Track your progress regularly and make adjustments to your business plan as needed.

# 9.1.4 Identifying Suitable Locations and Infrastructure Essentials

Identifying a suitable location for your techpreneurial business in a rural area requires careful consideration of various factors. First, market research is essential to pinpoint rural communities or villages genuinely needing your telecom and hardware solutions. Look for areas lacking reliable mobile connectivity, internet access, or tech literacy, as these are the niches where your services can make the most significant impact. Conducting a thorough community needs assessment is equally vital to understanding the local dynamics, socioeconomic factors, and cultural preferences that may influence the acceptance of your offerings.

Population density should be evaluated, as higher population areas may offer more potential customers. However, this also implies increased competition, so striking a balance is important. Additionally, consider the growth potential of the area. Infrastructure availability is critical, as basic amenities such as electricity, roads, and water supply are essential for a tech-based business. Ensure the quality and reliability of these services to avoid operational disruptions.

Assess the regulatory environment to ensure compliance with local laws and regulations governing telecom and hardware businesses in the area. Secure the necessary licenses and permits to operate legally. Accessibility is another key consideration, ensuring that your location is easily reachable by your team, suppliers, and customers. Evaluate transportation options, as convenient access can impact the efficiency of your operations.

Community support is invaluable for your venture's success. Look for communities open to innovation and receptive to your business idea. Building relationships and garnering local support can be a significant asset in establishing your techpreneurial business.

When setting up the necessary infrastructure for your Telecom Grameen Udhyami in a rural area, consider the following aspects:

- Communication Infrastructure: Depending on the size of the area and existing network coverage, you may need to set up cell towers or partner with mobile network operators to ensure reliable mobile connectivity. Consider satellite internet solutions to provide internet access in areas with limited infrastructure.
- **Power Supply:** Given potential power outages in rural areas, ensure a stable power supply. Consider backup options such as generators or solar power to minimize service disruptions.
- **Physical Space:** Acquire or lease a suitable physical space for your business operations tailored to your specific services, whether a storefront, office, or training center.
- Training Facilities: If offering tech literacy training, establish dedicated training facilities equipped
  with computers, internet access, and educational resources to empower the local population with
  essential skills.
- **Equipment and Hardware:** Procure reliable and rugged hardware and devices, such as computers, smartphones, and networking equipment, suitable for rural conditions.
- **Security Measures:** Implement a comprehensive security strategy encompassing physical security for your premises and robust cybersecurity measures to safeguard infrastructure and customer data.
- **Support Facilities:** Establish customer support and service centers to promptly address technical issues, inquiries, and complaints.
- Marketing and Outreach: Develop a strong marketing infrastructure, including a website, social
  media presence, and advertising materials. Forge local partnerships to extend your reach within
  the community.
- Logistics and Supply Chain: Create a well-organized logistics and supply chain infrastructure to ensure the timely delivery of devices and services to your customers, even in remote areas.
- **Health and Safety Measures:** If you offer telehealth services, prioritize health and safety compliance, ensuring your infrastructure adheres to healthcare regulations.
- **E-Governance Software and Platform:** For e-governance solutions, develop user-friendly software and online platforms that streamline access to government services, simplifying administrative processes for local citizens.
- **Data Centers:** If data storage is part of your services, consider setting up data centers or leveraging cloud services for secure and efficient data management.
- **Educational Resources:** For distance learning services, create or curate educational content and materials, making them easily accessible to students in rural areas.
- **Telemedicine Facilities:** When offering telehealth services, set up facilities for virtual medical consultations, equipped with video conferencing equipment and a secure platform for data exchange.

# **9.1.5** Process of Obtaining Necessary Permits and Licenses for the Business

Obtaining the necessary permits and licenses for a business set up by Telecom Grameen Udhyami (a small business focusing on rural telecom and hardware solutions) in a village involves several steps and careful adherence to local regulations.

#### 1. Identify the Required Permits and Licenses:

First, determine the specific permits and licenses needed for your business based on the nature of your services and your country's local and national regulations. This might include telecommunications licenses, business permits, and any other industry-specific permits.

#### 2. Business Registration:

Register your business with the appropriate government authorities. This may involve choosing a legal structure for your business, such as a sole proprietorship, partnership, limited liability company (LLC), or corporation. The registration process varies by location and legal structure, so consult with local business agencies or legal professionals for guidance.

#### 3. Telecom Licensing:

If your business involves telecom services, you'll likely need specific licenses related to telecommunications. This could include ISP (Internet Service Provider) licenses or other relevant permits. A national telecommunications authority or agency may regulate the process for obtaining these licenses.

#### 4. Local Permits and Clearances:

Depending on the location and nature of your business operations, you might need local permits and clearances, such as zoning permits, land-use permits, or environmental clearances. Contact the local government or municipal authorities to determine the specific requirements.

#### 5. Shop and Establishment Act License

This license is issued by the state labour department and is required for all establishments that employ more than 10 workers.

#### 6. Goods and Services Tax (GST) Registration

GST is a value-added tax that is levied on most goods and services sold in India. Telecom Grameen Udhyamis with an annual turnover of more than Rs. 40 lakhs are required to register for GST.

#### 7. Environmental and Health Regulations:

If your business activities have environmental or health implications, you may need to comply with environmental impact assessments and health safety regulations. Consult with local environmental and health agencies to ensure compliance.

#### 8. Tax Identification Number (TIN):

Obtain a Tax Identification Number (TIN) or similar identification number required for tax purposes. This number is used for income tax, sales tax, and other tax-related filings.

#### 9. Building and Construction Permits:

You'll need building and construction permits to construct physical infrastructure, such as cell towers or office buildings. These permits ensure that your structures comply with local building codes and safety regulations.

#### 10. Legal Consultation:

Given the complex nature of telecom and rural business regulations, consider consulting with legal professionals experienced in telecommunications and business law. They can provide valuable guidance and help ensure compliance with all relevant laws and regulations.

#### 11. Application Process:

Once you've identified the required permits and licenses, follow the application procedures the respective regulatory authorities outlined. This typically involves completing application forms, submitting required documents, and paying associated fees.

#### 12. Compliance and Inspections:

Be prepared for inspections and compliance checks. Regulatory authorities may conduct site visits to ensure your operations meet safety and operational standards.

After obtaining the necessary permits and licenses, maintain records of all documentation and ensure ongoing compliance with all regulations, including renewing permits.

#### The documents required for applying for a Trade license include:

- Address proof of the business
- ID proof of the applicant
- Aadhaar card
- PAN of the individual in case of proprietorship, else PAN of the firm of company
- Memorandum of Association (MOA) in case of Companies
- Certification of incorporating in case of Companies

# **UNIT 9.2: Digital Literacy and Service Offerings**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Define the purpose and benefits of organizing workshops to promote digital literacy in the village.
- 2. List the services involved in comprehensive telecom solutions, including SIM card sales, mobile recharge, top-up, and post-paid bill payment.
- 3. Explain the concept of internet connectivity solutions, such as broadband or wireless connections, for homes and businesses.
- 4. Elaborate the procedure to set up public Wi-Fi hotspots in central locations, ensuring proper installation and network security.
- 5. Describe the importance of expert hardware and software repair and troubleshooting services for various devices.
- 6. Identify ways to collaborate with government officials and NGOs to set up a village information center, including computer set-up and internet connectivity.

# 9.2.1 Organizing Workshops to Promote Digital Literacy in the Village

Organizing workshops to promote digital literacy in villages as part of the initiatives by Telecom Grameen Udhyami serves several important purposes and offers numerous benefits:

#### **Purpose**

- **Empower the Local Community:** Digital literacy workshops can empower the local community by providing them with the skills to effectively use digital technologies. This can open up a world of opportunities for them, such as accessing online education, finding remote work opportunities, and connecting with people worldwide.
- Bridge the Digital Divide: Rural areas often lag behind urban areas regarding access to and understanding of technology. Digital literacy workshops can help bridge this divide by teaching villagers how to use digital tools and access online resources. This can level the playing field and give everyone a fair chance to succeed in the digital age.
- Enhance Education: Digital literacy workshops can help improve education access for village
  children and adults. Villagers can use digital tools to access online educational resources, take
  online courses, and connect with teachers and tutors remotely. This can help them learn new skills,
  advance their careers, and improve their quality of life.
- Improve Employment Opportunities: Digital literacy is essential for many jobs in today's economy. By participating in digital literacy workshops, villagers can learn the skills they need to access better job opportunities, both locally and globally. This can help them improve their income and standard of living.
- Access to Government Services: Many government services are now available online. Digital
  literacy workshops can help villagers learn how to use digital tools and platforms to access these
  services, such as healthcare, education, and financial assistance. This can make it easier for them to
  access the needed services and improve their overall well-being.

• **Promote Entrepreneurship:** Digital literacy can help villagers start their own businesses, particularly in the tech sector. They can use digital tools to create and market their products and services to a wider audience. This can help boost the local economy and create new jobs.

#### **Benefits**

- **Empowerment:** Digital literacy empowers individuals to take control of their lives and achieve their goals. It gives them the confidence to learn new things, take risks, and pursue their dreams.
- **Economic Growth:** Digital literacy can lead to economic growth within the community. Villagers can participate in e-commerce and online markets and offer tech-related services to a wider market. This can create new jobs and boost the local economy.
- Access to Information: Digital literacy enables villagers to access a vast amount of information and knowledge available on the internet. This can be particularly valuable for educational purposes, skill development, and staying informed.
- **Healthcare:** Villagers can access telehealth services, connect with medical professionals, and receive vital health information online. This can lead to better health outcomes, especially in remote areas with limited access to healthcare.
- Agriculture and Farming: Digital literacy can help farmers access weather information, market prices, and agricultural best practices through online resources and apps, enhancing crop yields and income.
- **Community Development:** As villagers become digitally literate, they can actively engage in community development projects, share information, and collaborate more effectively, improving local governance and community well-being.
- **Social Inclusion:** Digital literacy fosters social inclusion by enabling villagers to connect with friends and family through social media, communicate with distant relatives, and engage with a broader online community. This can help to reduce isolation and build stronger social ties.
- **Job Opportunities:** Increased digital literacy expands employment opportunities as villagers can take on digital jobs, such as data entry, online customer service, or content creation. This can help them improve their income and standard of living.
- **Reduced Isolation:** Villagers can overcome isolation and geographical barriers by connecting with the outside world through digital platforms, reducing the sense of remoteness in rural areas.

# 9.2.2 Services Involved in Comprehensive Telecom

## **Solutions**

Comprehensive telecom solutions for Telecom Grameen Udhyami are tailored to meet the unique demands of rural areas, addressing the need for connectivity, education, healthcare, and economic opportunities while considering these regions' specific challenges and limitations.

- **SIM Card Sales and Activation:** Providing SIM cards to rural customers and assisting with the activation process to ensure access to mobile services.
- **Mobile Recharge and Top-Up:** Enabling customers to recharge their mobile balances, purchase top-up cards, and access various prepaid plans.
- **Post-Paid Bill Payment:** Assisting postpaid customers with bill payments, often through local service centers or mobile applications.
- **Prepaid and Post-Paid Mobile Plans:** Offering a range of prepaid and postpaid mobile plans tailored to rural customers' specific needs and budget constraints.

- **Data Plans:** Providing data plans suitable for mobile internet access in rural areas, considering network coverage and data affordability.
- **DTH and Cable TV Subscriptions:** Extending DTH and cable TV services to rural households, ensuring access to a variety of television channels and entertainment.
- **Broadband Internet:** Delivering broadband internet services to rural areas, possibly via DSL, fiberoptic, or other suitable technologies.
- Landline Phone Services: Making landline phone services available for those in rural regions who prefer traditional voice communication.
- Mobile Banking and Other Financial Services: Facilitating mobile banking, money transfers, and access to financial services, which can be vital for rural communities.
- **Enterprise Telecom Solutions:** Tailoring solutions for local businesses and entrepreneurs, including mobile plans, communication infrastructure, and internet services.
- **Telehealth Services:** Facilitating access to telemedicine and virtual healthcare consultations, ensuring rural communities can receive medical care remotely.



Fig. 9.2.1: Telehealth Service

• **Remote Education:** Extending educational opportunities through distance learning programs, enabling villagers to access quality education and skill development resources from their homes.



Fig. 9.2.2: Remote Education

• **E-Governance Solutions:** Enhancing access to government services by establishing online e-governance platforms, simplifying administrative processes, and improving citizen services.

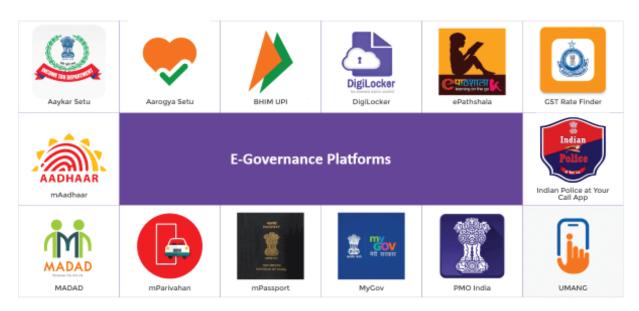


Fig. 9.2.3: E-Governance Platforms

## 9.2.3 Connectivity Solutions -

Access to the internet, whether through broadband or wireless connections, is pivotal in transforming the lives of individuals, homes, and businesses, particularly in rural areas.

As a Telecom Grameen Udhyami, understanding the concept and significance of these solutions is paramount for addressing the unique needs of rural communities.

#### **Broadband Connectivity**

Broadband connectivity typically involves delivering high-speed internet access to homes and businesses through various technologies like Digital Subscriber Line (DSL), fibre-optic, or cable. It offers several advantages:

- **High Speed:** Broadband connections provide fast and consistent internet speeds, enabling quick data downloads and uploads.
- **Reliability:** These connections are known for their reliability and stability, making them suitable for critical business operations and online activities.
- **Multiple Users:** Broadband connections can support multiple users and devices simultaneously, making them ideal for both households and businesses.
- **Improved Productivity:** For businesses, broadband connectivity enhances productivity by enabling efficient data transfers, video conferencing, and cloud-based applications.
- **Entertainment:** It allows for streaming high-definition content, online gaming, and digital entertainment, enhancing the quality of life for residents.
- **Economic Growth:** In rural areas, broadband connectivity can stimulate economic growth by attracting businesses and promoting e-commerce.

#### **Wireless Connectivity**

Wireless internet connectivity utilizes radio waves to connect devices to the internet, often through cellular networks or Wi-Fi. Key points to consider:

- **Mobility:** Wireless connections offer mobility, enabling users to access the internet from different locations, both indoors and outdoors.
- Last-Mile Access: Wireless solutions can bridge the "last mile" gap, extending internet access to areas where laying physical cables is not feasible.
- **Affordability:** Wireless plans can be cost-effective, making them accessible to a broader range of customers, including rural households.
- Scalability: Businesses can easily scale their wireless connections to accommodate growing data needs
- **Flexibility:** Wireless options, such as 4G and 5G, offer flexibility for homes and businesses to choose the speed and data packages that suit their requirements.
- **Community Connectivity:** In rural communities, wireless solutions can promote community internet access, connecting multiple homes and small businesses to the same network.

In rural regions, where geographical and infrastructural hurdles may pose challenges, wireless solutions, such as mobile broadband, emerge as invaluable tools for bridging the digital divide. These solutions bring essential internet services to underserved communities and act as catalysts for socio-economic transformation and the empowerment of rural populations.

By offering a blend of broadband and wireless connectivity solutions tailored to the unique requirements of rural homes and businesses, Telecom Grameen Udhyamis can profoundly contribute to these communities' digital transformation and inclusive development.

# 9.2.4 Setting up Public Wi-Fi Hotspots in Central Locations

Setting up public Wi-Fi hotspots in central locations is not only a valuable service for the community, but it also comes with the responsibility of safeguarding user data and ensuring network security. It requires careful planning to ensure proper installation and network security.

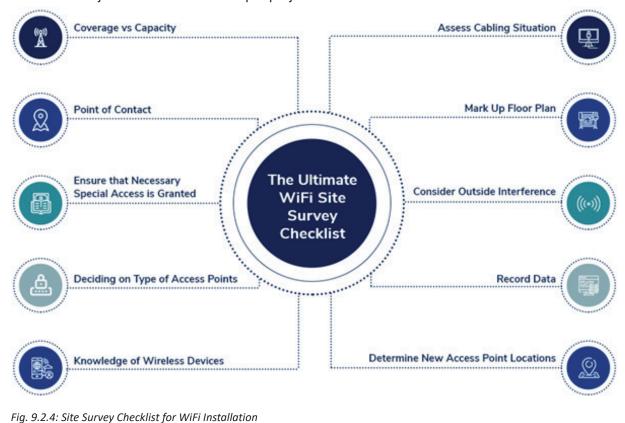
#### **Step 1: Feasibility and Location Selection**

Conducting a thorough site survey is critical in setting up public Wi-Fi hotspots in central locations. This survey helps Telecom Grameen Udhyamis determine the optimal placement of Wi-Fi equipment, ensure proper coverage, and address potential challenges.

Here's how to conduct a site survey effectively:

- **Define Objectives:** Clearly define the objectives of the Wi-Fi hotspot project. Determine the desired coverage area, user capacity, and expected performance. Understand the specific needs and demands of the local community.
- **Identify Central Locations:** Select central locations in the village where the Wi-Fi hotspots will be installed. These locations should be accessible to many users and serve as community hubs, such as town squares, marketplaces, community centers, or public parks.
- **Site Inspection:** Visit each selected location and conduct a thorough inspection. Take note of existing infrastructure, potential sources of interference, and physical barriers that may affect Wi-Fi signal propagation.

- Wireless Access Points (APs) Placement: Determine the optimal placement of wireless access points (APs) to provide uniform coverage. Consider factors such as building structures, foliage, and the density of users in the area.
- **Signal Strength and Coverage:** Use Wi-Fi survey tools or software to measure signal strength and coverage. Ensure that the signal is strong and stable throughout the intended coverage area. Pay attention to areas with potential signal dead zones.
- Interference Assessment: Identify potential sources of interference, such as other Wi-Fi networks, electronic devices, or physical obstacles. Mitigate interference by adjusting the placement of APs and selecting appropriate frequency channels.
- **User Density and Capacity:** Evaluate the expected number of users in the hotspot area. Ensure the Wi-Fi equipment can handle the concurrent connections without significantly decreasing performance.
- **Network Security Considerations:** Assess the security of the Wi-Fi network. Ensure proper encryption, authentication, and access controls are in place to protect users and the network from unauthorized access.
- Power Supply and Network Backhaul: Ensure that the selected locations can access reliable power sources for the APs and network equipment. Verify the availability of a stable network backhaul, such as a wired internet connection or dedicated line for data transmission.
- Antenna Selection: Select the appropriate type of antennas for the APs based on the area's size and layout. Directional antennas may be suitable for long and narrow coverage areas, while omnidirectional antennas are ideal for circular coverage.
- **Review and Adjust:** After completing the site survey, review the findings and make any necessary adjustments to the installation plan. Ensure that the final design aligns with the community's needs and the objectives of the Wi-Fi hotspot project.



#### **Step 2: Regulatory Compliance**

Ensure the public Wi-Fi network complies with local regulations and laws. For example, some regions may require you to log user activity or retain data for a specific duration.

To set up a public Wi-Fi network in villages in India, the following legal compliances must be met:

- Obtain a license from the Department of Telecommunications (DoT): All telecom service providers, including those providing public Wi-Fi, must obtain a license from the DoT. The license application process can be completed online through the DoT's website. Registration with the DoT through the online registration portal (SARALSANCHAR). Registration is granted within 7 days of the application.
- Comply with the Wireless Telegraphy Act, 1933 and the Wireless Telegraphy Rules, 1950: These laws govern the use of wireless spectrum in India. Public Wi-Fi network operators must comply with all applicable provisions of these laws.
- Comply with the Information Technology Act, 2000 and the Information Technology Rules, 2011:
   These laws govern the processing and storage of personal data in India. Public Wi-Fi network operators must comply with all applicable provisions of these laws, including obtaining the consent of users before collecting or processing their personal data.
- Comply with the Telecom Regulatory Authority of India (TRAI) regulations: TRAI is the regulatory body for the telecom sector in India. Public Wi-Fi network operators must comply with all applicable TRAI regulations, including those related to tariffs, quality of service, and customer support.

Other legal compliances for setting up public Wi-Fi networks in villages in India include:

- Bulk login IDs must be created for controlled distribution, with authentication done at a centralized server.
- The maximum output power of the transmitter must be 1W (30 dBm54) in spread of 10 MHz or higher.
- The maximum REP must be 4W (36 dBm).
- The height of the antenna must be within 5 meters above the rooftop of an existing authorized building.

**Note:** The Prime Minister's Wi-Fi Access Network Interface (PM WANI) Scheme states that last-mile Public Wi-Fi providers do not require a license, registration, or fees to the DoT. It is to encourage the setup of public Wi-Fi hotspots in rural and underserved areas.

The PM WANI Scheme is a government initiative to provide broadband internet access to all citizens of India. Under the scheme, Public Data Office Providers (PDOs) can set up Wi-Fi hotspots and provide internet access to users. PDOs can register with the Central Registry on the PM WANI website.

Users can access the internet through the PM WANI hotspots using an app. The app allows users to search for nearby hotspots, authenticate themselves, and make payments.



Fig. 9.2.5: PM WANI Scheme

The PM WANI Scheme is a significant step towards bridging the digital divide in India. By making it easy and affordable to set up public Wi-Fi hotspots, the scheme is helping provide internet access to everyone, regardless of location.

#### **Step 3: Network Infrastructure and Hardware**

When setting up public Wi-Fi hotspots in central locations, equipment selection and internet connection quality are critical factors for ensuring reliable and efficient service. Here's an elaboration on these aspects:

#### **Equipment Selection**

- Commercial-Grade Networking Equipment: Choosing networking equipment designed for commercial or enterprise use is essential. Commercial-grade routers, access points, and switches are built to handle higher user loads, offer advanced features, and provide better reliability than consumer-grade equipment. Brands like Cisco, Ubiquiti, and Aruba are well-known for their enterprise-grade hardware.
- Router: Select a robust router that can handle the demands of a public Wi-Fi network. The router should have advanced security features, support for multiple SSIDs (Service Set Identifiers), and Quality of Service (QoS) settings to manage bandwidth effectively.
- Access Points (APs): Access points are critical for extending the Wi-Fi signal's coverage area. Choose
  high-quality APs that support the latest Wi-Fi standards (e.g., 802.11ac or 802.11ax) for faster and
  more stable connections. Consider factors like signal strength and interference resistance.
- **Switches:** Ethernet switches are essential for connecting multiple access points and routing traffic to the internet connection. Managed switches offer greater control and flexibility over network configurations.
- Power-over-Ethernet (PoE): PoE technology allows both data and power to be transmitted over a single Ethernet cable. Using PoE-enabled devices, like PoE switches and PoE-compatible access points, simplifies cabling and reduces the need for separate power sources.
- Guest Portal and Authentication: Implement a guest portal with authentication to manage user access. This can include terms of service agreements and a login page for users to enter credentials or receive one-time access codes.
- **Security Features:** Ensure that the chosen equipment supports advanced security features such as WPA3 encryption, intrusion detection and prevention systems (IDS/IPS), and firewall capabilities. Robust security is essential to protect users and the network from cyber threats.

#### **Internet Connection**

- High-Speed Internet: To provide a reliable and fast public Wi-Fi service, invest in a high-speed
  Internet connection from a local Internet Service Provider (ISP). The bandwidth you require depends
  on the number of users and the expected data usage. A dedicated high-speed connection is often
  preferable.
- **Redundancy:** Consider implementing redundancy with a backup internet connection or failover mechanism. This ensures connectivity remains uninterrupted in case of primary connection issues.
- **Service Level Agreements (SLAs):** When contracting with an ISP, consider negotiating Service Level Agreements (SLAs) that define performance standards, including uptime guarantees, response times for issue resolution, and data transfer rates.
- Data Caps: Be aware of any data caps or fair usage policies that may apply to your internet plan. Unlimited data plans or plans with high data caps are usually preferred for public hotspots to accommodate multiple users.

- Quality of Service (QoS): Implement QoS settings to prioritize and allocate bandwidth to essential services, ensuring that critical applications receive sufficient bandwidth even during peak usage times.
- Content Filtering: If applicable, consider implementing content filtering solutions to block access
  to inappropriate or harmful websites, especially if the public Wi-Fi service is used in locations
  frequented by children or in educational environments.

#### **Step 4: Network Design**

Designing the network topology and capacity planning are crucial steps in setting up public Wi-Fi hotspots in central locations. Let's elaborate on these aspects:

#### **Network Topology:**

Hub-and-Spoke Design: A hub-and-spoke network design is a common choice for public Wi-Fi
hotspots. This topology connects a central router or hub to multiple access points (spokes). The
central router acts as the gateway to the internet and manages traffic routing to and from the
access points. This design is straightforward to set up and allows for centralized management and
monitoring. It's suitable for smaller to medium-sized deployments.

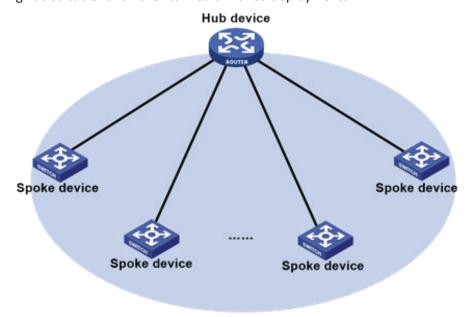


Fig. 9.2.6: A hub-and-spoke network design

Mesh Network: A mesh network may be considered when broader coverage is needed. Mesh
networks consist of interconnected access points that relay data to extend coverage. This topology
is suitable for larger areas or scenarios where running cables to all access points is challenging.
Mesh networks offer redundancy, as data can take multiple paths to reach its destination. However,
they can be more complex to set up and manage.

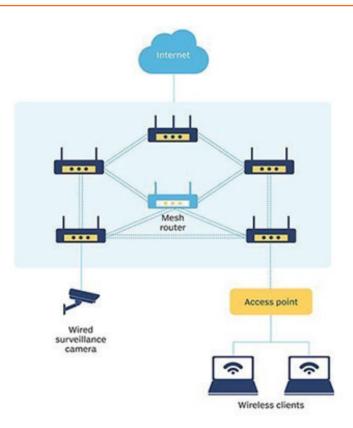


Fig. 9.2.7: Wireless Mesh Network

#### **Step 5: Installation and Configuration**

Proper installation and configuration are key steps in setting up public Wi-Fi hotspots. These steps ensure that the network is physically sound, secure, and user-friendly.

#### **Physical Installation:**

• Outdoor Access Points: If your hotspot includes outdoor access points, ensure they are installed in a way that protects them from environmental elements. Use outdoor-rated enclosures or enclosures designed for your specific access point model. This is especially important in locations where access points are exposed to rain, humidity, and extreme temperatures. Proper weatherproofing can prevent damage and maintain the functionality of equipment.



Fig. 9.2.8: WiFi Access Point

Mounting: Access points should be securely mounted to walls, poles, or other support structures.
 Mounting hardware should be appropriate for the location and equipment type. Ensure that access points are mounted at an optimal height and angle to provide the best coverage without obstructions.



Fig. 9.2.9: Access Point Mounts

• **Power Supply:** Access points may require a power source. Ensure that power cables and outlets are appropriately installed. In outdoor settings, consider Power-over-Ethernet (PoE) solutions to simplify cabling and reduce the need for separate power sources.



Fig. 9.2.10: PoE Adapter

#### **Network Configuration:**

- Access Point Configuration: Access points should be configured with strong security settings. For
  example, set up an SSID (Service Set Identifier) for your network and enable WPA3 encryption
  to secure communications. Restrict access to the network by implementing a pre-shared key or
  passphrase.
- **Guest Network:** It's often best to create a separate guest network to isolate guest traffic from internal or sensitive networks for public Wi-Fi. It ensures that users can access the internet without accessing your internal resources.
- Quality of Service (QoS): Implement Quality of Service (QoS) settings to prioritize and allocate bandwidth based on the type of traffic. Prioritize essential services to provide a better user experience. For example, give priority to VoIP traffic or video conferencing.
- **Firewall Rules:** Configure firewall rules to control traffic flow and protect the network from malicious activities. Block or restrict access to certain ports and services that are not needed for public Wi-Fi users.

#### **Splash Pages:**

- **User Authentication:** Create custom splash pages for user authentication. When users connect to the public Wi-Fi network, they are directed to a splash page where they must authenticate or agree to terms of service. Splash pages can be used to capture user information for analytics or provide additional information.
- Captive Portal Solutions: Implement a captive portal system that manages user access to the
  network. Some open-source solutions like CoovaChilli and commercial captive portal platforms
  offer customization options and advanced features. These solutions allow you to control user
  access, track usage, and customize the appearance of splash pages.
- **Terms of Service:** Clearly outline the terms of service for users on the splash page. This can include acceptable use policies, rules, and disclaimers. Users should agree to these terms before gaining access to the network.
- **Branding and Information:** Use the splash page to promote your brand or provide valuable information to users. This can include announcements, event details, or advertising.

#### **Step 6: Network Security**

#### **Firewalls and Intrusion Prevention:**

Implementing firewalls and intrusion prevention systems (IPS) is crucial to safeguard the public Wi-Fi network against unauthorized access and potential threats. This involves setting up barriers that monitor and filter network traffic. For instance, open-source solutions like Snort can detect and prevent intrusion. These systems identify and respond to suspicious or malicious activities, protecting the network and its users from cyberattacks.

#### **User Authentication:**

Ensuring secure user authentication is essential to control access to the public Wi-Fi network. RADIUS (Remote Authentication Dial-In User Service) servers offer an additional layer of security by centralizing user authentication. This centralized approach enhances security by validating user credentials before granting access to the network. Users must provide valid login information to access the Wi-Fi network, reducing the risk of unauthorized usage.

#### **Data Encryption:**

Robust data encryption is fundamental for protecting wireless connections. Utilizing protocols like WPA3 (Wi-Fi Protected Access 3) ensures that data transmitted over the network is encrypted, making it extremely challenging for malicious actors to intercept and decipher. Consider setting up a VPN (Virtual Private Network) gateway to enhance security further. A VPN encrypts traffic between the user's device and the internet, adding an extra layer of security and privacy to user communications.

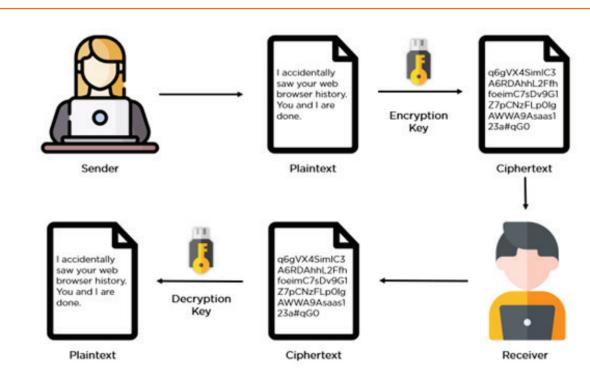


Fig. 9.2.11: Concept of Data Encryption

#### **Content Filtering:**

Content filtering is a valuable tool for managing and securing public Wi-Fi networks. Solutions like Squid or DansGuardian can be employed to filter web content, blocking access to malicious websites and inappropriate content. Content filtering helps maintain a safe and family-friendly browsing environment, especially in public places where a wide range of users access the network. It also reduces the risk of users stumbling upon harmful or unsuitable content while using public Wi-Fi.

#### **Step 7: Monitoring and Management**

#### **Network Management Tools:**

Effective network management is essential for ensuring the reliability and performance of a public Wi-Fi network. Tools like Nagios and Zabbix provide real-time monitoring and management capabilities. They continuously monitor network health, performance, and the availability of devices and services. Here's an elaboration:

- Real-time Monitoring: Nagios and Zabbix constantly monitor the network, checking the status of
  routers, switches, access points, and other critical components. This real-time monitoring allows for
  the immediate detection of issues or outages, ensuring quick responses to maintain uninterrupted
  service.
- Alerts and Notifications: These tools can be configured to send alerts and notifications when
  predefined thresholds are breached or when anomalies are detected. For instance, if network
  bandwidth usage exceeds a certain limit, administrators can receive alerts, allowing them to take
  corrective actions promptly.
- **Performance Metrics:** Nagios and Zabbix collect data on network performance, including bandwidth utilization, latency, and packet loss. These metrics help administrators identify performance bottlenecks and proactively address potential issues.
- **Service Availability:** Administrators can monitor the availability of network services and applications. If a service goes down, the system can automatically alert administrators to initiate troubleshooting and repairs.

 Resource Management: These tools assist in resource management by tracking the usage and availability of network resources. This helps in optimizing resource allocation and ensuring that the network functions efficiently.

#### **Usage Monitoring:**

Monitoring user behaviour and network usage is vital for both security and performance optimization. Tools like Wireshark, a packet analyzer, are used to gain insights into network traffic. Here's an elaboration:

- Traffic Analysis: Wireshark captures and analyzes network packets, allowing administrators to
  inspect the data transmitted over the network. It can help identify usage patterns, top bandwidth
  consumers, and potential anomalies.
- **Security Monitoring:** Wireshark can be used to detect suspicious activities or security breaches by examining network traffic for unauthorized access attempts, data exfiltration, or other irregularities.
- **Bandwidth Management:** By monitoring network traffic, administrators can identify applications or users consuming excessive bandwidth, which can help implement bandwidth management policies to ensure fair access for all users.
- **Troubleshooting:** When users experience connectivity issues or slow performance, Wireshark can be employed to trace the source of the problem. It helps in diagnosing and resolving network-related problems quickly.
- Quality of Service (QoS): Wireshark can be used to evaluate the quality of service provided by the network. It can help ensure critical applications receive the necessary bandwidth and are not adversely affected by less important traffic.

#### **Step 8: User Support and Helpdesk**

#### **Support Ticket System:**

Setting up a support ticket system, such as osTicket or Zendesk, is crucial to ensuring efficient user support and issue resolution on a public Wi-Fi network. Here's an elaboration:

- Efficient Issue Tracking: A support ticket system allows users to submit their queries, problems, or service requests, and these are then converted into tickets. This structured approach helps in organizing and tracking user issues effectively.
- Categorization: Users can categorize their issues (e.g., connectivity problems, login issues, or security concerns) when creating a ticket. This categorization streamlines the support process, enabling the support team to prioritize and address issues more efficiently.
- **Ticket Assignment:** The support ticket system allows administrators to assign tickets to specific support personnel based on their expertise. This ensures that issues are handled by individuals with the appropriate knowledge and skills to resolve them.
- **Progress Tracking:** Users and administrators can track the progress of their tickets. Users can see the status of their requests, and administrators can monitor the responsiveness and efficiency of their support team.
- **Response and Resolution:** The ticket system facilitates clear communication between users and support staff. It provides a platform for support agents to respond to user inquiries, seek additional information if needed, and ultimately mark tickets as resolved once the issue is fixed.
- **Historical Data:** The ticket system maintains a history of user issues and resolutions. This historical data is valuable for identifying recurring problems, improving service quality, and analyzing trends in user support needs.

#### **User Education:**

User education is critical to ensuring a public Wi-Fi network's secure and responsible usage. Providing user guides, FAQs, and security guidelines is essential to achieve this. User guides offer step-by-step instructions on connecting to the network, while FAQs address common user queries and provide insights into network policies and security practices.

Additionally, emphasizing the importance of secure internet practices, such as using secure connections and avoiding sensitive activities on public Wi-Fi, helps users protect themselves online.

Furthermore, instructing users on reporting security concerns and suspicious activities ensures that the network remains secure and reliable. User training workshops complement these resources by offering hands-on guidance, helping users configure their devices, and instilling best practices for online safety.

#### **Step 9: Regular Maintenance**

Regular maintenance of the public Wi-Fi network is essential to keep it secure, reliable, and performing optimally. Two crucial aspects of this maintenance include firmware updates and hardware maintenance.

- Firmware Updates: Access points and networking equipment rely on firmware to function.
   Manufacturers regularly release updates and patches to address known vulnerabilities and
   improve the device's performance. Regularly updating access point firmware ensures that security
   vulnerabilities are mitigated, reducing the risk of unauthorized access and potential threats.
   Staying up-to-date with firmware updates also allows you to take advantage of new features and
   enhancements offered by the manufacturer, improving the overall functionality of your network.
- Hardware Maintenance: Hardware components like access points, routers, and switches can
  degrade over time due to factors like environmental conditions and usage. Regular hardware
  maintenance involves inspecting these components, cleaning them, and addressing any issues
  promptly. This ensures that the equipment remains in optimal working condition, reducing the
  likelihood of unexpected failures or network disruptions. Effective hardware maintenance extends
  the lifespan of your equipment, which is cost-effective in the long run and contributes to the
  network's overall reliability.

#### **Step 10: Public Awareness**

Wi-Fi signage is more than just an information board; it plays a vital role in shaping the user experience and ensuring the responsible and secure usage of the public Wi-Fi network. Thoughtfully designed signage can contribute to the success of the network by providing users with all the necessary details while reinforcing the brand identity of the Telecom Grameen Udhyami. As a visual point of interaction with the service, it helps build trust, manage expectations, and promote safe online practices.

Regularly reviewing and updating Wi-Fi signage is also crucial. Changes in network policies, contact information, or legal requirements should be reflected in the signage promptly. By consistently maintaining clear and informative Wi-Fi signage, Telecom Grameen Udhyamis can offer their communities a user-friendly and secure public Wi-Fi experience.

#### **Step 11: Legal Considerations**

Drafting a privacy policy is a fundamental legal consideration for setting up and managing public Wi-Fi hotspots, as it helps establish transparency, build trust with users, and ensure compliance with data protection regulations.

The privacy policy should provide a clear and comprehensive overview of how user data is handled within the network. It typically includes the following elements:

- **Data Collection:** Explain what user data is collected while using the public Wi-Fi network. This may include information like MAC addresses, IP addresses, and browsing history.
- **Data Storage:** Clarify where and for how long user data is stored. Ensure that it is stored securely to protect user privacy.
- **Data Usage:** Detail the purposes for which user data is used. For instance, it may be used for network management, security monitoring, or analytical purposes.
- **Data Sharing:** Specify whether user data is shared with third parties and, if so, under what circumstances. If any data is shared, it should comply with relevant data protection laws.
- **User Rights:** Outline users' rights regarding their data, including the right to access, correct, and delete their personal information.
- **Security Measures:** Describe the security measures in place to protect user data from breaches and unauthorized access.
- **Contact Information:** Provide contact information for users to reach out with privacy-related concerns or inquiries.
- Compliance with Laws: Ensure that the privacy policy aligns with local, national, and international data protection regulations, such as the General Data Protection Regulation (GDPR) in Europe or applicable laws in India.
- **Updates:** Specify how and when the privacy policy will be updated to reflect changes in data handling practices or legal requirements.

Once the privacy policy is drafted, it should be made readily accessible to users, typically by providing a link to the policy on the splash page or signage. Users should be encouraged to read and understand the privacy policy before using the public Wi-Fi network.

Additionally, regular audits and reviews of the privacy policy are essential to ensure it remains compliant and effectively safeguarding user data.

#### **Step 12: Testing and Quality Assurance**

Pre-launch testing is critical in deploying public Wi-Fi hotspots, as it ensures that the network can perform optimally and withstand peak usage demands. To elaborate:

- Load Testing: Load testing is a fundamental component of pre-launch testing. It involves subjecting the network to simulated high loads to evaluate its performance under peak usage conditions. During load testing, several key aspects are assessed:
  - o **Network Capacity:** Load testing helps determine the maximum number of concurrent users the network can accommodate without a significant drop in performance. This is particularly crucial for public Wi-Fi hotspots, which are expected to serve numerous users simultaneously.
  - Bandwidth and Speed: Load testing assesses the network's ability to maintain consistent and high-speed connections even when multiple users stream content, conduct video calls, or download data.
  - Latency and Packet Loss: It evaluates network latency (delay in data transmission) and packet loss (data packets that fail to reach their destination). Low latency and minimal packet loss are essential for seamless user experiences, particularly for real-time applications.

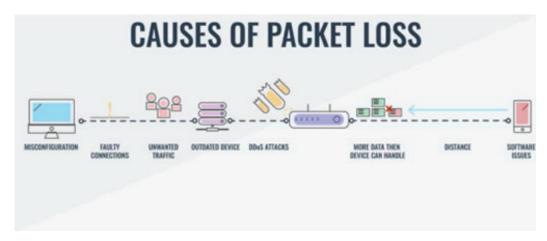


Fig. 9.2.12: Causes of Packet Losses

- o **Connection Stability:** The stability of connections during peak usage is assessed. This ensures that users don't experience frequent disconnections or disruptions, which can be frustrating and impact the network's reliability.
- Security Testing: In addition to load testing, security testing should also be part of the pre-launch testing process. This involves evaluating the network's vulnerability to common security threats, such as unauthorized access, data breaches, and malware. Robust security measures should be in place to protect user data and the network infrastructure.
- **Performance Optimization:** Based on the results of pre-launch testing, necessary optimizations can be implemented to improve network performance and stability. This may involve adjusting configurations, adding or relocating access points, or upgrading equipment to better handle peak loads.

#### **Step 13: Ongoing Security and Upkeep**

#### **Regular Security Audits:**

Security audits are a crucial aspect of maintaining the integrity of a public Wi-Fi hotspot. They involve scheduled assessments of the network's security measures and configurations to identify and rectify potential weaknesses. To elaborate:

- Vulnerability Scanning: Vulnerability scanning tools are used to systematically scan the network for known vulnerabilities in software, hardware, or configurations. This includes identifying unpatched software, misconfigured devices, or weak security settings. Once vulnerabilities are identified, they can be addressed promptly to mitigate potential security risks.
- Penetration Testing: Penetration testing, often called ethical hacking, involves simulating
  cyberattacks to assess the network's resilience against real-world threats. Ethical hackers attempt
  to exploit vulnerabilities to gain unauthorized access, allowing network administrators to identify
  security gaps and rectify them. Regular penetration testing helps ensure that the network's security
  measures remain effective against evolving threats.

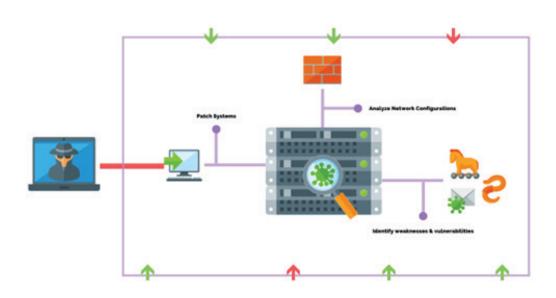


Fig. 9.2.13: WiFi Penetration Testing

#### **Incident Response Plan:**

An incident response plan is a documented strategy for handling various security incidents, such as security breaches, network outages, or other emergencies. It outlines the steps to be taken when an incident occurs and ensures a swift, coordinated, and effective response. Elements of an incident response plan include:

- Roles and Responsibilities: Clearly define the roles and responsibilities of team members involved in incident response. This includes incident coordinators, IT staff, and external contacts if necessary.
- **Incident Classification:** Establish a classification system for different types of incidents, such as minor disruptions, security breaches, or critical outages. This helps determine the appropriate response based on the severity of the incident.
- **Response Procedures:** Outline specific response procedures for each type of incident, including containment, eradication, and recovery steps. These procedures should be designed to minimize the impact of the incident and restore normal operations as quickly as possible.
- **Communication Plan:** Detail the communication plan for notifying relevant stakeholders, including users, management, and external authorities, if necessary. Clarity and transparency in communication are essential during incidents.
- **Documentation:** Maintain comprehensive documentation of each incident, including its timeline, actions taken, and outcomes. This documentation is invaluable for post-incident analysis and improvement of security measures.

# **9.2.5 Importance of Hardware and Software Repair Services**

Expert hardware and software repair and troubleshooting services are paramount for Telecom Grameen Udhyamis operating in villages. These services are vital in enhancing the effectiveness and sustainability of rural communities' telecom and hardware solutions. Here's why these services are crucial:

#### • Device Reliability and Functionality

- o **Enhanced Device Lifespan:** Expert repair and troubleshooting services ensure that devices such as smartphones, computers, and networking equipment have a longer lifespan. It reduces the frequency of replacements and associated costs.
- o **Improved Device Performance:** Regular maintenance and repairs can optimize device performance, allowing villagers to make the most of their hardware and software tools.

#### Cost-Efficiency

- o **Cost Savings:** Repairing devices is often more cost-effective than replacing them, which is especially important in economically challenged rural areas. It allows villagers to extend the utility of their existing hardware.
- o **Reduced Replacement Costs:** By providing repair services, Telecom Grameen Udhyamis can help villagers avoid the expense of purchasing new devices, making technology more accessible.

#### • Minimizing Downtime

- Less Disruption: Quick and effective repair services reduce the downtime associated with malfunctioning devices. This is particularly essential for businesses, students, and healthcare facilities that rely on technology for their operations.
- Improved Accessibility: Ensuring that devices are operational and accessible when needed
  ensures that villagers can stay connected, access information, and take advantage of digital
  services without unnecessary interruptions.

#### Sustainability

- Environmental Benefits: Repairing and refurbishing devices contribute to environmental sustainability by reducing electronic waste. This aligns with the principles of sustainable and responsible business practices.
- **Resource Conservation:** Extending the life of devices minimizes the consumption of resources required to manufacture new hardware.

#### • Empowerment and Inclusion

- o **Digital Inclusion:** Access to reliable repair services promotes digital inclusion by ensuring no one is left behind in the digital age. It empowers villagers to participate fully in the digital economy and society.
- o **Skill Development:** Repair and troubleshooting services can also involve training and skill development programs, enabling villagers to acquire valuable technical expertise.

#### Business Viability

- o **Diversified Revenue Stream:** Offering repair and troubleshooting services can provide an additional revenue stream for Telecom Grameen Udhyamis, enhancing their sustainability and ability to reinvest in the community.
- o **Business Growth:** By establishing a reputation for quality repair services, Telecom Grameen Udhyamis can attract a loyal customer base and expand its service offerings.

#### • Customer Trust and Satisfaction

- Customer-Centric Approach: Providing repair and troubleshooting services demonstrates a commitment to customer satisfaction. Villagers are more likely to trust and continue using the services of a Telecom Grameen Udhyami, that offers comprehensive support.
- o **Positive Word-of-mouth:** Satisfied customers are more likely to recommend the services to others, facilitating the growth of the business.

## 9.2.6 Collaborating with Government Officials and NGOs

Collaborating with government officials and NGOs to establish village information centers with computer setups and internet connectivity is a strategic approach that can significantly enhance the impact of Telecom Grameen Udhyamis (Telecom Grameen Udhyamis) in rural areas. This collaborative effort serves as a bridge to bring digital services, knowledge, and opportunities to underserved communities.

One of the key steps in this collaboration is to identify and engage with local government representatives. They play a pivotal role in understanding the unique needs of the village and can facilitate access to resources and support for the information center. Actively participating in local government meetings and community gatherings allows Telecom Grameen Udhyamis to build relationships, gather input, and align their initiatives with the community's priorities.

Creating a well-structured proposal is paramount. It should clearly outline the objectives and benefits of the village information center, emphasizing its role in digital empowerment, government service accessibility, and information dissemination. This proposal becomes a foundational document to present to government officials, NGOs, and potential funding sources, demonstrating the project's potential impact on rural development and digital inclusion.

Collaborating with NGOs, especially those with a focus on rural development and digital literacy, brings expertise and experience to the table. These organizations often have resources and knowledge that can complement TGLUs' efforts, from technical support and training to project management and community engagement. Together, they can create a comprehensive and sustainable solution for the village, ensuring that it meets the specific needs and aspirations of the local population.

In addition to financial support, this collaboration can also facilitate access to government schemes and funding opportunities, which can be instrumental in realizing the village information center. By sharing infrastructure costs, ensuring legal and regulatory compliance, and conducting impact assessments, TGLUs can create a network of stakeholders committed to improving digital access, education, and empowerment in rural areas.

### **UNIT 9.3: Introduction to UPS Installation and Maintenance**

# - Unit Objectives



#### By the end of this unit, the participants will be able to:

- 1. Identify various types of UPS and batteries used in them.
- 2. Perform measurements and analysis of voltage, current, and earthing to ensure correct UPS installation.
- 3. Demonstrate the process to route the power supply through the UPS and handle power supplies with necessary precautions.
- 4. Explain the consequences of not maintaining the UPS regularly.

# 9.3.1 Uninterruptible Power Supplies (UPS)

UPS (Uninterruptible Power Supply) is a device used to provide backup power in case of electrical interruptions, ensuring that critical electronic equipment continues to operate without disruption. UPS systems are commonly used to protect computers, servers, networking equipment, and other sensitive electronic devices from power outages, surges, and other electrical disturbances.



Fig. 9.3.1: UPS

There are several types of UPS systems, categorized based on how they function and the types of batteries they use:

#### Standby UPS (Offline UPS)

- o In standby mode, the UPS simply passes through the utility power to the connected devices. It switches to battery power when it detects a power outage.
- o Typically uses lead-acid batteries or sealed lead-acid batteries.



Fig. 9.3.2: Standby UPS

#### • Line-Interactive UPS

- **Function:** These UPS systems are similar to standby UPS but offer automatic voltage regulation (AVR) to stabilize voltage fluctuations.
- o **Battery Type:** Commonly uses valve-regulated lead-acid (VRLA) batteries, which include gel and AGM batteries.



Fig. 9.3.3: Line Interactive UPS

#### • Online UPS (Double-Conversion UPS)

- o **Function:** The most advanced type of UPS, an online UPS, continuously provides clean power by converting incoming AC power to DC power and then back to AC power. It offers the highest level of protection and can handle all types of electrical disturbances.
- o **Battery Type:** Typically uses sealed lead-acid batteries, nickel-cadmium (NiCd) batteries, or lithium-ion batteries for higher-end models.



Fig. 9.3.4: Double-Conversion UPS

#### • Ferroresonant UPS (Constant Voltage Transformer, CVT)

- **Function:** Ferroresonant UPS systems use a ferroresonant transformer to regulate voltage and provide a constant output voltage even during power fluctuations.
- o Battery Type: Usually employs sealed lead-acid batteries.



Fig. 9.3.5: Constant Voltage Transformer

#### Delta Conversion Online UPS

- **Function:** Similar to online UPS but with an extra stage called a delta converter, which helps reduce the number of power interruptions during certain events.
- o **Battery Type:** Typically uses sealed lead-acid or lithium-ion batteries.



Fig. 9.3.6: Delta Conversion Online UPS

#### • Hybrid UPS

o **Function:** Hybrid UPS systems combine elements of different UPS types to optimize efficiency and performance. They may integrate line-interactive or online technology with energy storage systems, such as lithium-ion batteries, to provide efficient backup power.



Fig. 9.3.7: Hybrid UPS

#### Flywheel UPS (Kinetic Energy UPS)

- o **Function:** Instead of traditional batteries, flywheel UPS systems store energy in a spinning flywheel. This kinetic energy is converted back into electrical energy during power outages.
- o **Battery Type:** The "battery" in this case, is the flywheel itself, which typically consists of a high-speed, low-friction rotor.



Fig. 9.3.8: Flywheel UPS (Kinetic Energy UPS)

#### Fuel Cell UPS

- o **Function:** Some advanced UPS systems, such as hydrogen fuel cells, use fuel cell technology as a power source, providing extended runtime and environmental benefits.
- o Battery Type: Utilizes fuel cells, not traditional batteries.



Fig. 9.3.9: Fuel Cell UPS

# 9.3.2 Types of Batteries Used in UPS

The type of battery best suited for a particular UPS system will depend on several factors, including the size of the system, the runtime requirements, and the budget.

The main types of batteries used in UPS systems are:

#### **Lead-Acid Batteries**

Lead-acid batteries are the most common type of battery used in UPS systems. They are relatively inexpensive and have a long lifespan. However, they are also the heaviest type of battery and require regular maintenance.

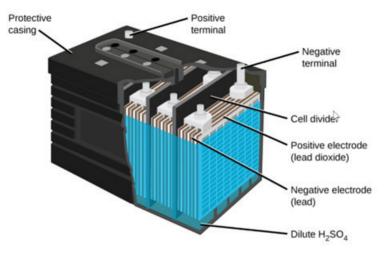


Fig. 9.3.10: Lead Acid Battery

Lead-acid batteries are divided into two main types: Flooded cell and Valve-regulated lead-acid (VRLA). Flooded cell batteries require regular maintenance to check and top off the electrolyte levels. VRLA batteries are more maintenance-free, but they are also more expensive.

#### **Nickel-Cadmium Batteries**

Nickel-cadmium batteries are more expensive than lead-acid batteries but are also lighter and have a longer lifespan. However, they are more susceptible to extreme temperatures and require more frequent charging.

Due to the environmental concerns associated with cadmium, these batteries are not as widely used in UPS systems as they were in the past. However, they are still a good option for applications where high performance and long lifespan are required.



Fig. 9.3.11: Nickel-Cadmium Batteries

#### **Lithium-ion Batteries**

Lithium-ion batteries are the most expensive type of battery used in UPS systems, but they are also the lightest and have the longest lifespan. They are also less susceptible to extreme temperatures and require less frequent charging.



Fig. 9.3.12: Lithium Battery

These are the newest types of batteries used in UPS systems. They are the most expensive type of battery, but they also offer the best performance and lifespan.

# 9.3.3 Analysis of Voltage, Current, and Earthing of UPS

Correctly measuring and analyzing voltage, current, and earthing during UPS installation is essential for its safe and reliable operation. It helps prevent overloading, ensures compliance with electrical standards, and minimizes the risk of electrical hazards.

#### **Voltage Measurements**

#### • Input Voltage:

- Measure the voltage of the incoming utility power to ensure it falls within the acceptable range specified by the UPS manufacturer. This range is typically provided in the UPS user manual or data sheet.
- Use a digital multimeter or voltage meter to measure the input voltage at the UPS input terminals.

#### • Output Voltage:

- o Verify the output voltage provided by the UPS under normal conditions. This output voltage should also fall within the acceptable range.
- o Connect a load to the UPS and measure the output voltage under load conditions to ensure it remains within the specified range.



Fig. 9.3.13: Digital Multimeter

#### **Current Measurements**

#### • Input Current:

- o Measure the input current drawn by the UPS from the utility power source. This helps determine the load on the UPS and ensures it's within its rated capacity.
- o Use a digital clamp meter to measure the input current on the input power cables of the UPS.

#### Output Current:

- o Measure the output current delivered by the UPS when it's supplying power to the connected load. This helps verify that the UPS can handle the connected load without overloading.
- Use a digital clamp meter to measure the output current on the output power cables from the UPS.



Fig. 9.3.14: Digital Clamp Meter

#### **Earthing Analysis**

#### **Grounding System Inspection:**

Corrosion and Damage Check: Inspect the grounding components, including grounding electrodes
(usually copper rods or plates), grounding conductors (copper or aluminium wires), and ground
connections (clamps or connectors) for any signs of corrosion, physical damage, or deterioration.
Ensure that all components are in good condition.



Fig. 9.3.15: Corrosion in Grounding Copper Pipe

- Local Electrical Codes and Standards: Consult local electrical codes and standards to determine
  the specific requirements for grounding in your area. These standards often prescribe the size and
  material of grounding electrodes and conductors and the minimum and maximum acceptable
  resistance values.
- **Ground Resistance Tester (Ground Megger):** Use a ground resistance tester (also known as a ground megger) to measure the resistance of the grounding system. Here's how:
  - o Disconnect the grounding conductor from the earth electrode (grounding rod or plate).
  - o Connect one lead of the ground resistance tester to the grounding conductor's exposed end.
  - o Connect the other lead to the earth electrode where the grounding conductor was originally attached.
  - o Initiate the ground resistance test. The tester will generate a known voltage and measure the resistance. It will provide you with a resistance value in ohms.
  - o Compare the measured resistance with the local electrical code or standard requirements. The grounding system is compliant if the measured resistance falls within the acceptable range.



Fig. 9.3.16: Ground Resistance Tester

#### **UPS Grounding:**

- **Grounding Lug or Terminal:** Most UPS systems have a grounding lug or terminal designated for connection to the grounding system. Ensure that this grounding point is clean, corrosion-free, and securely connected to the UPS chassis.
- **Measuring Resistance:** To measure the resistance between the UPS grounding point and the building's grounding system, follow these steps:
  - o Use a digital multimeter set to the resistance (ohms) measurement mode.
  - o Connect one multimeter lead to the UPS's grounding point (grounding lug or terminal).
  - o Connect the other multimeter lead to the building's grounding system, typically at the grounding electrode or an accessible ground point on a metal structure.
  - o Record the measured resistance value.
- Acceptable Resistance Limits: Compare the measured resistance with the acceptable limits specified
  in your local electrical code or standards. Typical acceptable resistance values are relatively low,
  often less than 1 ohm. The UPS grounding is considered satisfactory if the measured resistance is
  within these limits.

If any part of the grounding system or UPS grounding is found to be non-compliant or if the resistance values exceed the acceptable limits, corrective actions should be taken to rectify the issue. This may involve cleaning, repairing, or replacing components or connections to ensure proper grounding and electrical safety.

# 9.3.4 Routeing the Power Supply Through UPS -

Routing power through a UPS (Uninterruptible Power Supply) is critical to ensure that your sensitive electronic equipment remains operational during power interruptions.

Elaboration on the guide to routing power through a UPS

#### Step 1: Choose the Appropriate UPS

When choosing a UPS, there are a few key factors to consider:

- **Load requirements:** The UPS must be able to handle the power requirements of all the equipment that will be connected to it. This includes the VA (volt-amperes) and Watts rating of the equipment.
- **UPS topology:** There are three main types of UPS topologies: standby, line-interactive, and online. Standby UPSs are the least expensive but offer the least protection. Line-interactive UPSs offer better protection than standby UPSs but are also more expensive. Online UPSs offer the highest protection level but are also the most expensive.
- **Features:** Some UPSs come with additional features, such as network monitoring, automatic shutdown software, and extended runtime options. Consider which features are important to you and choose a UPS that has them.

#### Step 2: Determine the Load

To determine the load you want to connect to the UPS, calculate the total VA (volt-amperes) and Watts rating of all the equipment you will be connecting. You can find this information on the equipment's power supply label.

It is also important to be aware of the load's power factor (PF). The PF indicates how efficiently the UPS converts VA into Watts. A PF of 1 is ideal, but many electronic devices have a PF of 0.8 or lower. When choosing a UPS, select one rated for the load's VA and Watts rating at the load's PF.

#### **Step 3: Location and Placement**

The UPS should be placed in a well-ventilated area to dissipate heat generated during operation. It is also important to avoid placing the UPS near direct heat sources or in areas prone to moisture or extreme temperatures.

The UPS should also be placed on a level surface and should be easily accessible for maintenance and cooling.

#### **Step 4: Connect the Input Power**

The input power source for the UPS should provide the required voltage and frequency specified for the UPS. Typically, this is 120V or 230V AC at 50/60 Hz.

A suitable power cord or cable connects the UPS to the main power source. Ensure the cable has the right plug type for your region.

#### **Step 5: Connect the Output Power**

The UPS has output receptacles, often a mix of standard and battery-backed outlets. Critical equipment should be connected to the battery-backed outlets to ensure they receive backup power during outages.

#### **Step 6: Grounding**

Proper grounding is essential for safety and effective operation. The UPS chassis should be connected to an appropriate grounding system, which includes a grounding conductor and electrode.

A digital multimeter should measure the resistance between the UPS's grounding point and the building's grounding system. The resistance should typically be less than 1 ohm.

#### **Step 7: Configure UPS Settings**

The UPS may have a variety of settings that can be configured, such as input voltage sensitivity, battery runtime, and alarm notifications. Consult the UPS manual for instructions on how to configure these settings.

#### Step 8: Test the UPS

Once the UPS is connected and configured, it is important to test it to ensure that it is working properly. This can be done by initiating a self-test on the UPS. During the self-test, the UPS simulates a power outage. Confirm that it seamlessly switches to battery power and protects your equipment.

#### **Step 9: Battery Charging**

Allow the UPS to charge its internal batteries fully. The charging time depends on the UPS model and the state of the batteries.

Battery health should be regularly monitored, and ageing or failing batteries should be replaced promptly.

#### **Step 10: Regular Maintenance**

Perform routine maintenance on the UPS, including checking for alarms, error messages, or visible issues.

As the manufacturer recommends, maintain an up-to-date service schedule, including inspections and battery replacements.

#### **Step 11: Backup Power Monitoring**

Implement UPS monitoring software to track the UPS's status and the condition of connected devices. Configure email or SMS notifications to alert you during a power outage or UPS fault.

#### **Step 12: Emergency Shutdown Procedures**

Establish emergency shutdown procedures for extended power outages. Safely power down nonessential equipment to maximize battery runtime for critical systems. Ensure that automatic shutdown software is in place to execute these procedures when necessary.

## 9.3.5 Handle Power Supplies with Necessary Precautions

Handling power supplies safely is paramount in residential and industrial settings to prevent electrical hazards. Telecom technicians and other professionals working with power supplies should adhere to strict safety guidelines to ensure individuals' well-being and the equipment's integrity.

First and foremost, before any work is conducted on electrical equipment or power supplies, it is imperative to disconnect them from the power source. This entails unplugging the power cord or shutting off the relevant circuit breaker to eliminate the risk of electrical shock. Personal Protective Equipment (PPE) is essential, and technicians should be outfitted with appropriate gear, including insulating gloves, safety glasses, and non-conductive footwear. This PPE is critical in reducing the risk of electrical shock during handling.

Visual inspections play a crucial role in safety maintenance. Regularly examining power supply units and cords for signs of visible damage, such as frayed wires, exposed conductors, or overheating, ensures early detection and remediation of potential hazards. Additionally, power supplies and electrical equipment should be kept away from water and moisture to prevent electrical shorts and the risk of shock. Maintaining a dry work environment is equally important, with attention to keeping the area free from water or other conductive materials that may induce electrical hazards.

Proper grounding of power supplies and equipment is a fundamental safety measure. Adequate grounding helps dissipate electrical charges safely and prevents equipment damage. Overloading electrical outlets or power strips should be strictly avoided as it can lead to overheating and fire hazards. Technicians should always verify that the power supply voltage and frequency match the requirements of the connected equipment, ensuring that an incorrect voltage or frequency does not damage equipment or pose safety risks.

Secure power cords and cables with cable management solutions to minimise tripping hazards. The routing of power cables should also be carefully planned, avoiding areas with heavy foot traffic or under rugs and furniture to prevent damage. Properly labelling of power supplies and cords with their ratings and usage instructions simplifies identification and ensures correct use. When disconnecting a power supply, technicians should follow proper procedures, firmly grasping the plug and pulling it out by the plug, not the cord, to prevent damage.

Maintaining adequate ventilation for power supplies to prevent overheating is essential, and ventilation openings should never be blocked or covered. In cases of emergencies, such as electrical faults, short

circuits, or fires, it is crucial to develop and document emergency shutdown procedures. All personnel handling power supplies should be well-versed in these procedures to ensure efficient execution.

Training programs should be established to educate individuals who handle power supplies, ensuring they understand safety procedures and precautions. Additionally, technicians must follow lockout/tagout procedures in industrial settings to prevent accidental energization when working on electrical equipment. This involves isolating the power source and attaching a lock or tag to indicate that work is being conducted, adding an extra layer of safety.

Regular maintenance and inspections of power supplies and associated equipment should be scheduled, enabling the identification and resolution of potential issues before they become hazards. Strict adherence to these safety guidelines is crucial to maintaining a secure environment while handling power supplies, whether in a residential or industrial setting.

# 9.3.6 Consequences of Not Maintaining the UPS Regularly

The consequences of not maintaining a UPS regularly can be severe, especially for businesses and organizations that rely on critical electronic equipment. Some of the potential consequences include:

- **Reduced battery life:** UPS batteries typically have a 2-4 years of lifespan, but this can be shortened by improper maintenance. For example, the batteries can overheat and degrade more quickly if the UPS is not kept in a cool, well-ventilated area.
- Increased risk of failure: A poorly maintained UPS is more likely to fail during a power outage, leaving critical equipment unprotected. This can lead to data loss, productivity disruptions, and costly repairs.
- **Safety hazards:** A malfunctioning UPS can pose a safety hazard, such as a fire or electrical shock. It is essential to regularly inspect the UPS for any signs of damage or wear and tear.
- **Compliance issues:** Some businesses and organizations must maintain their UPS systems per industry regulations or best practices. Failure to do so could result in fines or other penalties.

# **UNIT 9.4: Technology Setup and Consultation**

# **Unit Objectives**



#### By the end of this unit, the participants will be able to:

- 1. Explain how to coordinate with healthcare providers to set up and manage telemedicine centers, ensuring proper equipment and connectivity
- 2. Discuss how to assist in installing and maintaining security measures like CCTV cameras, ensuring proper functioning and coverage.
- 3. Demonstrate the correct procedure to install and configure internet connectivity solutions in homes and businesses, such as broadband or wireless connections.
- 4. Show how to configure and establish local area networks (LANs) in offices and homes, enabling file sharing and communication.
- 5. Show how to install and provide support for software applications, remove viruses and malware, and perform data backup and recovery.
- 6. Provide personalized advice and consultation services to individuals and businesses on technology-related matters, addressing their specific needs.
- 7. Explain the role of technology advice and consultation services in helping individuals and businesses make informed decisions.
- 8. Outline the importance of providing technology-related advice and consultation to individuals and businesses.

# **9.4.1 Set Up and Manage Telemedicine Centers**

Telemedicine is using telecommunication and information technologies to provide healthcare services at a distance. It allows patients to consult with healthcare providers remotely without travelling to a medical facility. Telemedicine can be used to diagnose and treat a wide range of medical conditions, including chronic diseases, acute illnesses, and mental health issues.

Telemedicine is delivered using various technologies, including video conferencing, telephone, and messaging apps. Patients can typically schedule telemedicine appointments with their regular healthcare providers or use telemedicine services to consult with specialists or providers in other locations.

Healthcare providers in telemedicine, also known as telehealth, are medical professionals and institutions that offer healthcare services remotely, typically through the use of digital communication technologies.

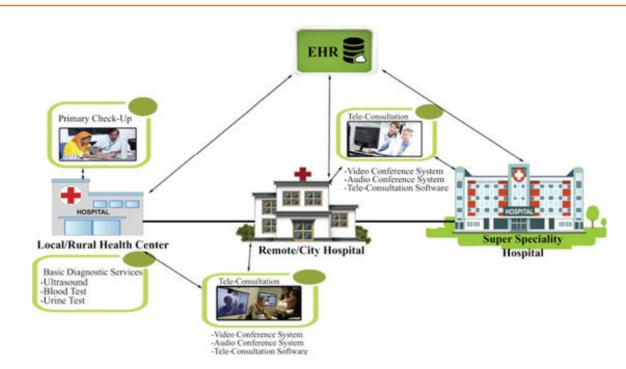


Fig. 9.4.1: Concept of TeleMedicine Center

To coordinate with healthcare providers to set up and manage telemedicine centers, ensuring proper equipment and connectivity, a Telecom Grameen Udhyami can follow these steps:

- Identify local healthcare providers: The first step is to identify local healthcare providers who are interested in participating in telemedicine programs. Telecom Grameen Udhyami can do this by contacting local hospitals, clinics, and private practitioners.
- Assess the needs of the community: Once Telecom Grameen Udhyami has identified interested
  healthcare providers, they should assess the needs of the community to determine what types
  of telemedicine services are most needed. This can be done through surveys, focus groups, and
  interviews with community members.
- **Develop a plan:** Based on the needs of the community and the capabilities of the participating healthcare providers, Telecom Grameen Udhyami should develop a plan for setting up and managing the telemedicine centers. The plan should include details about the following:
  - The type of equipment that will be needed
  - The type of connectivity that will be needed
  - o The staffing requirements
  - The procedures for scheduling and delivering telemedicine appointments
- **Secure funding:** Telecom Grameen Udhyami may need to secure funding to set up and manage the telemedicine centers. This funding can come from a variety of sources, such as government grants, private donations, and corporate sponsorships.
- **Purchase and install equipment:** Once Telecom Grameen Udhyami has secured funding, they can purchase and install the necessary equipment in the telemedicine centers. The equipment may include video conferencing systems, medical devices, and computers.
- **Establish connectivity:** Telecom Grameen Udhyami must establish reliable and high-speed internet connectivity for the telemedicine centers. This can be done through various providers, such as mobile network operators, fixed-line internet providers, and satellite internet providers.

# 9.4.2 Installing and Maintaining Security Measures (CCTV)

Closed-circuit television (CCTV) cameras come in various types, each designed for specific surveillance needs and environments. Here are some common types of CCTV cameras:





















Fig. 9.4.2: Types of CCTV Cameras

Assisting in installing and maintaining security measures like CCTV (Closed-Circuit Television) cameras in a village is a valuable service that Telecom Grameen Udhyamis can provide to enhance the safety and security of the community.

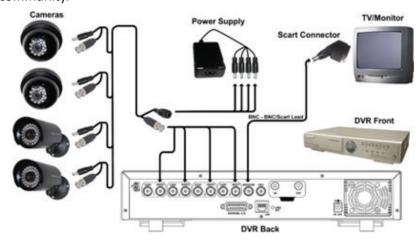


Fig. 9.4.3: Working of CCTV

Here's a step-by-step guide on how to effectively install and maintain CCTV camera systems in the village:

#### **Installation Phase**

- Assess Security Needs: Begin by conducting a comprehensive security needs assessment in collaboration with local authorities and community members. Identify high-risk areas and key locations where CCTV cameras can provide maximum coverage.
- **Select Camera Locations:** Determine the strategic placement of CCTV cameras based on the assessment. Common locations include public areas, entry and exit points, streets, marketplaces, and community centers. Ensure that cameras cover both public and private spaces.
- **Procure Quality CCTV Equipment:** Source high-quality CCTV cameras, DVR (Digital Video Recorder) systems, monitors, power sources, and cabling. Ensure that the selected equipment is durable, weather-resistant, and capable of producing clear video footage.
- **Professional Installation:** Employ trained technicians or collaborate with professional installation services to install the cameras. Ensure that cameras are securely mounted, positioned at optimal angles, and connected to the DVR system for recording.
- Wiring and Connectivity: Set up the necessary wiring for power and data transmission. If wireless cameras are used, ensure a stable and secure Wi-Fi or cellular network connection. Consider backup power options to keep cameras operational during power outages.
- **Data Storage and Monitoring:** Establish a secure data storage system (DVR or cloud-based) to store video footage. Configure remote monitoring capabilities, allowing authorized personnel like local law enforcement to access live feeds and recorded footage.
- **Regulatory Compliance:** Ensure compliance with local and national regulations concerning the use of CCTV cameras. Obtain any required permits and permissions from relevant authorities.

#### **Maintenance and Monitoring**

- **Regular Inspections:** Schedule routine inspections of the CCTV camera system to check for physical damage, tampering, or malfunction. Ensure that all cameras are functional and aligned correctly.
- Cleaning and Maintenance: Clean camera lenses, housings, and cables as needed to maintain clear video quality. Regularly service and maintain the system components, including the DVR and storage devices.
- **Technical Support:** Establish a dedicated technical support team or hotline to address any technical issues or concerns the community reports. Ensure a swift response to technical problems to minimize downtime.
- **Security Measures:** Implement security measures to protect the CCTV system from vandalism and unauthorized access. It may include securing the cameras with tamper-proof casings and maintaining password protection for access to the system.
- **Community Engagement:** Educate the local community about the presence and purpose of CCTV cameras. Encourage residents to report any security incidents or concerns to local authorities.
- Collaboration with Local Authorities: Foster collaboration with local law enforcement agencies to ensure they have access to CCTV footage when investigating incidents. Share recorded video footage when necessary to assist in law enforcement efforts.
- **Evaluate and Upgrade:** Periodically assess the effectiveness of the CCTV system and consider necessary upgrades or expansions based on evolving security needs and technological advancements.

# 9.4.3 Internet Connectivity Solutions in Homes and Businesses

In rural villages, ensuring reliable and efficient connectivity solutions for homes and businesses is essential for bridging the digital divide and facilitating economic development.



Fig. 9.4.4: Internet Access Technologies

The common connectivity solutions in homes and businesses in a village are:

- **Broadband:** Broadband is a high-speed internet connection that can be used to access the internet, stream movies and TV shows, play online games, and make video calls. Broadband can be delivered through a variety of technologies, including:
  - DSL (Digital Subscriber Line): DSL technology utilizes existing telephone lines to deliver highspeed internet to homes and businesses. It's widely available and often more affordable than other options, making it a practical choice for many villages.
  - o **Cable:** Cable internet uses coaxial cables primarily designed for television services. It's known for delivering high-speed internet and is a suitable option if the infrastructure is available in the area.



Fig. 9.4.5: Coaxial Cables with Connectors

o **Fiber optic:** Fiber optic internet is the fastest broadband option, using light signals to transmit data. While it offers incredible speed and reliability, its availability in rural areas may be limited due to the high cost of laying fiber optic cables.



Fig. 9.4.6: Fiber Optic Cables

Wireless: Wireless internet connections, such as Wi-Fi or fixed wireless solutions, use radio waves
to transmit data. They are more cost-effective to set up and are an excellent choice for areas where
laying physical cables is impractical or costly. However, they may have limited coverage or be subject
to interference, affecting reliability and speed.



Fig. 9.4.7: Fixed Wireless Internet

• **Satellite:** Satellite internet is an option for remote rural areas with no access to traditional broadband services. It relies on communication with satellites in space, which means it can cover vast geographical areas. However, satellite internet can be more expensive and comes with latency issues, affecting data transmission speed.

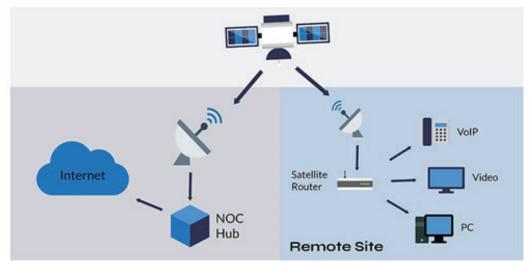


Fig. 9.4.8: Working of Satellite Internet

In selecting the most appropriate connectivity solution for a village, Telecom Grameen Udhyamis should consider several factors, including the village's geographic location, the existing infrastructure, budget constraints, and the specific needs of the local community. By offering a mix of these connectivity solutions and addressing the unique challenges faced by rural areas, they can significantly contribute to improving the quality of life and economic prospects for villagers.

# 9.4.4 Install and Configure the Internet Connectivity Solutions

To install and configure internet connectivity solutions in homes and businesses in a village by Telecom Grameen Udhyami, such as broadband or wireless connections, the following steps can be followed:

#### Assessment and Planning

- o **Needs Assessment:** Conduct a thorough survey of the community to identify the number of potential users, their expected data usage, and the types of online activities they engage in.
- o **Infrastructure Evaluation:** Evaluate the existing infrastructure, including the availability of wired broadband services and the feasibility of setting up wireless connectivity. Assess wireless solutions' coverage, signal strength, and interference sources.
- o **Budget and Resources:** Calculate the budget required for equipment procurement, infrastructure setup, and ongoing maintenance. Seek funding from government grants, private investors, and partner organizations, and allocate resources accordingly.

#### • Selecting Internet Connectivity Type

 Broadband or Wireless: Based on the assessment, decide whether wired broadband or wireless technology is the most suitable. For wired broadband, consider the available options like DSL, cable, or fiber-optic. Explore technologies like 4G/5G mobile broadband or point-to-point wireless connections for wireless solutions.

#### Acquiring Equipment and Services

- o **Equipment Procurement:** Purchase enterprise-grade networking equipment such as routers, switches, access points, DSL modems, fiber-optic transceivers, or wireless CPEs. Ensure the selected hardware is robust, reliable, and suited to the community's needs.
- o **Service Provider Selection:** Partner with a reputable internet service provider (ISP) that can offer dedicated lines for broadband or high-quality wireless broadband services. Ensure the chosen ISP can provide the necessary bandwidth and reliability.

#### • Installation and Configuration

- Physical Setup: Install networking equipment in central locations, ensuring proper ventilation and protection from the elements. For broadband connections, deploy modems and routers on user premises. Set up outdoor access points with line-of-sight to user locations for wireless solutions.
- o **Network Configuration:** Configure the equipment with security measures. Implement encryption, such as WPA3, to protect data in transit. Set up VLANs and virtual LAN segmentation for network management and user separation.
- Connectivity Testing: Conduct extensive testing to ensure that each user location receives an
  adequate and consistent internet connection. Verify signal strength, signal-to-noise ratios, and
  bandwidth availability.

#### Network Security and Management

 Security Measures: Implement firewalls, intrusion detection systems (IDS), intrusion prevention systems (IPS), and content filtering to protect the network against cyber threats. Use opensource solutions like Snort for IDS/IPS.

- o **User Authentication:** Employ secure authentication methods like RADIUS (Remote Authentication Dial-In User Service) for centralizing user access control.
- o **Data Encryption:** Utilize robust data encryption protocols like WPA3 for wireless connections. Consider setting up a VPN gateway for enhanced security.
- o **Content Filtering:** Deploy tools like Squid or DansGuardian to block malicious websites and filter inappropriate content, ensuring a safe browsing experience.

#### • Network Monitoring and Management

- o **Network Management Tools:** Utilize network management tools like Nagios, Zabbix, or Cacti to monitor the network's health performance and detect potential issues in real-time.
- Usage Monitoring: Implement network traffic analysis tools like Wireshark or ntop to monitor usage patterns, detect irregularities, and identify any suspicious activities that may compromise network integrity.

#### Maintenance

 Regular Maintenance: Perform scheduled maintenance activities, including firmware updates for networking equipment, hardware inspections, and optimization measures to ensure a robust and reliable internet connection.

# 9.4.5 Establishing Local Area Networks (LANs) in Offices and Homes

A LAN, or Local Area Network, is a network of interconnected devices within a limited geographical area, such as a home, office, or a small group of buildings in close proximity. LANs are designed to facilitate sharing of resources and data between connected devices, making it easier for users to communicate and collaborate.

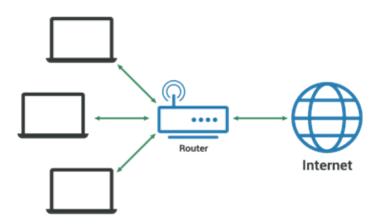


Fig. 9.4.9: A Simple Graphical Representation of LAN

LANs are commonly used in homes and small offices to connect computers, printers, smartphones, and other devices to share files, printers, and internet access. Larger organizations and enterprises often have extensive LANs that support a wide range of services and applications, including data storage, email, and more.

Configuring and establishing Local Area Networks (LANs) in offices and homes for file sharing and communication requires a structured approach.

Here, we'll provide a step-by-step guide for Telecom Technicians:

#### **Step 1: Define Network Requirements**

Before setting up a LAN, it's essential to understand the specific needs of the office or home. Consider factors like the number of users, the types of devices (computers, printers, phones), data transfer requirements, and the physical layout of the space. This initial assessment will guide subsequent decisions.

#### **Step 2: Choose Network Topology**

Select a network topology that suits the requirements:

- Star Topology: A central hub (switch or router) connects all devices.
- Bus Topology: All devices are connected to a central cable.
- Ring Topology: Devices form a closed loop.
- Mesh Topology: Every device is connected to every other device.

Most home and small office networks use the star topology as it's simple and scalable.

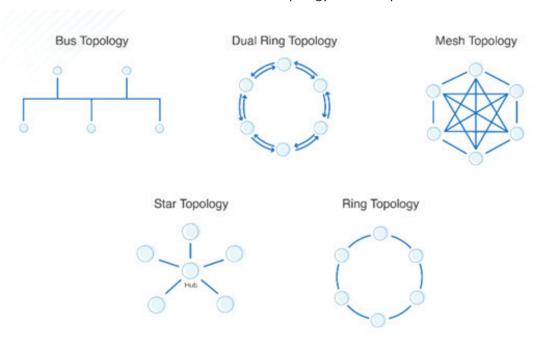


Fig. 9.4.10: Common Network Topologies

#### **Step 3: Select Network Hardware**

Invest in quality networking hardware:

• **Router:** A router connects your LAN to the internet. Choose one with sufficient ports and Wi-Fi capabilities.



Fig. 9.4.11: WiFi Router

• **Switch:** For wired connections, a switch is needed to connect devices.



Fig. 9.4.12: Network Switch

• Access Points: If deploying Wi-Fi, access points (APs) are used to provide wireless connectivity.



Fig. 9.4.13: Access Pont

• Ethernet Cables: Ensure you have Cat6 or higher quality cables for wired connections.



Fig. 9.4.14: Ethernet Cables

Network Adapters: Install network adapters (Ethernet or Wi-Fi) on all devices.



Fig. 9.4.15: Network Adaptor

#### **Step 4: IP Address Assignment**

Configure IP addressing:

• **Dynamic Host Configuration Protocol (DHCP):** Enable DHCP on the router to automatically assign IP addresses to devices.

## **Dynamic Host Configuration Protocol**



Fig. 9.4.16: Dynamic Host ConFig.uration Protocol (DHCP)

• Static IP: For some devices like printers or servers, use static IP addresses for consistent access.

#### **Step 5: Configure the Router**

Access the router's web interface and set up essential configurations:

- SSID: Define the network name (SSID) for your Wi-Fi.
- **Security:** Enable WPA3/WPA2 encryption with a strong passphrase.
- Port Forwarding: If hosting servers, configure port forwarding for services like HTTP, FTP, etc.

#### **Step 6: Connect Devices**

For wired connections, use Ethernet cables to connect devices to the switch. Connect to the Wi-Fi network using the SSID and password you've configured for wireless devices.

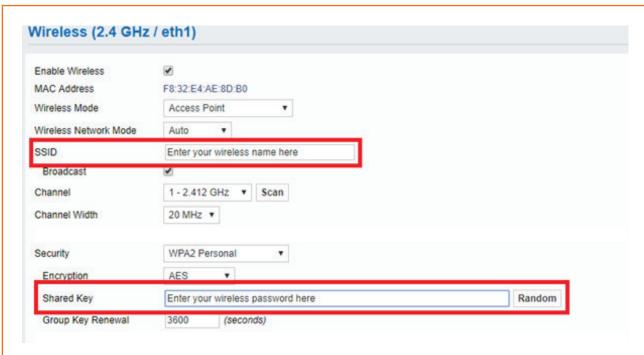


Fig. 9.4.17: SSID and Password ConFig.uring Page

#### **Step 7: Test Connectivity**

Ensure all devices can connect to the network and access the internet. Troubleshoot any connectivity issues at this stage.

#### **Step 8: File and Printer Sharing**

Set up file sharing on the LAN:

- Network Shares: Define shared folders on computers.
- **Permissions:** Configure access permissions for shared resources.

For printer sharing:

- Share the printer from the computer it's connected to.
- Other devices can add the shared printer through their settings.

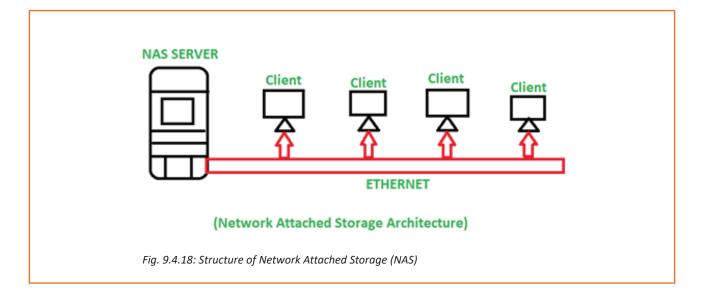
#### **Step 9: Network Monitoring and Security**

Implement network monitoring tools and ensure network security:

- **Firewall:** Enable the router's firewall to protect against external threats.
- Antivirus: Install and maintain antivirus software on devices.
- **Monitoring Tools:** Use network monitoring software to track traffic, detect anomalies, and troubleshoot issues.

#### Step 10: Backup and Recovery

Implement data backup solutions to protect against data loss. For businesses, consider network-attached storage (NAS) for centralized backups.



## 9.4.6 Ensuring System Reliability and Data Security

Performing software installation, removing viruses and malware, and data backup and recovery are essential computer maintenance tasks.

#### **Software Installation**

Installing software applications is a straightforward process.

#### **Step 1: Downloading the Installation File**

- To ensure you're downloading the genuine and most up-to-date version of the software, go to the
  official website of the software developer. You can usually find this through a search engine or by
  going to the software's official page.
- If you can't find the software on the official website, make sure to download it from a trusted source, such as reputable download platforms like CNET, Softpedia, or trusted app stores for mobile applications.

#### Step 2: Running the Installer

- Once the installation file has finished downloading, it's typically located in your computer's "Downloads" folder. The filename usually has an extension like .exe (for Windows) or .dmg (for macOS).
- To start the installation process, double-click the downloaded file. You might need administrative permissions on some systems, so you may need to provide an administrator password.

#### Step 3: Accepting License Agreement, Choosing Installation Location, and Configuring Settings

- Read and accept the software's license agreement, which specifies the terms and conditions for using the software. You often need to check a box to indicate your acceptance.
- You'll be prompted to choose the directory where the software will be installed. The software will suggest an installation location by default, but you can typically change it if needed.
- Some software may have additional configuration options during installation, such as language
  preferences, shortcuts on the desktop or Start menu, or integration with other software. Review
  and configure these options according to your preferences.

#### **Removing Viruses and Malware**

If you suspect your computer has viruses or malware, follow these steps to remove them:

#### Step 1: Install and Update Antivirus or Anti-Malware Software

- Choose a reputable antivirus or anti-malware software and install it on your computer. Popular
  options include Norton, McAfee, Bitdefender, Kaspersky, or free alternatives like Avast, AVG, or
  Windows Defender (built into Windows).
- Ensure that your antivirus software is up to date with the latest virus definitions and software updates. These updates are crucial for detecting and removing the latest threats.
- Perform a full system scan using your antivirus software. This scan will check all files and areas of your computer for malware.

#### **Step 2: Disconnect from the Internet**

• Disconnect your computer from the internet to prevent malware from communicating with its source. This will help contain the infection and prevent it from downloading additional malicious software or sending your data to cybercriminals.

#### Step 3: Restart in Safe Mode

 Restart your computer in Safe Mode to minimize the number of processes and drivers that load during startup. This can help prevent certain types of malware from running. Depending on your operating system, the key to enter Safe Mode may vary (e.g., F8, Shift + F8, or another key). Consult your computer or motherboard documentation for the correct key.

#### Step 4: Run Full System Scan and Follow Instructions

- While in Safe Mode, run another full system scan with your antivirus or anti-malware software. It may detect and quarantine or remove additional threats.
- Follow the instructions provided by the antivirus software. If it finds malware, it will typically give you options to quarantine or delete infected files.

#### **Step 5: Check Installed Programs**

• After the scans, check your list of installed programs (also called "Add or Remove Programs" on Windows or "Applications" on macOS). Remove any unfamiliar or suspicious applications. Sometimes, malware can disguise itself as legitimate software.

#### **Step 6: Update Software and Change Passwords**

- Ensure your operating system and all software are up to date with the latest security patches. This helps close potential vulnerabilities that malware might exploit.
- As a precaution, change passwords for all your accounts, especially sensitive ones like email, banking, and social media. Malware may have compromised your login credentials.

#### **Data Backup**

• Data backup is essential to protect your important files and prevent data loss. Let's elaborate on each step of the data backup process:

#### Step 1: Use an External Hard Drive or Cloud Storage

- External Hard Drive: You can use an external hard drive or a USB drive to back up your data. Connect the external drive to your computer and copy your important files to it. This provides a physical backup that you can store in a safe place.
- Cloud Storage Services: Cloud services like Google Drive, Dropbox, OneDrive, and others offer
  secure online storage for your files. Sign up for an account and upload your data to the cloud, and
  it will be accessible from any device with internet access. Cloud storage provides an off-site backup
  solution, which is useful in case of physical disasters.

#### **Step 2: Consider Using Backup Software**

 Backup Software: Backup software, such as Acronis True Image and Macrium Reflect, or built-in solutions like Windows Backup (Windows) and Time Machine (macOS), can automate the backup process. They provide features like scheduled backups, incremental backups (only saving changes), and easy recovery options.

#### Step 3: Choose What Data to Backup

- Select Important Files: Identify the data you want to back up, including documents, photos, videos, music, and other files. Focus on critical data that is difficult or impossible to replace.
- Personal Data: Consider backing up personal data like financial records, family photos, and important documents.
- Application Settings: Some backup solutions can also save your application settings and preferences, which can be useful for quickly restoring your system.

#### Step 4: Set Up a Regular Backup Schedule

- Frequency: Determine how often you need to back up your data. The frequency of backups depends on how frequently you create or modify files. For most users, daily or weekly backups are sufficient.
- Scheduled Backups: Use backup software to schedule regular backups automatically. This ensures that you have up-to-date copies of your data without remembering to do it manually.
- Multiple Copies: It's a good practice to keep multiple versions of backups (daily, weekly, monthly) so that you can restore from different points in time if needed.

#### **Additional Tips:**

- Periodically test the restore process to ensure that your backups are working as expected. Knowing that you can recover your data when you need it is crucial.
- Consider keeping a copy of your important data off-site, such as in a safety deposit box or by using a cloud storage service. This protects your data in case of physical disasters like fire or theft.
- For sensitive data, consider encrypting your backups to enhance security.

#### **Data Recovery**

Data recovery is crucial when you've lost data due to accidental deletion, hardware failure, or other reasons.

#### **Step 1: Check for Backups**

Always start by checking your backups. If you regularly back up your data to an external hard drive
or cloud storage, you can recover your lost files from these backups. This is the easiest and most
reliable way to recover data.

#### Step 2: Recycle Bin/Trash

- Windows (Recycle Bin): Deleted files are often moved to the Recycle Bin, which acts as a temporary
  holding area before permanent deletion. You can open the Recycle Bin, select the files you want to
  recover, right-click, and choose "Restore."
- macOS (Trash): Delete files go to the Trash on macOS. You can open the Trash, select the files, and then right-click and choose "Put Back" to restore them to their original location.

#### **Step 3: Data Recovery Software**

If you don't have backups, data recovery software can help you attempt to recover lost files. Software tools like Recuva, EaseUS Data Recovery Wizard, or Disk Drill are designed to scan your storage device for deleted or lost files.

#### Here's how to use them:

- Install and run the data recovery software.
- Select the drive or location from which you want to recover data.
- Initiate a scan. The software will search for lost or deleted files on the selected drive.
- Once the scan is complete, the software will display a list of recoverable files. Review the list and select the files you want to recover.
- Specify a safe location to save the recovered files (do not save them to the same drive you're recovering from).

Please note that the success of data recovery with software tools depends on various factors, including the time since the data was deleted, whether the storage space has been overwritten, and the specific software being used.

#### **Step 4: Professional Data Recovery Services**

- If your data is extremely important, and software solutions fail to recover it, consider seeking help
  from professional data recovery services. These services have specialized equipment and expertise
  to recover data from physically damaged or severely corrupted storage devices.
- Professional data recovery services can be expensive, so they are typically reserved for critical situations where the data's value far exceeds the cost of recovery.

### 9.4.7 Provide Personalized Advice and Consultation Services

As a Telecom Grameen Udhyami looking to provide personalized advice and consultation services on technology-related matters to individuals and businesses, you can follow these steps to establish and effectively run your consultancy:

#### • Identify Your Niche

Determine your specific area of expertise within the telecom and technology sector. Consider focusing on areas like networking, cybersecurity, telecommunications infrastructure, or software solutions. Specializing in a niche will help you stand out and attract clients looking for your specific skills.

#### Build Your Knowledge and Skills

Stay updated with the latest trends and developments in your chosen niche. Attend relevant workshops, conferences, and training programs. Consider obtaining relevant certifications to establish your credibility.

#### Create a Business Plan

Outline your business goals, target market, pricing structure, and marketing strategy in a comprehensive business plan. This will serve as your roadmap for your consultancy.

#### Legal and Financial Considerations

Register your consultancy as a legal business entity and ensure you comply with all necessary licenses and regulations. Set up a business bank account and manage your finances effectively.

#### Establish an Online Presence

Create a professional website showcasing your expertise, services, client testimonials, and contact information.

Leverage social media platforms and professional networking sites like LinkedIn to connect with potential clients and share your expertise.

#### Marketing and Branding

Develop a strong brand identity and marketing strategy to attract clients. Use content marketing, social media, email marketing, and paid advertising to reach your target audience.

Network with local business associations, attend industry events and collaborate with other professionals to expand your reach.

#### Offer Free Initial Consultations

Initially, offer free or low-cost initial consultations to build trust and rapport with potential clients. This will also allow you to assess their needs more effectively.

#### Customize Solutions

Tailor your advice and consultation services to meet each client's specific needs. Understand their unique challenges, goals, and budget constraints before recommending solutions.

#### • Provide Comprehensive Solutions

Offer a wide range of services, including technology audits, system design, implementation, troubleshooting, and ongoing support. Address both short-term and long-term needs.

#### • Excellent Customer Service

Focus on delivering exceptional customer service. Respond promptly to client inquiries, be attentive to their concerns, and maintain open communication throughout the consulting process.

#### • Maintain Client Confidentiality

Adhere to strict confidentiality standards, especially when dealing with sensitive business information.

#### • Build a Network of Partners

Collaborate with other technology service providers, hardware vendors, and software developers to expand your offerings and provide comprehensive solutions to your clients.

#### Measure and Improve

Continuously evaluate the effectiveness of your services. Seek feedback from clients and use this feedback to improve your services and offerings.

#### Consider the Future

Stay that prepare your clients for the technology challenges and opportunities ahead.

# 9.4.8 Role of Technology Advice and Consultation Services

Technology advice and consultation services can play a vital role in helping individuals and businesses make informed decisions about their technology needs. These services can provide expert guidance on a wide range of topics, including:

- Choosing the right technology: Technology advice and consultation services can help individuals and businesses choose the right technology for their specific needs and budget. This can include everything from selecting the right hardware and software to designing and implementing complex IT systems.
- **Using technology effectively:** Technology advice and consultation services can also help individuals and businesses learn how to use technology effectively. This can include training on using specific software applications, troubleshooting problems, and securing their IT systems.
- Staying up-to-date on the latest trends and technologies: Technology is constantly evolving, and it can be difficult for individuals and businesses to keep up with the latest trends and technologies. Technology advice and consultation services can help individuals and businesses stay informed about the latest developments and how they can impact their business.

Here are some specific examples of how technology advice and consultation services can help individuals and businesses:

- Help individuals choose the right computer or mobile device for their needs.
- Help businesses select the right software and hardware for their operations.
- Help businesses develop and implement IT strategies.
- Help businesses to secure their IT systems and data.
- Help businesses to troubleshoot and resolve technical problems.

In addition to the benefits mentioned above, technology advice and consultation services can also help individuals and businesses to:

- Stay ahead of the curve: Technology is constantly evolving, and it can be difficult for individuals and businesses to keep up with the latest trends and developments. Technology advice and consultation services can help individuals and businesses to stay ahead of the curve and identify the technologies that can help them to achieve their goals.
- Reduce risk: Technology investments can be costly, and ensuring these investments are worthwhile is important. Technology advice and consultation services can help individuals and businesses reduce the risk of poor technology investments.
- Improve efficiency: Technology can improve the efficiency of many business processes. Technology advice and consultation services can help businesses to identify and implement technologies that can help them to improve their efficiency.

# **Summary**



- Conduct a thorough assessment of the telecommunications and hardware requirements in a village, considering the unique needs of the community.
- Create a comprehensive business plan encompassing service offerings, target market identification, financial projections, and effective marketing strategies.
- Identify an optimal location and outline the essential infrastructure needed to establish a successful techpreneurial business.
- Navigate the process of obtaining the necessary permits and licenses for your techpreneurial venture in compliance with local regulations.
- Promote digital literacy within the village by organizing workshops, emphasizing the purpose and benefits of enhancing tech skills.
- Offer a range of telecom solutions, including SIM card sales, mobile recharge, top-up services, and post-paid bill payment to cater to diverse customer needs.
- Provide internet connectivity solutions, such as broadband and wireless connections, for both residential and business clients.
- Set up public Wi-Fi hotspots in central locations, ensuring secure installation and network integrity.
- Stress the importance of expert hardware and software repair and troubleshooting services to maintain and repair various devices effectively.
- Collaborate with government agencies and NGOs to establish a village information center with computer setups and internet access, facilitating community development and connectivity.



#### **Multiple Choice Questions**

- 1. What is the primary purpose of conducting workshops to promote digital literacy in a village?
  - a. To generate additional revenue
  - b. To provide entertainment to the villagers
  - c. To enhance the village's technological infrastructure
  - d. To offer free digital literacy education
- 2. Which of the following services is NOT typically included in comprehensive telecom solutions?
  - a. SIM card sales

b. Mobile recharge

c. Grocery delivery

d. Post-paid bill payment

- 3. What is the primary purpose of setting up public Wi-Fi hotspots in central locations?
  - a. To monitor villagers' online activities

b. To restrict internet access

c. To provide free internet access to the community

- d. To sell Wi-Fi services for profit
- 4. Why is regular maintenance of UPS (Uninterruptible Power Supply) important?
  - a. To save electricity
  - b. To prevent data loss during power outages
  - c. To increase the speed of internet connections
  - d. To reduce maintenance costs
- 5. What is the key role of technology advice and consultation services for individuals and businesses?
  - a. To maximize profits
  - b. To provide entertainment
  - c. To offer emotional support
  - d. To help make informed technology-related decisions

#### **Descriptive Questions:**

- 1. What are the specific considerations when analyzing the needs and demands for telecom and hardware solutions in a village?
- 2. What key components should be included in a comprehensive business plan for a techpreneurial venture focusing on telecom and hardware solutions?
- 3. Describe the factors to consider when selecting a suitable location and infrastructure requirements for setting up a techpreneurial business.
- 4. What is the process for obtaining necessary permits and licenses to operate a techpreneurial business in the telecom and hardware sector?
- 5. What is the purpose and potential benefits of organizing workshops to promote digital literacy in a village?

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# 10. Employability Skills



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**Employability Skills** 









# 11. Annexure



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a Telecom Grameen Udhyami	Unit 1.2: Optical Fiber Technology and the Role of an Optical Fiber Splicer	1.2.1 Introduction to Optical Fibre Technology	45	https://youtu.be/G-UyeFDsX- II?si=iF4gaeTx4HmqHhb5	Optical fiber in hindi
2: Handle hand and power tools relevant to construction electrical works	Unit 2.1: Electrical Fundamen- tals and Circuits	2.1.1 Basic principle of electrical cur- rent flow and fundamental concept	81	https://youtu.be/nzmoGca5rX- c?si=zHhMMrD5VQbBJ_qH	Flow of Electricity through a Circuit
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