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Telecom Sector Skill Council

Facilitator Guide



Sector
Telecom

Sub-Sector
Passive Infrastructure

Occupation
Customer Service - Passive Infrastructure

Reference ID: **TEL/Q0102,** Version **5.0**
NSQF level **4**

Broadband Technician

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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

Acknowledgements

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The preparation of this guide would not have been possible without the Telecom Industry's support. Industry feedback has been extremely beneficial since inception to conclusion and it is with their guidance that we have tried to bridge the existing skill gaps in the industry. This facilitator guide is dedicated to the aspiring youth, who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this Guide

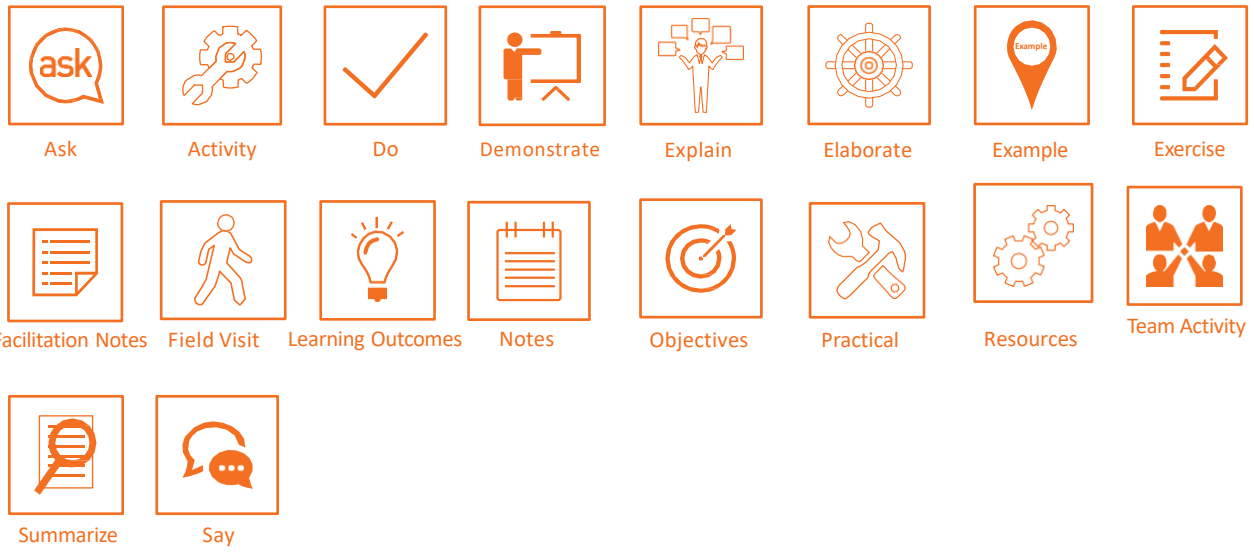
The facilitator guide (FG) for Broadband Technician is primarily designed to facilitate skill development and training of people, who want to become professional Broadband Technicians in the industry. The Facilitator Guide is aligned to the Qualification Pack (QP) and the National Occupational Standards (NOS) as drafted by the Telecom Sector Skill Council of India (TSSCI) and ratified by National Skill Development Corporation (NSDC).

It includes the following National Occupational Standards (NOSs):

1. TEL/N0111: Lay cable/system wiring and install equipment at customer premises
2. TEL/N0112: Configure customer premises equipment and establish broadband connectivity
3. TEL/N0113: Troubleshoot and rectify faults
4. TEL/N9105: Follow sustainable practices in telecom infrastructure installation
5. DGT/VSQ/N0101: Employability Skills (30 Hours)

Post this training, the participants will be able to perform tasks as professional Broadband Technician. We hope that this Facilitator Guide provides a sound learning support to our young friends to build a lucrative career in the telecom industry.

Symbols Used



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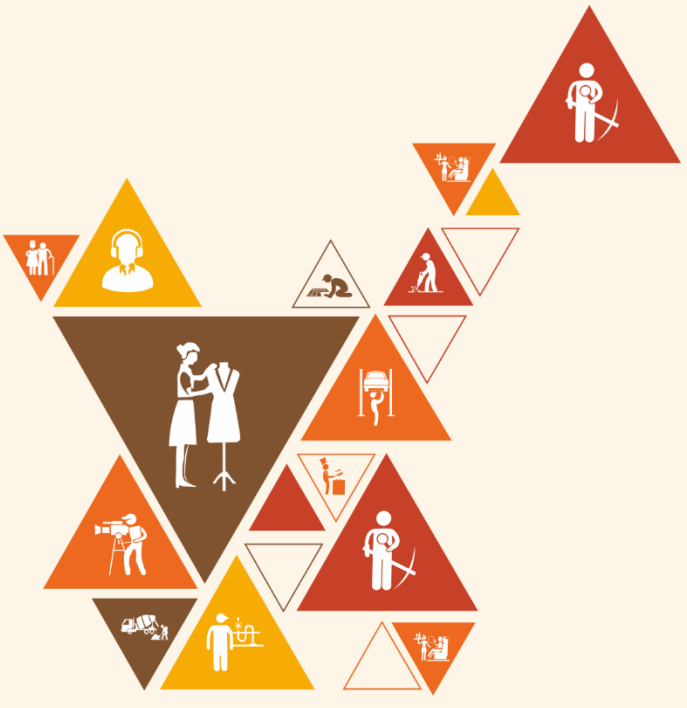
1. Introduction to the Sector and the Job Role of a Broadband Technician

Unit 1.1 - Introduction to Telecom Sector and Role of a Broadband Technician



TEL/N0111

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain the importance of Telecom Sector.
2. Discuss the roles and responsibilities of a Broadband Technician.

Unit 1.1: Introduction to Telecom Sector and Role of a Broadband Technician

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the role of a Broadband Technician in deploying, maintaining, and troubleshooting wired and wireless broadband networks.
2. Describe the key components of broadband infrastructure and customer premises equipment (CPE).
3. Identify different types of broadband connections, such as fiber-to-the-home (FTTH), digital subscriber line (DSL), cable internet, and fixed wireless access (FWA)..
4. Elucidate the importance of network performance metrics, such as bandwidth, latency, jitter, and packet loss, in broadband service quality.
5. Explain the importance of customer service skills in assisting end-users with troubleshooting, configuring network devices, and resolving connectivity issues.
6. Discuss safety protocols, grounding techniques, and personal protective equipment (PPE) required for handling broadband installation and maintenance tasks.
7. Explain the career opportunities available for a Broadband Technician.

Resources to be Used

Participant Handbook, pen, writing pad, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, equipment, and tools

Say

Good morning and warm welcome to the training program on Broadband Technician. Let us start the unit by discussing the broadband technology and the duties and responsibilities of a broadband technician.

Ask

Ask the participants whether they know about the broadband technology.

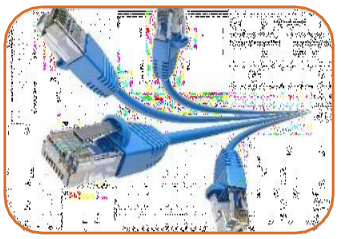
Notes for Facilitation

- Explain to the participants that “broadband” is a radio term that refers to a wide band of frequencies used to transmit information. In general, broadband refers to high-speed connection to Internet that is faster than the traditional fixed telephone line.

- Tell them that the different platforms that provide broadband are:

Digital Subscriber Line (DSL)

Cable Modem



Fiber

Wireless

DIsh

Broadband over Powerline (BPL)

Fig. 1.1.1: Different broadband platforms

- Explain the different broadband technologies one by one.
- Tell them that the Digital Subscriber Line (DSL) is one of the oldest Internet technologies and uses telephone lines for high-speed Internet connections. Tell them that the pros and cons associated with DSL are as follows:

Pros	Cons
☐ It is widely available	☐ Connection quality depends on distance
☐ Can use the phone and Internet at the same time	☐ Is not available everywhere
☐ Is faster than regular modem	☐ Connection for sending data is slower than for receiving data
☐ Does not need new wiring	
☐ It is cheaper than satellite or broadband connections	

Fig. 1.1.2: Pros and Cons of DSL

- Tell them that the cable modem is a hardware device designed to operate over cable TV lines. It enables a user to attach a PC to a local cable TV line and receive data.
- Tell them that with the help of a cable modem one can watch TV shows and browse the web at the same time.
- Tell the participants that the fibre optic cables are cables that contain pure glass strands of very thin size called optical fibres, in a protective, insulated jacket. The optical fibre cables can transmit large amount of data at a very high speed.
- Tell them that fibre optics provide a faster download and upload speed but is not as widely available as cable or DSL.
- Next, tell them that wireless is a broad term that refers to a technology that uses radio waves instead of wires to transmit and receive data.
- Tell them that some examples of wireless devices are TV remote controls, radios and GPS systems.
- Explain that people living in rural areas do not have access to cable services or Internet through wired connection. In such cases, satellite internet service is the only possible solution.
- Tell them that similar to satellite TV, satellite broadband is transmitted wirelessly through satellite dish. The difference being that with a satellite broadband connection one van not just receive information but also send out data to the satellite.
- Further, explain to them that Broadband over power line (BPL) is a technology that enables the data to be transmitted over ordinary residential electrical lines and power cables.
- Draw a comparison between DSL vs. cable vs. fibre vs. satellite with the help of the following table:

Broadband Type	Affordability	Speed	Reliability
DSL	Moderate	Moderate	Moderate
Cable	Moderate	High	High
Fibber	Moderate to high	Very High	High
Satellite	High	Low	Low

Table. 1.1.1: Comparison between DSL vs. cable vs. fibre vs. satellite

Ask

Ask the participants whether they know about the duties and responsibilities of a broadband technician.

Notes for Facilitation

- Start the session by telling the participants that a good broadband technician should possess the following attributes:
  - Patience
  - Integrity
  - Punctuality
  - Critical thinking
  - Amenable behaviour
  - Good interpersonal relationship building
- Explain to them about the responsibilities of a broadband technician.
- Tell the participants about the full scope of work of a broadband technician.
- Explain the importance of having thorough knowledge of the various components used in their job role.
- Explain the various technical skills they must possess to do their job efficiently and effectively.
- Explain that in addition to these technical skills, they must also have certain practical skills such as shown in the following figure:

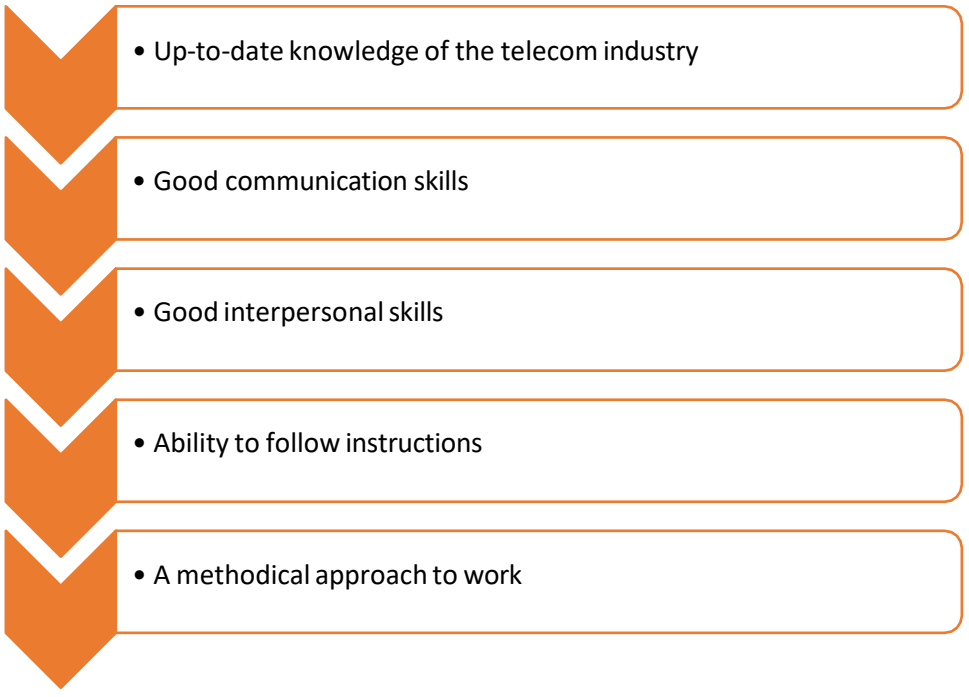


Fig. 1.1.3: Practical skills

Exercise

Answers to exercises for PHB

Exercise Handling Strategy – **The solution for the exercise is given as**:

1. Ask the participants to write down the roles and responsibilities they have to perform as a Broadband Technician. Then, provide the solution as:

- Installation of the customer premise equipment.
- Review maps to route job orders in an efficient and timely manner.
- Attend all required technical, safety and team meetings.

- Thorough knowledge of cable and internet products.
- Properly operate and maintain installation tools and equipment.
- Provide customers with product and service information.
- Perform other duties as needed to meet customer expectations.

2. Ask the participants to write down few points to explain the broadband technology in brief. Then, provide the solution as:

- The technique which lets any user access the Internet services at higher speeds as compared to a dial—up connection is called Broadband. The speeds vary, subject to the technology set up and the distribution of the levels. Residential services have quicker download speed when compared to upload speeds

3. Ask the participants to give definitions of ADSL and SDSL to differentiate between them. Then provide the solution as:

    - Asymmetrical Digital Subscriber Line: Mainly used in homes. ADSL provides faster downstream rather than the upstream. This sanctions faster data transmission toward the end user, on the same line used for voice service
    - Symmetrical Digital Subscriber Line: Used mainly in commercial set ups, for services like video and voice conferencing. Here both the download and upload speeds remain identical. Faster forms of SDSL include High-data-rate DSL (HDSL) and Very High-data-rate DSL (VDSL)

- **The solution for the Multiple-Choice Questions is as below**:
    - Ask the participants what Wifi stands for. Then provide the solution as Wireless Fidelity.
    - Ask the participants what waves are used for transmitting signals in a wireless network. Then provide the solution as Radio waves.
    - Ask the participants which is the slowest Internet Connection. Then provide the solution as Dial-up service.
    - Ask the participants which equipment is needed to allow home computers to connect to the Internet. Then provide the solution as

Notes

2. Lay Cable/System Wiring and Install Equipment at Customer Premises

Unit 2.1 - Cable and Connectors
Unit 2.2 - Cable Laying and Connectorisation
Unit 2.3 - Customer Premise Equipment
Unit 2.4 - Equipment Installation Procedures
Unit 2.5 - UPS and its Types
Unit 2.6 - Checking of Voltage, Current and Earthing
Unit 2.7 - Checking and Testing Battery
Unit 2.8 - Installation and Repair of UPS
Unit 2.9 - Basic Load Calculation
Unit 2.10 - UPS and Battery Compatibility
Unit 2.11 - Record Keeping and Documentation

TEL/N0111

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain the types, specifications, and selection criteria of network cables and PoE devices.
2. Demonstrate the process of assessing site feasibility and selecting appropriate installation locations.
3. Explain the functions, configurations, and troubleshooting methods for customer premise equipment (CPE).
4. Demonstrate structured wiring installation, device configuration, and power management techniques.
5. Explain post-installation site restoration, documentation, and customer communication procedures.
6. Demonstrate proper cleanup, record-keeping, and customer sign-off processes.

UNIT 2.1: Cable and Connectors

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the specifications of network cables, PoE devices, and network equipment.
2. Identify different sizes, colors, and categories of network cables, including CAT5e, CAT6, CAT6A, and fiber optic cables.
3. Describe the types of cables (OFC, UTP, STP, Twisted Pair, etc.) and connectors (RJ-45, RJ-11, SC, LC, etc.).
4. Explain the proper use of hand tools and power tools for cable installation, routing, and device mounting.
5. Demonstrate how to select and use appropriate connectors, ensuring PoE-supported devices receive stable power and data signals.
6. Show how to collect and organize the required tools, equipment, and PoE-compatible components for installation.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Coaxial cables, paired cables, twisted pair cables, fibre optic cables
- RJ-45, Straight tip(ST) connector, Lucent connector, Mutli-fiber Push On (MPO)

Say

Good morning and warm welcome to this training program. Before we begin this session on cable and connectors, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on cable and connectors.

Demonstrate

- Show the participants the different types of cables.

Notes for Facilitation

- Explain that a cable can be defined as an assembly of electrical conductors/wires insulated from each other but laid up together (by being twisted around a central core).
- In addition, tell the participants that a cable is often misunderstood with a wire. Explain to them the difference between a wire and a cable with the help of the following table:

Parameter	Wire	Cable
Definition	Is a thin, flexible thread of metal	Is an assembly of electrical conductors/wires
Uses	Used to bear mechanical loads or electricity and telecommunication signals	Used for: • Power transmission • Connecting two or more devices • Carrying electric currents
Types	Solid wire and stranded wire	Twisted pair cable, coaxial cable, multi conductor cable, fibre optic cable and so on

Table 2.1.1: Difference between a wire and a cable

- Tell them the basic classification of network cables with the help of the following figure:

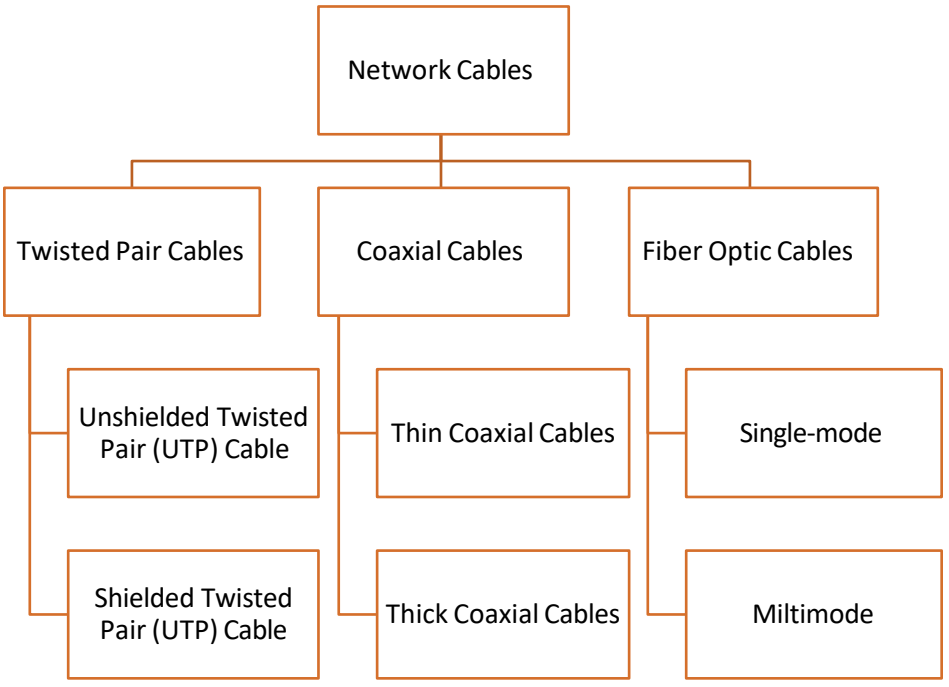


Fig. 2.1.1: Classification of Network Cables

- Briefly explain various cables used in broadband installation and show them the available ones.

Demonstrate

- Show them different types of connectors.

Notes for Facilitation

- Tell them that connectors provide interfaces for linking devices by using cables.
- Also, tell that connectors either have a male end with pins sticking out from it or a female part, also known as a socket, with holes for accommodating the pins.
- In addition, tell them that a pin layout describes which pin is to be coupled with which wire. Generally, each numbered pin corresponds to a wire within the cable.
- Tell them the different types of connectors with the help of the following figure:

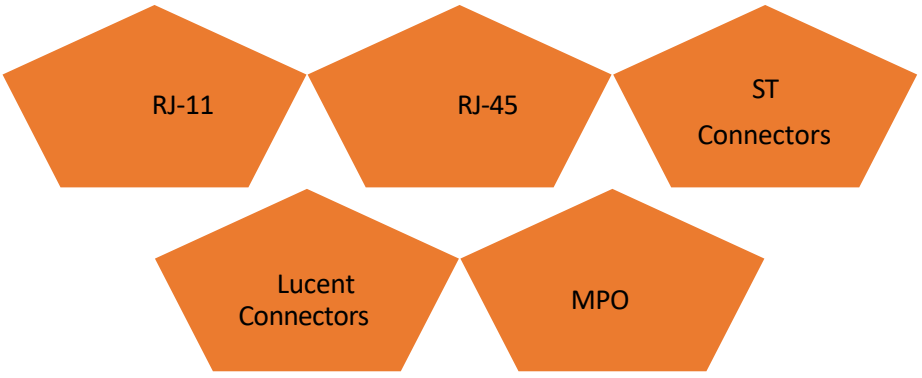


Fig. 2.1.2: Different Types of Connector

- Exercise Handling Strategy **– The solution for the exercise is given as:**
  - Ask the participants to list down different types of cables available in the lab with some practical application of each type of cable. Then provide the solution as:
    - Twisted Pair Cable
    - Coaxial Cable
    - Fibre Optic Cable
  - Ask the participants to list down different types of connectors and their applications with the types of cables they are used for. Then provide the solution as:
    - RJ-11
    - RJ-45
    - F- Type Connectors
    - Fibre Connectors
    - RS-232
  - Ask the participants to write down about fibre optic cable and mention some of the examples with its benefits. Then provide the solution as:
    - To prevent interference, any optical fibre has a glass core in center, surrounded by numerous coatings of material for protection which is further topped with an outer layer of PVC jacket or insulating Teflon.

This is for sure an expensive method when compared to others available in the market, but it has proven to be efficient in transmitting data in longer distances while ensuring good speed. This is further helpful in video conferencing and different interactive facilities.

- Ask the participants to answer the fill in the blanks.
    - Ask the participants what is used to connect the computer parts to the main supply. Then provide the answer as Power Unit Supply.
    - Ask the participants what is used to establish connectivity between computers. Then provide the answer as Router.
    - Ask the participants which cable is used to transmit. High-Definition signals. Then provide the answer as Standard HDMI Cable.

UNIT 2.2: Cable Laying and Connectorization

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Define methods for accurately measuring distances to maintain permissible limits for network performance and PoE voltage drop.
2. Explain structured cabling standards for conventional and PoE-supported installations.
3. Explain the criteria for selecting suitable installation.
4. Describe crimping, splicing, and termination techniques for various cable types, ensuring proper power delivery for PoE.
5. Demonstrate how to perform cable splicing and crimping, ensuring proper termination for both standard and PoE-enabled cables.
6. Show neat wiring and clipping techniques within customer premises while following structured cabling norms.
7. Demonstrate how to test cables and joints for transmission loss and signal strength, and re-terminate if loss exceeds permissible limits.
8. Show how to properly dispose of installation waste and restore the worksite to its original condition.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Cables, connectors, crimping tools, cable tester

Say

Good morning and warm welcome to this training program. Before we begin this session on cable laying and connectorization, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on cable laying and connectorization.

Ask

Ask the participants whether they know about the cable laying process.

Notes for Facilitation

- Explain to the participants that structured cabling refers to a complete system of cabling and associated hardware that integrates the voice, data and video to provide a comprehensive telecommunications infrastructure.

Say

Good morning and warm welcome to this training program. Before we begin this session on cable laying and connectorization, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on cable laying and connectorization.

Ask

Ask the participants whether they know about the cable laying process.

Notes for Facilitation

- Explain to the participants that structured cabling refers to a complete system of cabling and associated hardware that integrates the voice, data and video to provide a comprehensive telecommunications infrastructure.

- Tell them that the whole system is made up of manageable blocks which can be easily moved, changed or added without disrupting the entire system.
- Explain the benefits of structured cabling with the help of the following figure:

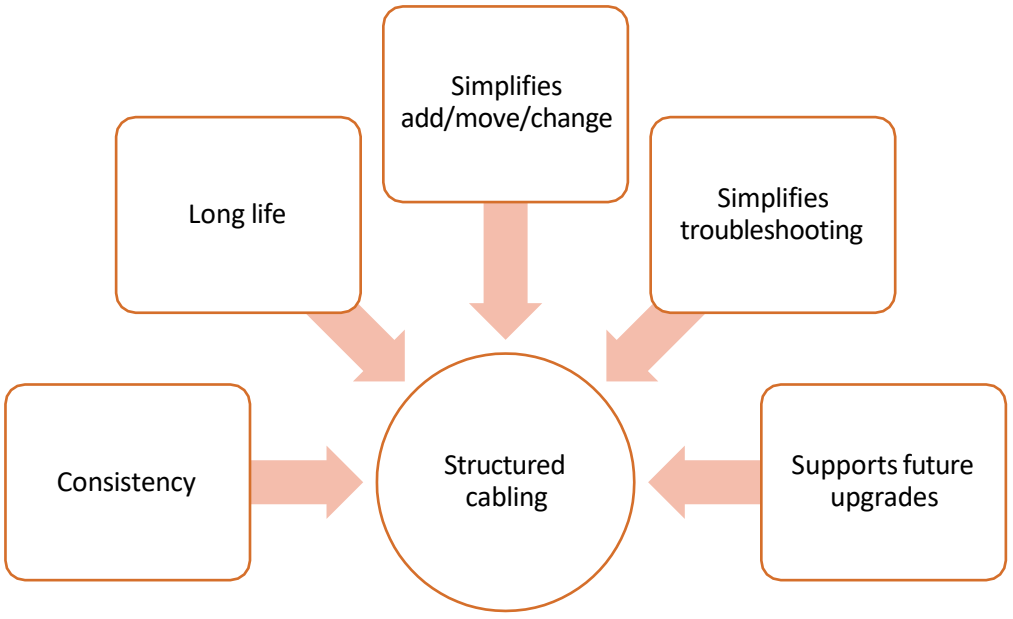


Fig. 2.2.1: Benefits of Structured Cabling

- Next, tell them that the key components of structured cabling system are:
  - Horizontal Cabling
  - Backbone Cabling
  - Telecommunication Room
  - Work Area
  - Equipment Room
  - Entrance Facility
- Tell them that horizontal cabling uses Ethernet or fibre optic cables.

- Explain that the individual cable length should be 90 meters between the work area and the telecommunication room and the cables connecting computers to outlets should be limited to 3 meters in length, as shown in following figure:

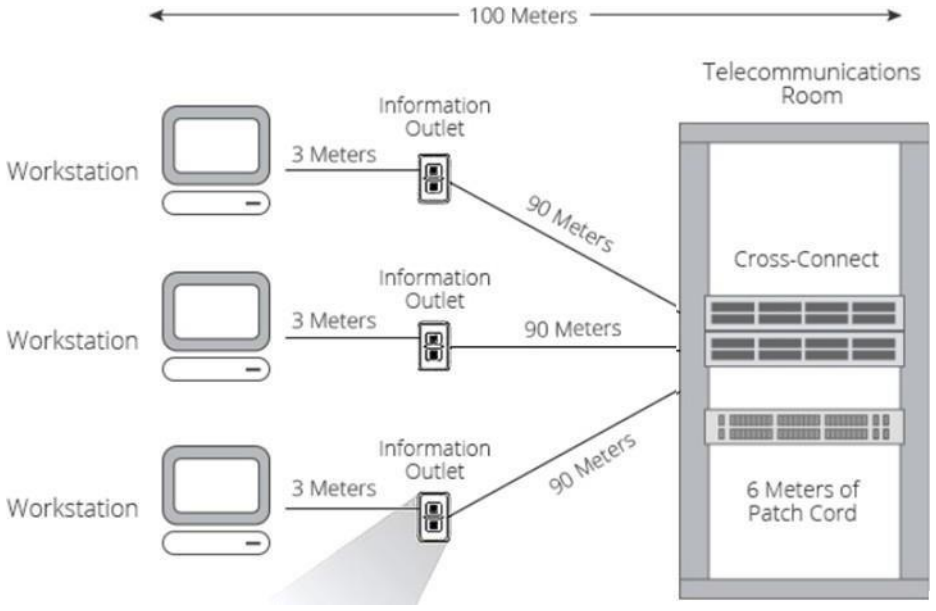


Fig. 2.2.2: Horizontal Cabling

- Explain that backbone cabling is done from floor to floor. The length of the cables connecting the equipment should not be more than 30 meters, as shown in following figure:

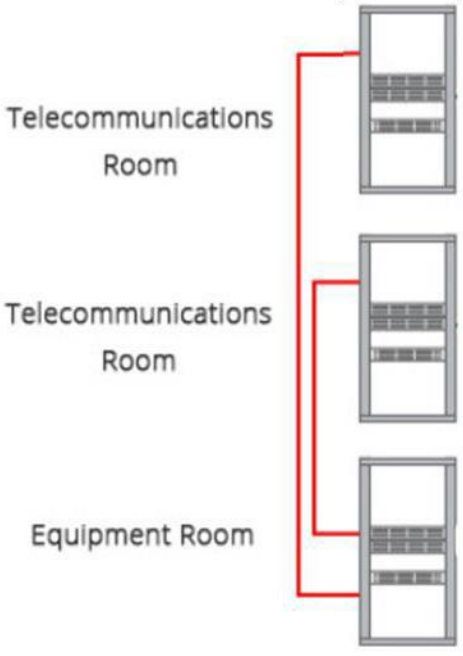


Fig. 2.2.3: Backbone Cabling

- Explain that the telecommunications room contains the termination points between horizontal cabling and backbone cabling.

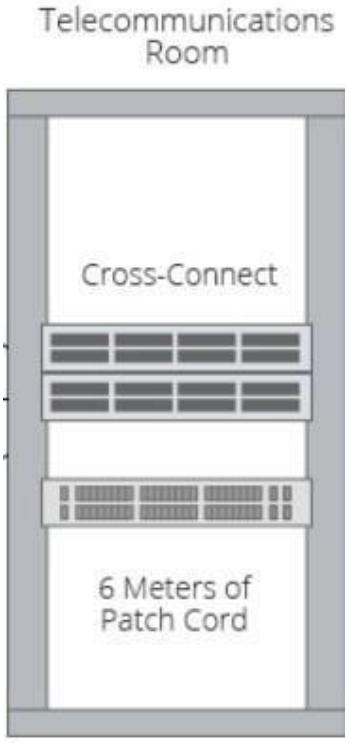


Fig. 2.2.4: Telecommunications Room

- Explain that the work area refers to the place where the equipment is connected to the termination point of the horizontal cabling. There should be a minimum of two outlets at each work area.
- Explain that the equipment room houses the equipment such as racks and routers and the wiring combination points in an environmentally protected zone.
- Explain that the entrance facility contains the cabling components that connect the indoor cabling to outside service facilities. This consists of service entrance pathways, cables, connecting hardware, circuit protection devices, and transition hardware.
- Explain the factors that help in choosing the correct cables for a network.

Ask

Ask the participants whether they know about the connectorization process.

Notes for Facilitation

- Explain to the participants that connectorization is the process of placing a connector on the end of a cable or wire.
- Tell them that a connector is a device such as a plug or jack that joins two wires or cables together.

- Explain the steps of the TIA/EIA 568A wiring sequence.
- Explain the steps of the TIA/EIA 568B wiring sequence.
- Explain to the participants that crimping refers to the joint between a cable and a connector. The joint is formed by deforming one of them and enabling one to hold the other. The resultant deformity is known as a crimp.
- Explain the steps of the cable crimping process.
- Exercise Handling Strategy – **The solution for the exercise is given as**:
  - Ask the participants the steps that need to be performed for performing a cable crimping. Then provide the solution as:
    - Cut the category 5 UTP is specified length
    - Strip of the outer covering
    - Insert these eight wires into the connector
    - Ensure every wire fits in their eight separate respective slots
    - Insert the cables with a firm and steady pressure
    - Complete assembly of connector should reach RJ-45 slot
  - Ask the participants to list the factors that need to be considered while choosing a cable for a network setup. Then provide the solution as:
    - Bandwidth
    - Signal attenuation
    - EMI (Electro-Magnetic Interference)
    - Cost of the cable
- Ask the participants to answer the fill in the blanks.
- Ask the participants what is the amount of data that needs to be transferred at a given time called. Then provide the answer as Bandwidth.
- Ask the participants Topology plays a critical role in determining what to set up networking infrastructure. Then provide the answer as hardware and cable types

Demonstrate

- TIA/EIA 568A wiring sequence
- TIA/EIA 568B wiring sequence
- Cable crimping process

UNIT 2.3: Customer Premises Equipment

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Describe the functions, features, and configurations of customer premise equipment, including modems, routers, PoE switches, IP cameras, and VoIP phones.
2. Explain troubleshooting methods for CPE, including resolving power and connectivity faults in PoE-supported devices.
3. List different diagnostic tools such as LAN testers, PoE testers, and network analyzers, and explain their safe handling and usage.
4. Demonstrate how to install and configure equipment such as modems, routers, PoE switches, IP cameras, and VoIP phones, ensuring proper functionality.
5. Demonstrate how to guide customers on using installed equipment, including PoE-enabled devices.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Modem and broadband router, wireless router

Say

Good Morning and warm welcome to this training program. Before we begin this session on customer premises equipment, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Ask

Ask participants, whether they know about the various customer premises equipment.

Say

Let us begin this session on customer premises equipment.

Say

Good Morning and warm welcome to this training program. Before we begin this session on customer premises equipment, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on customer premises equipment.

Ask

Ask participants, whether they know about the various customer premises equipment.

Notes for Facilitation

- Explain to the participants that a modem stands for Modulator/Demodulator. It is a network device that enables a computer to transfer the data over a telephone line or a cable or a satellite connection.
- Tell them that modems are used in pairs, one at the transmitting end and the other at the receiving end.

Notes for Facilitation

- Explain to the participants that a modem stands for Modulator/Demodulator. It is a network device that enables a computer to transfer the data over a telephone line or a cable or a satellite connection.
- Tell them that modems are used in pairs, one at the transmitting end and the other at the receiving end.

- Explain that there are different types of modems based on the category of modem features such as:
  - Transmission mode: Synchronous and Asynchronous
  - Directional capacity: Half-duplex and full-duplex
- Explain that a synchronous modem uses a clock signal to transmit a continuous stream of data bits which are synchronized to the signal.
- Tell them that the asynchronous modems do not have a separate timing signal or clock between the modem and the DTE. They handle data bytes with start and stop bits.
- Tell them that the half-duplex modem allows transmission of data in a single direction only at a time.
- Tell them that the full-duplex modem permits transmission of data in both directions simultaneously as it has two carriers on the line, one outgoing and the other incoming.
- Explain that the modem uses the following continuous wave (CW) modulation techniques to convert digital data to analog signals:
  - Frequency shift keying (FSK)
  - Amplitude shift keying (ASK)
  - Phase shift keying (PSK)
  - Differential PSK (DPSK)
- Tell them about the parts of a modem.
- Explain to them that routers are at the gateways of networks.
- Tell them that a router is a device that routes the internet traffic between networks by joining the networks together. Data sent through the internet is in the form of data packets. A router receives the data packets, analyses its contents and then forwards the incoming packets to another network.
- Tell them that there are two types of routers:
  - Broadband routers
  - Wireless routers
- Tell them that the broadband routers also known as Cable or DSL router. They provide internet connection to the users through (RJ-45) WAN port.
- Tell them that the key features of a broadband router are as follows:
  - Provides broadband Internet access for users
  - Connects using wired or wireless LAN
  - Authenticates ISP subscribers
  - Enables multiple users to access the Internet simultaneously
- Tell them that instead of relying on cables for distributing data packets to computers, data packets are converted into radio signals by the wireless router which are broadcasted wirelessly using antennae.

- Explain that the primary function of a switch is to receive information from any source connected to it and transmit that information to the suitable destination.
- Tell them that essentially, a switch serves as a controller that enables networked devices such as PCs, printers, access points, phones, lights, servers, and other hardware devices to talk to each other efficiently.
- Tell them that about Ethernet switch types:
  - Unmanaged switches
  - Managed switches
  - LAN switches
  - PoE switches
- Explain that an unmanaged switch does not require configuration. It can be simply plugged in and is therefore suitable only for basic connectivity.
- On the other hand, a managed switch can be custom-configured and thus provides more features and flexibility and improves the quality of service.
- Tell them about circuit-switching and packet-switching.
- Illustrate the differences between a router and a switch with the help of the following table:

	Router	Switch
Layer	Network layer	Data link layer
Function	Directs data in a network	Connects multiple devices
Used In	LAN, MAN, WAN	LAN
Transmission Mode	Full duplex	Half/Full duplex
Address used for data	Uses IP address	Uses MAC address
Examples	Linksys WRT54GL, Juniper MX, Cisco 3900	Alcatel's Omni Switch 9000; Cisco Catalyst switch 4500
Manufacturers	Linksys, Netgear, Cisco	Cisco, D-link and Juniper

Table 2.3.1 Difference between a router and a switch

- Exercise Handling Strategy – The solution for the exercise is given as:
  - Ask the participants which network device stores the IP adresses. Then provide the solution as: Router
  - Ask the participants which network device among the options connects two networks. Then provide the solution as: Gateway
  - Ask the participants which network device works in the network layer. Then provide the solution as: Router
  - Ask the participants which network device works on the data link layer of an OSI model. Then provide the solution as: Hub
  - Ask the participants which network device connects the devices in a twisted pair. Then provide the solution as: Bridge

UNIT 2.4: Equipment Installation Procedures

Unit Objectives

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

1. Show how to conduct a site survey at customer premises to assess installation feasibility for PoE-supported devices.
2. Show how to analyze the installation environment and select appropriate cables, connectors, and PoE injectors/switches.
3. Demonstrate how to inspect indoor and outdoor cable routes to avoid electrical hazards and interference sources.
4. Show how to verify that cable lengths remain within permissible limits for signal continuity and PoE power transmission.
5. Demonstrate how to determine the correct placement of network equipment to ensure proper signal coverage and power efficiency.
6. Demonstrate real-time fault clearance techniques to resolve connectivity or power issues during installation.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Modem, router, network switch, Power supply, Ethernet cable, tools

Say

Good morning and warm welcome to this training program. Before we begin this session on customer premise equipment, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Ask

Ask participants, whether they know about installation of modem, router or network switch.

Demonstrate

- Modem Installation process
- Router Installation process
- Networking Switch Installation process

Notes for Facilitation

- Explain that this session will help them understand the correct way of installing network equipment such as modem, router and network switch at a customer's premises.
- Tell them that before beginning installation, they should prepare the site and ensure that they have the required and correct tools and equipment.
- Tell them that the following tools will be needed for installation:

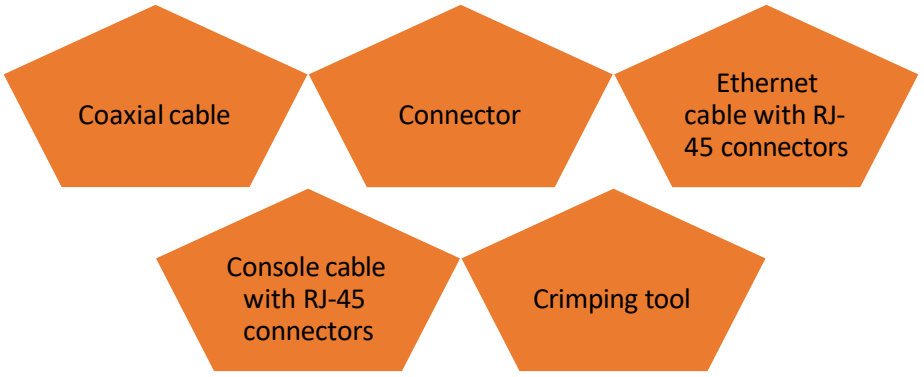


Fig. 2.4.1: Tools for Installation

- Explain that to ensure safety, they should work according to the following guidelines:

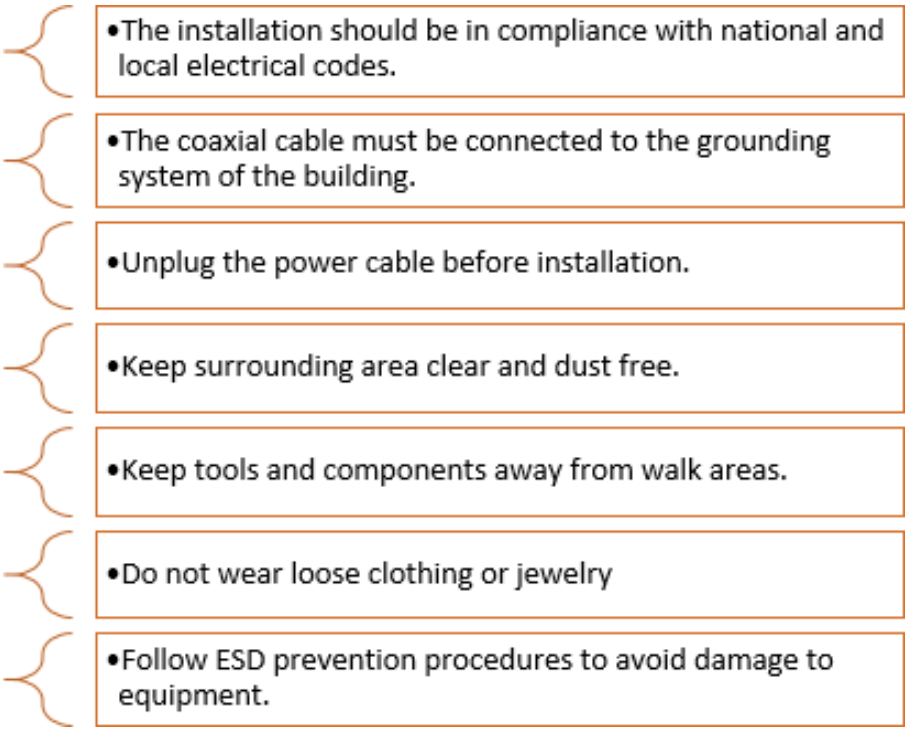


Fig. 2.4.2: Safety guidelines for Installation

- Explain the steps of installing a modem with the help of the following figure:

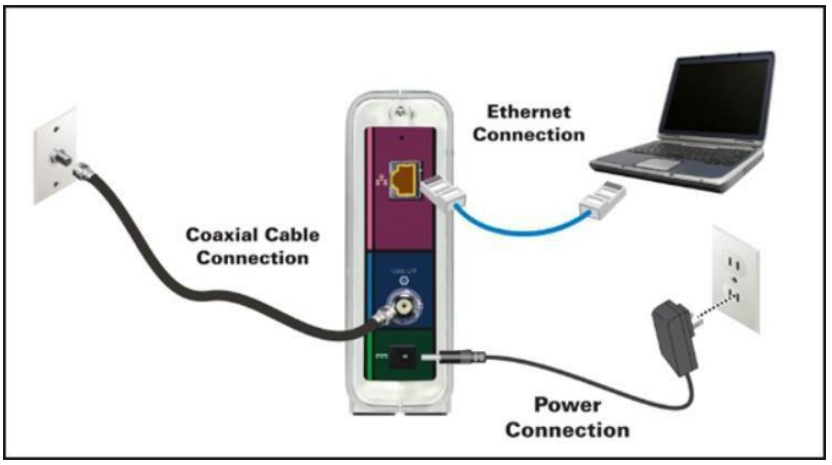


Fig. 2.4.3: Modem Installation

- Explain the steps of installing a router with the help of the following figure:

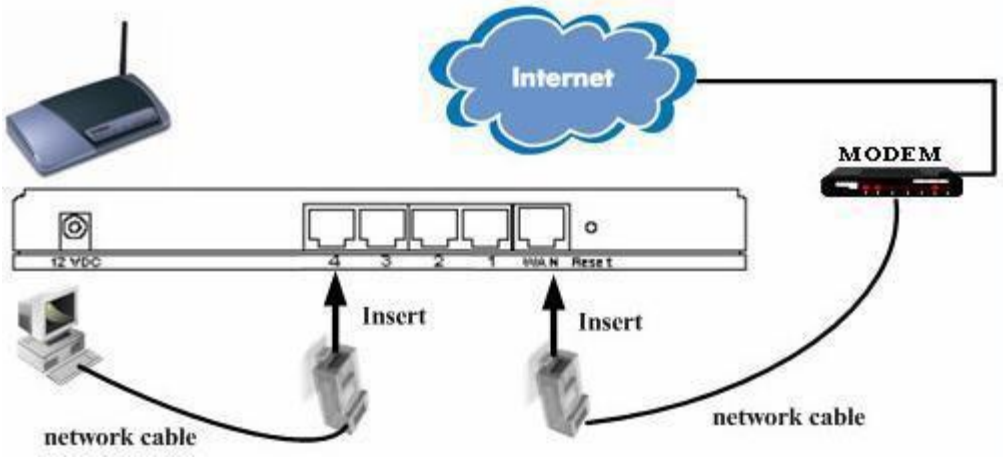


Fig. 2.4.4: Router Installation

- Explain the steps of installing a network switch with the help of the following figure:

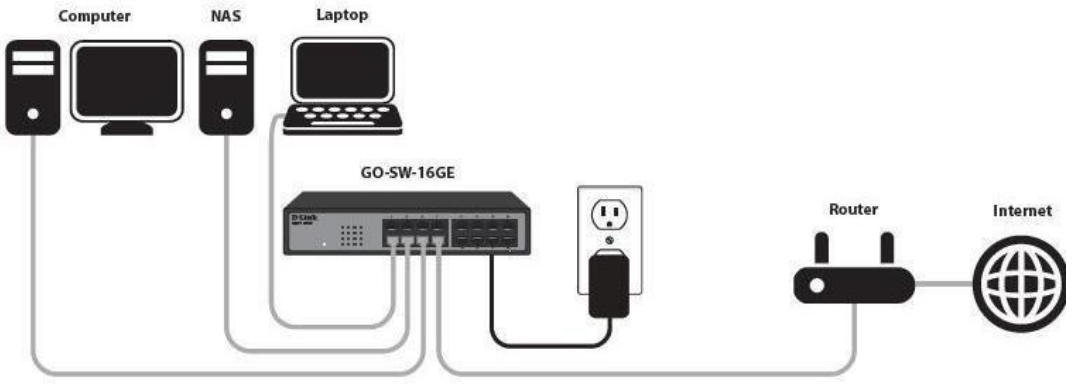


Fig. 2.4.5: Network Switch Installation

- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants to install a modem in the lab and write down the step-by-step process of installation. Then provide the solution as:
    - Connect the coaxial cable to a splitter or a cable outlet.
    - Connect the other end of the cable to the modem through the cable connector on the modem.
    - To avoid damage, use hands to tighten.
    - Plug the end of the power cord to the modem's power port and other end into an electrical wall outlet.
    - Connect the end of the Ethernet cable to the Ethernet port and the other end to the modem
    - Do not plug power cord to power outlet while mounting the modem.
    - Ensure you have:
      - Wall-mounting template
      - Crosshead and flathead screwdriver
      - Two M3.5 (#6) screws with a flat underside. The maximum diameter of the screw head, required to mount the cable modem, is 9.0 mm
    - Mark the holes on the wall, by positioning and securing the wall mounting template.
    - Select the depth and diameter, to drill the holes. The depth of the holes should be at least 1½ inches (3.8 cm)
    - Reconnect the coaxial and Ethernet cable, after mounting the cable modem.
    - Connect the power cord into the power outlet on the wall and the +12VDC Power connector on the cable modem.
    - Arrange the cables properly to avoid any safety hazards.
    - Ensure that the cable modem is attached to the wall securely
  - Ask the participants to install a router in the lab and write down the step-by-step process of installation. Then provide the solution as:
    - Check the package of router for the items it is carrying in new pack
    - Arrange the following list before setting up a router
      - Internet service.
      - Information of Internet Service Provider (ISP) required for configuring the wireless router to access the Internet such as:
        - Internet Login Name and Password
        - Host and Domain Names
        - Fixed or Static IP Address Domain Name Server (DNS) Addresses
    - Use the indicator lights on the front of the wireless router to verify the status of various conditions

- Check the back of the wireless router

- Ask the participants to install network switches in the lab and write down the step by step process of installation. Then provide the solution as:
  - Plug in the power supply
  - Connect the incoming network cable to the switch, preferably in the first slot. The incoming cable from the modem will be considered in case of home and small office
  - Connect a Cat5 or Cat6 cable to another slot in the network switch. Attach the other end to a computer which needs to be connected to the network
  - Repeat this process until all the computers are connected or all slots are filled

UNIT 2.5: UPS and its Types

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Describe the process of installing, replacing, and managing UPS systems to ensure a stable power supply for network infrastructure.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- UPS

Say

Good morning and warm welcome to this training program. Before we begin this session on UPS and its types, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on UPS.

Ask

Ask participants, whether they know what a UPS is.

Demonstrate

- Show a UPS that could be in the classroom.

Notes for Facilitation

- Explain to the participants that a UPS is a device that gets self-activated in events of power cuts.
- Tell them about the various types of UPS:
    - Standby UPS (Offline UPS)
    - Line Interactive UPS
    - Double Conversion On-Line
    - Delta Conversion On-Line

- Explain the participants about Offline and Online UPS on the basis of various parameters such as Operational Difference, Voltage distortion, Price, when to use, etc.
- Explain about UPS connectivity.
- Exercise Handling Strategy **– The solution for the exercise is given as:**
    - Ask the participants the purpose of UPS power supply. Then provide the solution as: An uninterruptible power supply (UPS) is a device that allows a computer to keep running for at least a short time when incoming power is interrupted. As long as utility power is flowing, it also replenishes and maintains the energy storage.
    - Ask the participants about the different types of UPS. Then provide the solution as: Standby UPS, Line Interactive UPS, Double Conversion On-Line, Delta Conversion On-Line

UNIT 2.6: Checking of Voltage, Current and Earthing

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Show how to perform voltage, current, and earthing checks to ensure a stable and safe power supply.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Multimeter

Say

Good morning and warm welcome to this training program. Before we begin this session on how to check voltage, current and earthing, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on checking voltage, current and earthing.

Ask

Ask participants, whether they know about voltage, current or earthing.

Demonstrate

- Show the multimeter.

Notes for Facilitation

- Explain what multimeter is used for.
- Tell them what all appliances can be verified using a multimeter.
- Tell them the two types of multimeter, Analog and Digital.
- Explain them about positive and negative connection.
- Explain to them what earthing is and why is it essential by telling them how it helps in avoiding hazards.
- Tell them about Grounding and how it protects the power system from malfunctioning.
- Elaborate on what can go wrong if grounding or earthing is avoided.
- Explain to them the Earthing checking procedure.
  Step 1: Connect the probes and set the knob of the multimeter to 750V AC. Insert the red probe in phase hole and black probe in neutral hole
  Step 2: Turn on the switch to measure the voltage.
  Step 3: Insert the black test probe and red test probe, in earth and in phase respectively,
  and measure.
  Step 4: Put the red probe and black probe in earth and neutral respectively, and measure.
  Step 5: Calculate the voltage difference between Step 3 and Step 2.
  Step 6: Calculate the difference in voltage received in Step 5 and Step 4

- Exercise Handling Strategy:
  - Ask the participants to explain how they will check current and voltage of power supply.
    Then provide the answer as:
    < Refer Unit 2.6 : Checking of Voltage, Current and Earthing Topic-2.6.1 Voltage and Current Checking >
  - Ask the participants to explain how they will check earthing.
    Then provide the answer as:
    < Refer Unit 2.6 : Checking of Voltage, Current and Earthing Topic-2.6.2 Earthing >

UNIT 2.7: Checking and testing battery

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate how to inspect and replace UPS batteries when required to maintain uninterrupted network operations.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Battery

Say

Good morning and warm welcome to this training program. Before we begin this session on how to check and test battery, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on checking and testing battery.

Ask

Ask participants, whether they know about how to test battery.

Demonstrate

- Show the battery.

Notes for Facilitation

- Briefly explain what battery is.
- Tell them why battery checking and testing is critical.
- Tell them how to assess the condition of battery.
- Explain them the various types of battery testing.
  - Impedance Testing
  - Electro-Chemical Testing
  - Load Bank Testing
  - Partial Discharge Testing
- Explain to them about UPS Battery Monitoring.
- Tell them about the maintenance check required for UPS.

- Exercise Handling Strategy: **(Fill in the blanks)**
  - Ask the participants the best way to assess the correct battery condition is through?
    Then provide the answer as: External Battery Testing
  - Ask the participants for large battery sets, what is more dependable.
    Then provide the answer as: block testing
  - Ask the participants in which testing batteries are discharged up to 80% of the capacity.
    Then provide the answer as: Partial Discharge Testing
  - Ask the participants what standard does UPS battery monitoring use.
    Then provide the answer as: IEEE 1491
  - Ask the participants under which testing method cell is evaluated to be charged.
    Then provide the answer as: Load Bank Testing(Discharge testing)
- Exercise Handling Strategy: (Answer the questions)
  - Ask the participants to list the different types of battery testing in detail.
    Then provide the answer as:
    < Refer Unit 2.7 : Checking and Testing Battery
    Topic-2.7.1 – Types of Battery Testing >
  - Ask the participants to list their observations while conducting a type of testing.
    Then discuss their observations.

UNIT 2.8: Installation and repair of UPS

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Show how to install and route power supply through UPS, ensuring equipment is protected against power fluctuations.
2. Explain the risks and consequences of not following structured wiring guidelines, safety procedures, and PoE power limits.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- UPS

Say

Good Morning and warm welcome to this training program. Before we begin this session on how to install and repair UPS, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on installing and repairing UPS.

Ask

Ask participants, whether they know about installing and repairing UPS.

Demonstrate

- Show the UPS.

Notes for Facilitation

- Briefly explain what is UPS used for.
- Tell them about the pre-installation checks.
  - Selecting the right company
  - Selecting the UPS
  - Location to install
- Explain them the UPS installation procedure.
- Explain them the procedure of installing and connecting batteries.
- Tell them about the common problems which a UPS normally faces.
- Tell them about the process to fix the UPS problems.
- Tell them about the preventive measures to undertake for a longer UPS life.

- Exercise Handling Strategy:
  - Ask the participants the pre-installation checks to be made for UPS installation. Then provide the answer as:

    < Refer Unit 2.8 : Installation and Repair of UPS

    Topic-2.8.1 UPS Installation -> Pre-Installation Checks >
  - Ask the participants the top three maintenance checks for a healthy UPS. Then provide the answer as:
    1. Cleaning of dust on or around UPS and batteries
    2. Rigidity of cable terminations inside the UPS systems, terminal blocks, and breakers
    3. Strength of DC capacitor banks

UNIT 2.9: Basic Load Calculation

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate how to calculate equipment power load and compare it with UPS capacity to prevent overloading and ensure efficient power backup.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia

Say

Good Morning and warm welcome to this training program. Before we begin this session on how to calculate the basic load, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

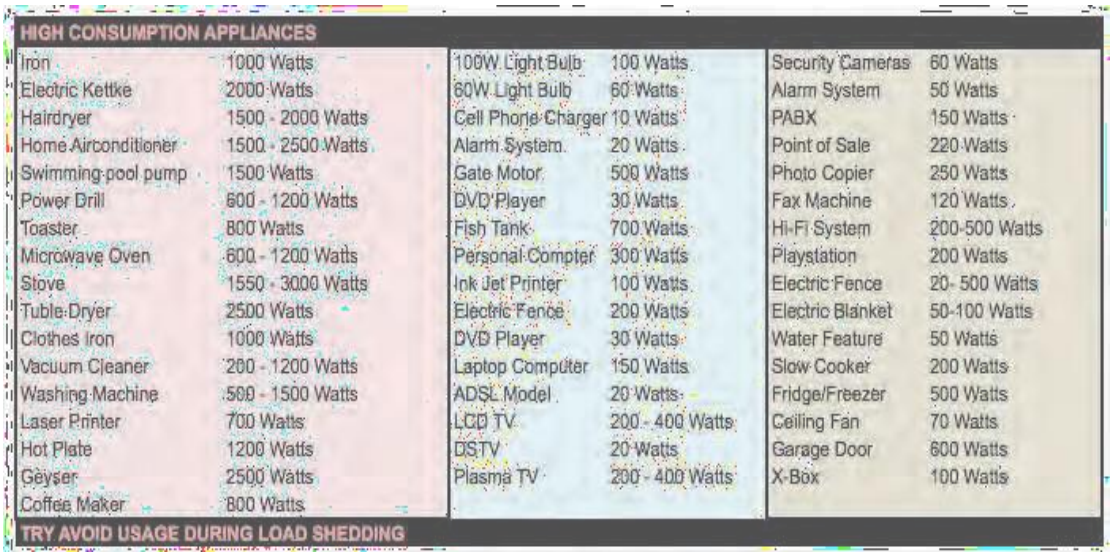
Let us begin this session on basic load calculation.

Ask

Ask participants, whether they know about load calculation.

Notes for Facilitation

- Tell them about the different appliance consumption.



HIGH CONSUMPTION APPLIANCES					
Iron	1000 Watts	100W Light Bulb	100 Watts	Security Cameras	60 Watts
Electric Kettke	2000 Watts	60W Light Bulb	60 Watts	Alarm System	50 Watts
Hairdryer	1500 - 2000 Watts	Cell Phone Charger	10 Watts	PABX	150 Watts
Home Airconditioner	1500 - 2500 Watts	Alarm System	20 Watts	Point of Sale	220 Watts
Swimming pool pump	1500 Watts	Gate Motor	500 Watts	Photo Copier	250 Watts
Power Drill	600 - 1200 Watts	DVD Player	30 Watts	Fax Machine	120 Watts
Toaster	800 Watts	Fish Tank	700 Watts	Hi-Fi System	200-500 Watts
Microwave Oven	600 - 1200 Watts	Personal Compter	300 Watts	Playstation	200 Watts
Stove	1550 - 3000 Watts	Ink Jet Printer	100 Watts	Electric Fence	20- 500 Watts
Tuble Dryer	2500 Watts	Electric Fence	200 Watts	Electric Blanket	50-100 Watts
Clothes Iron	1000 Watts	DVD Player	30 Watts	Water Feature	50 Watts
Vacuum Cleaner	200 - 1200 Watts	Laptop Computer	150 Watts	Slow Cooker	200 Watts
Washing Machine	500 - 1500 Watts	ADSL Model	20 Watts	Fridge/Freezer	500 Watts
Laser Printer	700 Watts	LCD TV	200 - 400 Watts	Ceiling Fan	70 Watts
Hot Plate	1200 Watts	DSTV	20 Watts	Garage Door	600 Watts
Geyser	2500 Watts	Plasma TV	200 - 400 Watts	X-Box	100 Watts
Coffee Maker	800 Watts				
TRY AVOID USAGE DURING LOAD SHEDDING					

- Tell them about the four steps to detect load by locating the Watts rating.

- **Step 1:** Start by listing and placing all the equipment that are protected by inverter or a UPS in one column. For example, computers, alarm, TV, DSTV, lights and fridge.

- **Step 2:** Put the volts and amps of each of these items in column 'b'. This information will be available on nameplates of each item. For example, 120V x 2.0A is written on the plate.

- **Step 3:** Calculate the product of the volts and the amps of each equipment and note the total in a column labelled as "VA". If the rating of the equipment is given in watts, convert the rating to VA by multiplying the figure by 1.43 and note it into your VA column.

- **Step 4:** Add an additional 25% to the total VA load to adapt any future growth. This also helps to avoid any potential overloading of the Inverter/UPS.

- Exercise Handling Strategy:
  - Ask the participants the meaning of load calculation.
    Then provide the answer as: The load is the combined amount of power that electrical devices will consume. To calculate the load, one should make an equipment list, which includes the total watts each piece of equipment requires to run properly.
  - Ask the participants steps to decide UPS Sizing.
    <Refer Unit 2.9: Basic Load Calculation
    Topic – 2.9.1 – Basic Load Calculation -> Sizing a UPS

UNIT 2.10: UPS and Battery Compatibility

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate how to calculate equipment power load and compare it with UPS capacity to prevent overloading and ensure efficient power backup. (Included here to ensure compatibility discussions along with load calculation, without repeating content)

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- UPS

Say

Good Morning and warm welcome to this training program. Before we begin this session on UPS and battery compatibility, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on UPS and Battery compatibility.

Ask

Ask participants, whether they know about UPS and battery compatibility.

Demonstrate

- Show the UPS.

Notes for Facilitation

- Briefly explain them the importance of selecting the optimum UPS size and battery.
- Tell them about the factors on which the installation depends.
- Tell them about the various battery types used in a UPS.
- Explain them about battery sizing.

- Exercise Handling Strategy:
  - Ask the participants what system compatibility means.
    Then provide the answer as:
    Compatibility is the capacity for two systems to work together without having to be altered to do so. Compatible software applications use the same data formats. For example, if word processor applications are compatible, the user should be able to open their document files in either product.
  - Ask the participants how they will check UPS and battery compatibility.
    Then provide the answer as:
    <Refer Unit 2.10 : UPS and Battery Compatibility
    Topic- 2.10.1 – UPS and Battery Compatibility>

UNIT 2.11: Record Keeping and Documentation

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the importance of documentation and record-keeping for network infrastructure and PoE installations.
2. Describe best practices for customer communication, including explaining installation details and resolving customer queries.
3. Explain payment processing procedures and how to handle customer transactions professionally.
4. Describe proper waste disposal methods to ensure environmental safety and compliance with regulations.
5. Explain the importance of obtaining customer sign-off and how to verify customer satisfaction.
6. Demonstrate how to record installation details, including cable routes, device configurations, and test results.
7. Show how to update network plans to reflect any modifications, PoE device placements, and system changes.
8. Demonstrate how to complete installation documents, ensuring all required details are accurately filled in.
9. Show how to communicate with customers regarding installation completion, equipment usage, and troubleshooting guidelines.
10. Demonstrate how to process payments and issue receipts according to company policies.
11. Show how to obtain customer feedback and sign-off, ensuring their concerns and queries are addressed.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Two toy car mechanic set
- Sample repair form
- Sample installation report
- Sample feedback form

Say

Good Morning and warm welcome to this training program. Before we begin this session on record keeping and documentation, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us begin this session on record keeping and documentation.

Ask

Ask participants whether they know the importance of record keeping and documentation.

Team Activity

- Divide the participants into two groups, Group A and Group B.
- Give one toy car mechanic set to each group.
- Ask them to make the model of a car using the set.
- Give an instruction manual to Group A.
- Do not give an instruction manual to Group B.

Time

- Set 10 minutes as the time for completing the activity
- Ensure that the activity finishes in time.

Explain

- Introduce the topic of record keeping and documentation.
- Explain that group A was able to perform better as they had been given clearly written step-by-step procedure.

Notes for Facilitation

- After the end of team activity, ask both the groups to show their models.
- Ask them to observe that Group A's model is better than Group B.
- Explain to the participants the importance of maintaining proper documentation for all the activities undertaken.
- Tell them that maintaining proper documentation serves the following purpose:

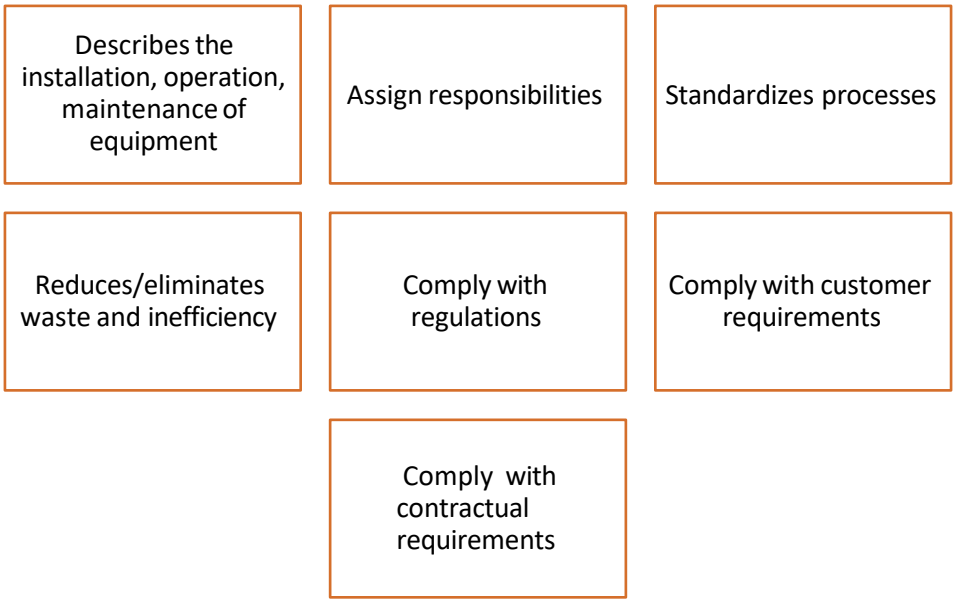


Fig. 2.5.1: Purpose of Documentation

- Tell them that the broadband technician should be able to understand and maintain the following:
  - Installation schedules
  - Operation manuals
  - Verbal instructions
  - Sequential start-up and operation tasks
  - Daily tasks

Demonstrate

- Show a sample of repair form.
- Show a sample of installation report.
- Show a sample of feedback form.

Notes for Facilitation

- Explain the importance of filling forms and submitting to the respective person for record keeping.
- Tell them that for documentation to be effective, it should possess the following characteristics:

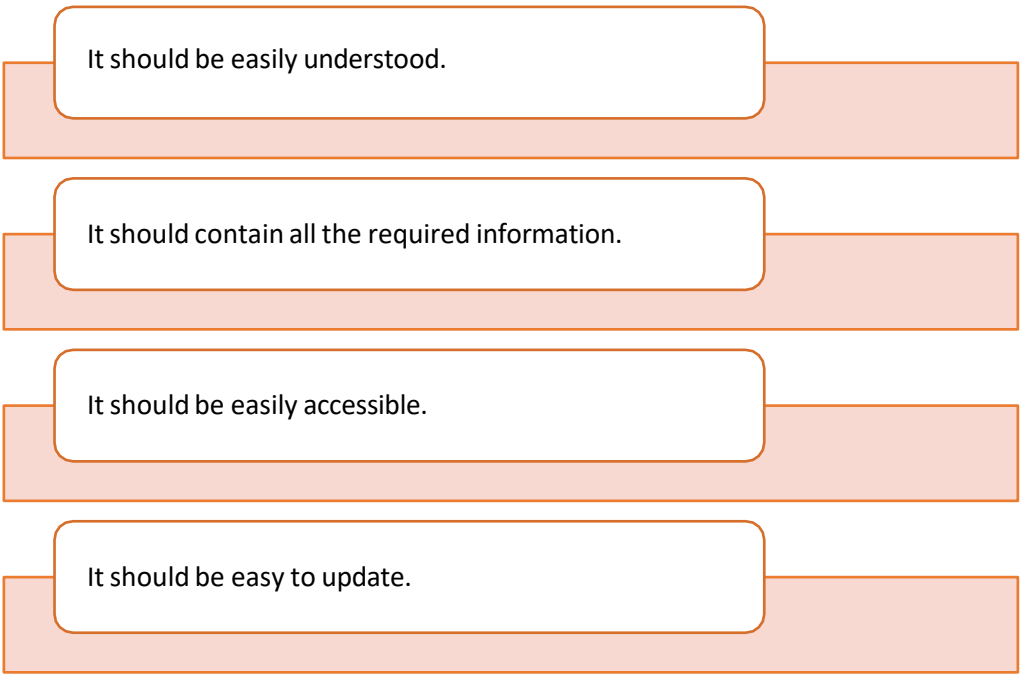


Fig. 2.5.2: Effective Documentation

- Explain the information that a repair/replacement form contains.
- Explain the information that an installation report contains.

- Explain the information that a feedback form contains.
- Exercise Handling Strategy – The solution for the exercise is given as:
  - Ask the participants to prepare a Customer Complaint Report. Then provide the solution as:
    - Fill in the sample format of customer complaint form
  - Ask the participants to answer what they mean by record keeping. Then provide the solution as:
    - Documentation and record keeping guarantees accountability and coordination.
    - While giving best possible service to the customer, following-up is considered to be a major aspect and records in this step helps by providing previous history of the case and brief overview. Records become essential in cases which involves different steps of service to resolve an intricate problem

Exercise

Answers to exercises for PHB

Short Answer Questions:

1. **Importance of keeping cable lengths within limits:**
   - Prevents signal loss and ensures stable data transmission.
   - Ensures sufficient PoE power delivery, as longer cables increase resistance and reduce voltage.

2. **Steps to conduct a site survey for PoE installation:**
   - Inspect layout, cable pathways, and mounting locations.
   - Check power points, network points, and environmental conditions.
   - Identify distance limitations, interference sources, and equipment placement.

3. **Differences between UTP and STP cables & usage:**
   - **UTP**: Unshielded, cheaper, easier to install, used in normal environments with low interference.
   - **STP**: Shielded, prevents EMI, used in industrial areas or places with high electrical noise.

4. **Safe handling of diagnostic tools (PoE testers):**
   - Power off equipment before connecting tester.Verify correct ports and connectors.
   - Follow safety guidelines and manufacturer instructions to prevent damage or shocks.

5. **Importance of documentation & record-keeping:**
   - Helps in troubleshooting and maintenance.
   - Ensures future upgrades, audits, and compliance.
   - Keeps track of cable paths, device details, and test results.

Multiple Choice Questions (MCQs):

1. b) RJ-45
2. b) Provide uninterrupted power supply during outages
3. c) STP
4. c) The correct termination and continuity of the cable
5. b) To ensure proper electrical contact and stable connection

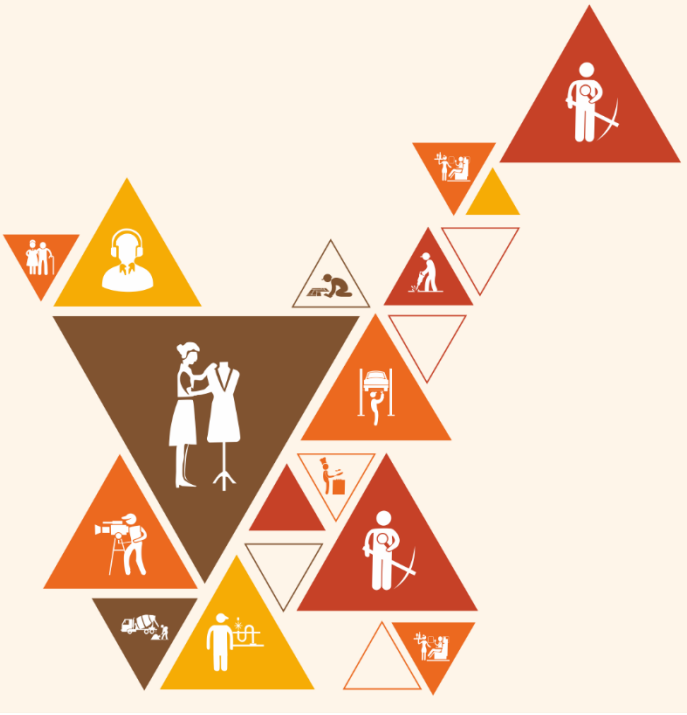
Fill in the Blanks

1. 100 meters
2. PoE injector or switch
3. Cable tester (or network tester)
4. Structured cabling
5. Safety guidelines

Notes

3. Configuring Equipment and Establishing Wireless Network Connectivity

Unit 3.1 - Network Topologies
Unit 3.2 - Establishing Connectivity
Unit 3.3 - Connectivity of CPE and End User Devices
Unit 3.4 - Configuration Testing
Unit 3.5 - Comprehension and Interpretation of Technical Data
Unit 3.6 - Executing Speed Test and Analyze



TEL/N4123

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Explain CPE configuration steps, network security, and integration with broadband and smart home systems.
2. Demonstrate establishing and troubleshooting connectivity between CPE, service provider networks, and end-user devices.
3. Explain the process of connecting CPE to the service provider gateway and end-user devices.
4. Demonstrate network diagnostics, troubleshooting, and performance optimization.

UNIT 3.1: Network Topologies

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Describe wired and wireless CPE configurations, including VLAN, NAT, and QoS settings.
2. Explain the basics of VPNs and Internet Lease Lines (ILL) and their role in secure network communications.
3. Describe IPv6 addressing, subnetting, NAT configurations, and the impact of QoS on broadband services.
4. Explain connectivity options for CPE and end-user devices, including advanced Wi-Fi security settings.
5. Describe how to integrate smart home systems (Amazon Alexa, Google Home, Apple HomeKit) with broadband networks.
6. Explain cybersecurity fundamentals, including securing home networks, firewall configurations, and threat mitigation strategies.
7. Explain the escalation matrix for troubleshooting major network failures and handling emergencies.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia

Say

Good Morning and warm welcome to this training program. Before we begin this session on network topologies, let us revise the previous session.

Do

- Begin with revising the things explained in previous session
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on network topologies.

Ask

Ask to the participants, whether they know about network topologies.

Notes for Facilitation

- Explain to the participants that the term topology refers to the relationship between objects. Network topology refers to the layout of a network and the relationship between its various nodes.

- Explain the importance of network topology with the help of the following figure:

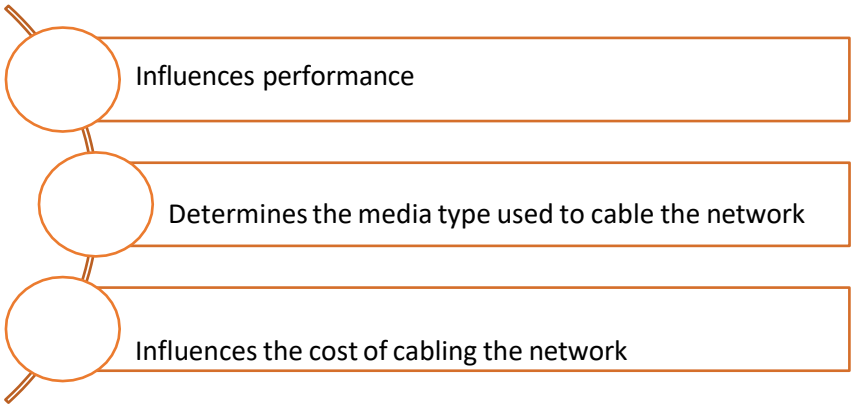


Fig. 3.1.1: Importance of Network Topology

- Tell them that network topologies are of two types:
  - Physical topology: the physical layout of the devices
  - Logical topology: the paths all the signals take between nodes
- Tell them that physical topologies are of following types:
  - Bus
  - Star
  - Token Ring
  - Ring
  - Mesh
  - Tree
- Explain each topology one by one with the help of diagram.
- Explain the advantages and the disadvantages of the bus topology as follows:

Advantages	Disadvantages
• Cost effective • Used in small networks • Easy to understand • Easy to expand • Requires least cable length	• Slower than ring topology • Cable has limited length • Cannot handle heavy traffic • Cable failure leads to network failure

Fig. 3.1.2: Advantages and Disadvantages of Bus Topology

- Explain the advantages and the disadvantages of the ring topology as follows:

Advantages	Disadvantages
• Cheap to install • Easy to expand • Can handle heavy traffic	• Difficult to troubleshoot • Adding and deleting compters disturbs network activity • One computer failure leads to network failure

Fig. 3.1.3: Advantages and Disadvantages of Ring Topology

- Explain the advantages and the disadvantages of the star topology as follows:

Advantages	Disadvantages
• Fast performance • Easy to upgrade • Easy to troubleshoot • Easy to setup • A node failure does not disrupt network activity	• High cost of installation • Expensive to use • Performance gased on capacity of hub • Hub failure leads to network failure

Fig. 3.1.4: Advantages and Disadvantages of Star Topology

- Explain the advantages and the disadvantages of the mesh topology as follows:

Advantages	Disadvantages
• Robust • Provides privacy and security • Easy to diagnose fault • Each connection carries its own data load	• Difficult to install and configure • High cost of cabling • Requires bulk wiring

Fig. 3.1.5: Advantages and Disadvantages of Mesh Topology

- Explain the advantages and the disadvantages of the tree topology as follows:

Advantages	Disadvantages
• Easy to maintain • Easy to diagnose fault • Easy to expand	• High cost • Requires heavy cabling • Difficult to add nodes • Hub failure leads to network failure

Fig. 3.1.6: Advantages and Disadvantages of Tree Topology

Ask

Ask to the participants, whether they know about broadband network elements.

Demonstrate

- How to find the IP address of a network card
- How to find the IP address of a smart phone
- How to find the MAC address of a network card

Notes for Facilitation

- Introduce the topic of broadband network elements.
- Tell them that network elements are as follows:
  - Network Gateway
  - IP address
  - Subnet Mask
  - Ethernet Address
  - MAC Address
- Explain each element one by one.
- Explain that network gateway that is a hardware device such as a router, firewall, or a server which acts as a gate between two networks.
- Explain the features of a gateway as follows:
  - Enables flow of traffic
  - Protects the nodes
  - Translates data received from other networks

- Explain that IP address is a unique identity for every computing device such as personal computers, tablets, and smartphones using the internet. The device uses this address to identify itself and set up communication with the other devices in the IP network.
- Illustrate by giving the following example:
  - Suppose you want to send a letter to your friend. You have to write the destination address on the envelope to enable the letter to reach your friend.
- Tell them that in the same way, an IP address basically has two primary functions:
  - As an interface identification for a network of host machines
  - To provide a location of that machine
- Tell them that there are specific types of IP address, which are as follows:
  - Private IP address: The address reserved for internal use behind a router.
  - Public IP address: The address provided by Internet Service Provider (ISP) for a user.
  - Static IP address: A permanent internet address that never changes. It has to be manually configured for a device.
  - Dynamic IP address: A temporary internet address that is assigned every time a computer or device accesses the Internet. It is automatically assigned to each connection.
- Tell them about the two standards of IP addresses, IPv4 and IPv6.
- Tell them that an IP address has two parts, the network address and the host address. A subnet mask separates the IP address into the network and the host addresses.
- Tell them that subnet mask is short for sub network mask. The subnet mask is basically used by the TCP/IP protocol to check whether a host is on local subnet or on remote network.
- Tell them that the benefits of sub netting are as follows:
  - Enhances network performance and speed
  - Improves network security
  - Reduces network congestion
  - Eases administration
  - Controls network growth
- Tell them that the Ethernet address is the physical address that uniquely identifies an individual Ethernet controller board.
- Tell them that the Ethernet address is also referred to as media access control address (MAC address). It is a unique 48-bit hardware number that is "burnt into" the device by the manufacturer of the Ethernet or network card.
- Tell them that the MAC address is also referred to as hardware or physical address of a device.

- Tell them the difference between the IP address and the MAC address with the help of the following figure:

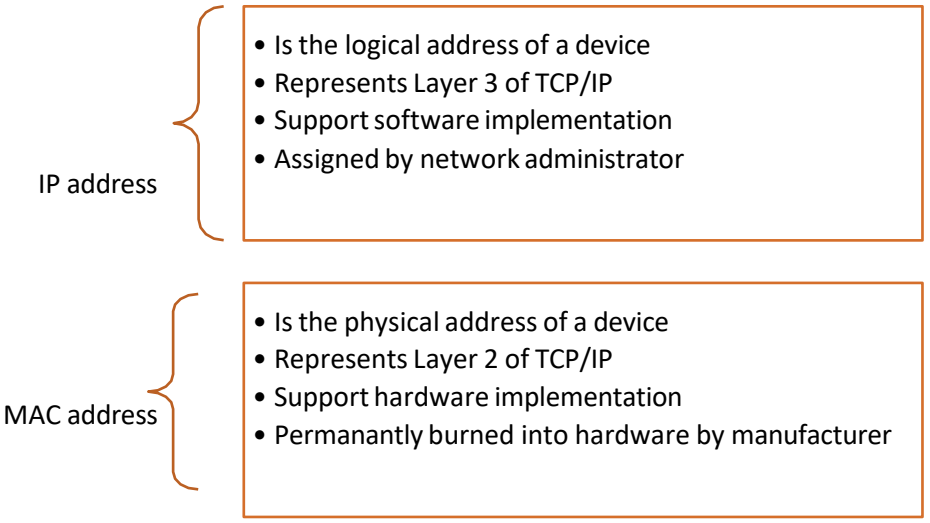


Fig. 3.1.7: IP address vs. MAC address

- Exercise Handling Strategy – The solution for the exercise is given as:
  - Ask the participants to describe the term topology. Then provide the solution as:
    - Schematic description of the planning of a network is referred to as topology, when discussing communication networks.
  - Ask the participants to describe the mesh network. Then provide the solution as:
    - A mesh network is a group of connectivity devices, such as Wi-Fi routers that act as a single network, so there are multiple sources of connectivity around your house instead of just a single router. 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.
  - Ask the participants what they understood by the term MAC Address. Then provide the solution as:
    - The hardware address of a network interface card (NIC) is called its MAC address. MAC stands for Media Access Control.
- Ask the participants to answer the Multiple Choice Questions.
  - Ask the participants which term refers to the way in which the nodes of a network are linked together. Then provide the solution as: Topology
  - Ask the participants what a network comprising multiple topologies is known as. Then provide the solution as: Hybrid
  - Ask the participants the maximum number of IP addresses that can be assigned to hosts on a local subnet that uses the 255.255.255.224 subnet mask. Then provide the solution as: 30
  - Ask the participants if a host on a network has the address 172.16.45.14/30, what is the subnetwork this host belongs to Then provide the solution as: 172.16.45.12

UNIT 3.2: Basic Commands

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate how to ping the service provider gateway and analyze response time for troubleshooting.
2. Show how to analyze connectivity test results, including latency, throughput, and packet loss.
3. Demonstrate how to configure LAN/Wi-Fi connectivity, including SSID and security settings.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Computer with internet connection

Say

Good Morning and warm welcome to this training program. Before we begin this session on basic commands related to networking, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on basic commands related to networking.

Ask

Ask to the participants, whether they know about the basic commands related to networking.

Notes for Facilitation

- Tell the participants that ipconfig is the short form of internet protocol configuration. It is a Windows console application designed to run from the Windows command prompt. It displays the IP address, subnet mask, and default gateway for all physical and virtual network adapters.

Demonstrate

- How to use the ipconfig command
- How to use the ping command

Notes for Facilitation

- Tell them that ipconfig supports various command line options. The command ipconfig /? displays the set of available options, such as:
  - ipconfig /all
  - ipconfig /release
  - ipconfig /renew
  - ipconfig /displaydns
  - ipconfig /flushdns
  - ipconfig /registerdns
- Tell them that the ping command is a basically Command Prompt command which is used to test the whether the source computer can reach another computer at a specified destination.
- Explain that the ping command works by sending Internet Control Message Protocol (ICMP) Echo Request messages to the destination computer and then waits for the response.
- Tell them that the purpose of using ping command is:
  - To test connectivity
  - To determine the response time
- Tell them that they can use the ping command in following ways:
  - Ping xxx.xxx.xxx.xxx
  - Ping site.com (web address)
  - Continuous Ping (Ping xxx.xxx.xx.xx –t)
  - Number of Pings (Ping xxx.xxx.xx.xx -n 10)
  - Size of Packet (Ping xxx.xxx.xx.xx -l 1500)
  - Time Out (Ping xxx.xxx.xx.xx -w 5000)
  - Resolving Host name Address (Ping -a xxx.xxx.xx.xx)

- Tell them that in all of these examples "xxx.xxx.xxx.xxx" is an example of a Domain Name or an IP Address.
- Exercise Handling Strategy – **The solution for the exercise is given as**:

1. Internet Protocol Configuration
2. TCP/IP network configuration values ; DHCP and DNS
3. ipconfig /flushdns
4. ipconfig /registerdns
5. ipconfig/displaydns
6. ping
7. “n”
8. ping
9. ping<<site>>.com
10. Continuous Ping

UNIT 3.3: Connectivity of CPE and End User Devices

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Show how to connect a laptop/PC, smart/IP TV, IoT devices, and other customer devices to the CPE and establish connectivity.
2. Show how to configure the CPE with base settings, including IP, gateway, mask, NAT, QoS, and enable IPv6 support.
3. Demonstrate setting up a VPN or Internet Lease Line (ILL) based on customer requirements.
4. Show how to apply basic cybersecurity settings such as strong password policies, firewalls, and MAC filtering.
5. Show how to verify all cables and connectors are properly plugged in and functional.
6. Demonstrate how to configure LAN/Wi-Fi connectivity, including SSID and security settings.
7. Show how to integrate broadband with smart home systems like Amazon Alexa, Google Home, or Apple HomeKit.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia

Say

Good Morning and warm welcome to this training program. Before we begin this session on connectivity of CPE and end user devices, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Now let us start this session on connectivity of CPE and end user devices.

Notes for Facilitation

- Tell the participants that, in telecommunication terminology, any equipment that is installed at a customer location is referred to as customer premises equipment (CPE).
- Tell them that CPE is generally owned by the telecommunication provider and includes hardware such as telephone handsets, cable TV set-top boxes, and Digital Subscriber Line routers.

- Explain the connectivity of CPE and end user devices from the main infrastructure with the help of the following figure:

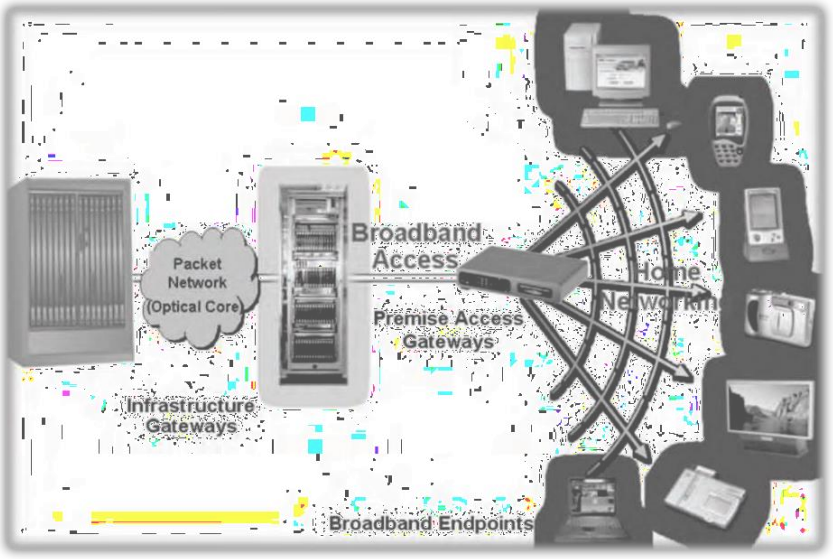


Fig. 3.3.1: Broadband Connectivity

- Explain them how to check if the Internet is connected.
- Explain to them the steps of configuring TCP/IP for Windows 11.

  Step 1: Click Start -> Control Panel

  Step 2: Click Network and Internet

  Step 3: For Wi-Fi, select Wi-Fi-> Manage known networks and choose network for which the settings needs to be altered

  Step 4: For Ethernet, select Ethernet, then select network to connect

  Step 5: Next to IP assignment, select Edit

  Step 6: Select Automatic (DHCP) or Manual under Edit network IP settings or Edit IP settings

  Step 7: To specify IPv4 / IPv6 settings manually. Under Edit network IP settings or Edit IP settings, choose Manual, then turn on IPv4/IPv6

  Step 8: To specify an IP address, in the IP address, Subnet mask, and Gateway boxes, type

  Step 9: To specify a DNS server address, in the Preferred DNS and Alternate DNS boxes, type the addresses of the primary and secondary DNS servers

  Step 10: To specify if you want to use an encrypted (DNS over HTTPS) or unencrypted connection to the DNS server you specify, for Preferred DNS encryption and Alternate DNS encryption, choose the setting you want

  Step 11: Select Save.

- Exercise Handling Strategy – **The solution for the exercise is given as**:
  - Ask the participants to demonstrate configuration of TCP/IP in Windows 11 and write the steps. Then provide the solution as:

    <Refer Unit 3.3: Connectivity of CPE and End use devices Topic – 3.3.3 Configuring TCP/IP for Windows 11>

- Ask the participants, demonstrate configuration of TCP/IP in MAC and write the steps. Then provide the solution as:
  - Click the Apple menu then select System Preferences.
  - When the System Preferences screen appears, look for Internet & Wireless section and click Network.
  - Under the Network screen, select Airport, and then click Advanced
  - Click TCP/IP->In the Configure IPV4 box, please select "Manually"->and then fill in the IP address, Subnet Mask and the Router (the default gateway)-> click OK
- Ask the participants to explain CPE. Then provide the solution as:

  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.

UNIT 3.4: Configuration Testing

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate how to ping the service provider gateway and analyze response time for troubleshooting.
2. Show how to analyze connectivity test results, including latency, throughput, and packet loss.
3. Show how to ping the CPE from an end-user device, analyze the response, and optimize network settings for stability.
4. Demonstrate how to enable Quality of Service (QoS) settings to prioritize network traffic based on user needs.
5. Demonstrate how to record CPE configuration settings, including network security configurations and VPN/ILL setups.
6. Show how to document end-user device configurations, including IP allocation and firewall settings.
7. Demonstrate how to record the pinging procedure and expected result parameters for troubleshooting reference.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids

Say

Good Morning and warm welcome to this training program. Before we begin this session on configuration testing, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Now let us start this session on configuration testing.

Notes for Facilitation

- Start by explaining the meaning of configuration testing.
- Tell them that configuration testing is a process of testing the system along with the supported software and hardware configurations.
- Tell them that the purpose of configuration testing is to find out the ideal configuration that the system can work with, without any flaws or bugs.
- Explain that there are certain pre-requisites for configuration testing. These are as follows:
  - Creating various combinations of configuring software and hardware
  - Prioritizing the configurations
  - Testing every configuration based on prioritization

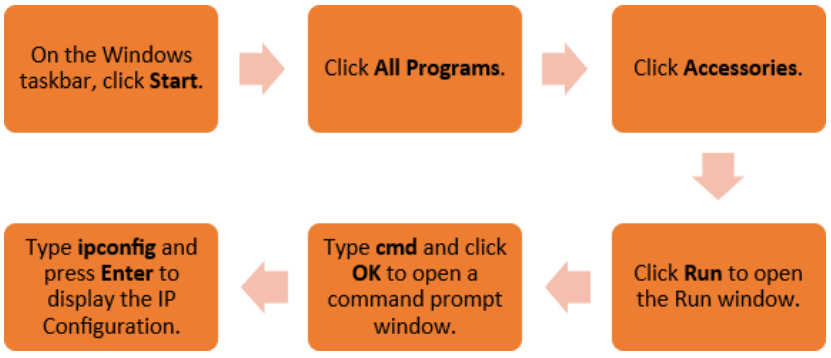
- Tell them that the objectives of configuration testing is to:
  - Validate the system to ensure that it fulfils the configurability requirements
  - Manually causing failures to help identify any inherent defects
  - Determine an ideal configuration of the application
  - Analyse the performance of the system by adding or modifying the hardware resources
  - Analyse the efficiency of the system

Demonstrate

- How to verify IP address in Windows 11 for Wifi.
- How to verify IP address in Windows 11 for Ethernet.

Notes for Facilitation

- Explain that once the TCP/IP configuration is done in Windows 11, the next step is to verify the IP address.
- Explain the steps of to verify the IP address in windows 11.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants to explain the term configuration testing with an example. Then provide the solution as:
    - Configuration testing is defined as a software testing. It checks a system with multiple combinations of software and hardware to find out the optimal configurations that the system can work without any flaws or bugs.
  - Ask the participants the steps of configuration testing. Then provide the solution as:



  - Ask the participants, explain the importance of configuration testing while discussing an example. Then provide the solution as:
    - Without configuration testing being performed it is difficult to analyze the optimal system performance and also software might encounter compatibility issues that it is supposed to run on.

UNIT 3.5: Comprehension and Interpretation of Technical Data

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Show how to brief customers on basic troubleshooting steps/self-help techniques, including cybersecurity best practices.
2. Demonstrate how to guide customers in monitoring network activity and updating firmware for security and performance improvements.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids

Say

Good Morning and warm welcome to this training program. Before we begin this session on comprehension and interpretation of technical data, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Now let us start this session on comprehension and interpretation of technical data.

Demonstrate

- Run ipconfig/all command at the command prompt and display the output.

Notes for Facilitation

- Explain to the participants that it is very important for a broadband technician to be able to comprehend and interpret technical data such as IP configuration and network problems.
- Tell them that they need to understand the output displayed when they type " ipconfig /all" at the command prompt.

- Tell them that the meaning of output is as follows:
  - **Host Name:** Displays the name of the computer, as seen by Internet Protocol
  - **Node Type:** Tells how one computer identifies the address of another computer on the LAN
  - **DHCP Enabled:** If set to yes, implies dynamic IP address and if set to no, implies static IP address
  - **Description:** Provides short description of the network connection
  - **IPv6 address:** Displays IP address in new IPv6 protocol.
  - **IPv4 address:** Displays IP address of your computer in the local network.
  - **Default gateway:** Displays IP address of router used to connect to Internet
  - **DHCP server:** Displays address of server which assigns dynamic addresses to the computers on the network
  - **Subnet mask:** Defines the range of addresses that can be assigned to computers by the router
  - **Physical address:** Displays the MAC address of the computer.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants to explain about the term technical data and give some examples. Then provide the solution as:
    - 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.
    - "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.
  - Ask the participants, what is method to interpret the technical data? Explain in brief. Then provide the solution as:
    - Data interpretation refers to the implementation of processes through which data is reviewed for the purpose of arriving at an informed conclusion.
    - Regression analysis
    - Cohort analysis
    - Predictive and prescriptive analysis
  - Ask the participants to explain what a DNS number indicates. Then provide the solution as:
    - **D**omain **N**ame **S**ystem is the Internet's system for converting alphabetic names into numeric IP addresses. For example, when a Web address (URL) is typed into a browser, DNS servers return the IP address of the Web server associated with that name.

UNIT 3.6: Executing speed test and analyze

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Perform a speed test, record throughput data, and demonstrate network performance as per the subscribed plan.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids

Say

Good Morning and warm welcome to this training program. Before we begin this session on speed tests, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Now let us start this session on executing and analyzing speed tests.

Notes for Facilitation

- Explain to them why speed tests are required.
- Talk about certain terminologies such as Download speed, Upload speed, Mbps, Latency and Ping.
- Demonstrate to them how they can run a speed test.
- Explain how they can interpret the results of the speed test.
- Discuss ways to troubleshoot a faulty speed test.
- Explain how important it is to communicate the speed result analysis with the client.
- Discuss with them situations that could make the client and angry and how they have to stay composed.

- Exercise Handling Strategy – **The solution for the exercise is given as:**
    - Ask the participants to explain about the process of running a speed test. Then provide the solution as: < Refer Unit 3.6 : Executing speed test and analyze Topic 3.6.1 – Speed Test measures -> How to run a speed test >
    - Ask the participants what they mean by latency. Then provide the solution as: the time data took to travel to its destination and returned back to user

      Solution of fill in the blanks:

1. Ping
2. speed of uploading and downloading information bits per second(bps)
3. 1,000,000 bps ; 1,000,000,000 bps
4. coaxial
5. maintain the connection

Exercise

Answers to exercises for PHB:
Short Answer Questions:

1. **Accessing CPE settings & importance of updating credentials:**
   - Access via browser (typing gateway IP like 192.168.1.1) or via CLI using telnet/SSH commands.
   - Updating default credentials prevents unauthorized access and secures the network.

2. **VLAN & NAT and their effect on traffic management:**
   - VLAN: Segments the network into logical groups to improve security and reduce congestion.
   - NAT: Translates private IPs to public IPs, conserving addresses and managing traffic routing.

3. **How IPv6 support improves connectivity:**
   - Provides a larger address space and eliminates IPv4 limitations.
   - Enhances security, performance, and ensures compatibility with future internet devices.

4. **Role of QoS in broadband:**
   - Prioritizes traffic like video calls, gaming, or VoIP.
   - Reduces lag, buffering, and ensures smoother performance for critical applications.

5. **Steps for Level 1 and Level 2 diagnostics:**
   - Level 1: Check cables, power, router LEDs, reboot equipment, verify Wi-Fi settings.
   - Level 2: Run ping/traceroute tests, check IP configuration, inspect logs, update firmware, verify line parameters.

Multiple Choice Questions (MCQs):

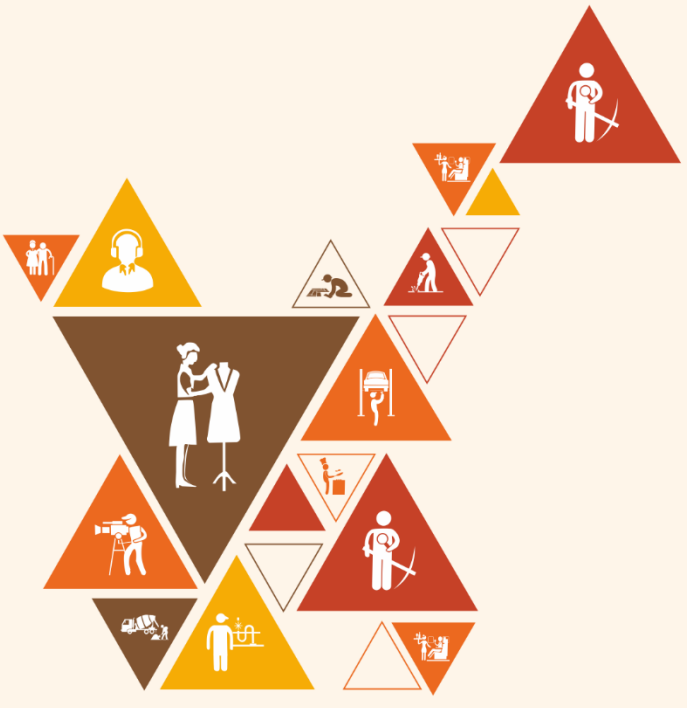
1. b) Enabling MAC filtering and firewalls
2. b) Provide secure communication over the internet
3. b) ping
4. c) Compatibility and secure network access settings
5. b) Variations in packet delay affecting real-time applications

Fill in the Blanks

1. Ping
2. Password
3. VLAN
4. jitter test (or simply jitter)
5. Wi-Fi settings

Notes

4. Troubleshoot and Rectify Faults



Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Determine the methods used to diagnose and rectify wiring faults in wireless networks.
2. Explain the process of troubleshooting and repairing Wi-Fi backhaul equipment operating at 5 GHz.
3. Describe the procedures for troubleshooting and restoring Wi-Fi access points operating at 2.4 GHz.
4. Discuss the steps involved in carrying out documentation and restoring the worksite after wireless network fault rectification.

UNIT 4.1: Escalation Matrix

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain escalation procedures and risk factors for unresolved broadband issues.
2. Explain the importance of documentation in broadband troubleshooting and service maintenance.
3. Explain best practices for customer communication and remote troubleshooting assistance.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Escalation matrix form

Say

Good Morning and warm welcome to this training program. Before we begin this session on escalation matrix, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on escalation matrix.

Ask

Ask the participants whether they know about escalation matrix.

Demonstrate

- Escalation Matrix Guideline of the company “Vistara”

Notes for Facilitation

- Explain to the participants that the term escalation means when something or some problem increases or intensifies in magnitude.
- Give an example:
  - If a customer has registered a complaint and it is not solved by the field technicians, then he might raise the issue to the technician's supervisor or manager. This is called escalation.
- Escalation matrix refers to the hierarchy in an organization that deals with issues or problems as they escalate.
- To continue with the same problem:
  - If the manager is not able to resolve customer complaint, it then goes to senior manager and then to operations head and so on higher up till it reaches the top level.
- Tell them that this chain of people or hierarchy is referred to as escalation matrix.
- Explain the key features of escalation matrix.
- Explain the escalation matrix form to the participants.
- Explain the importance of having a clear-cut escalation matrix in place.
- Tell them that it helps both the technician as well as the customer.
- Explain that there will be situations in which the technicians might not be able to resolve an issue even after making reasonable effort. In such cases, he/she can seek help so that the next higher person (with more authority/decision-making powers) can step in and try to resolve the issue in the best possible manner and as per the policies laid down.
- Similarly, from a customer's point of view, an escalation matrix assures that the issue will eventually get resolved as per his/her satisfaction and within a specified time period.
- Tell them that escalation matrix consists of levels L1, L2 , and L3 where:
  - L1 is the first line of end user support
  - L2 is the next level, if L1 is not able to resolve the issue within a specified number of days
  - L3 highest level, if L2 is not able to resolve the issue within a specified number of days
- The following figure depicts the levels of escalation matrix:

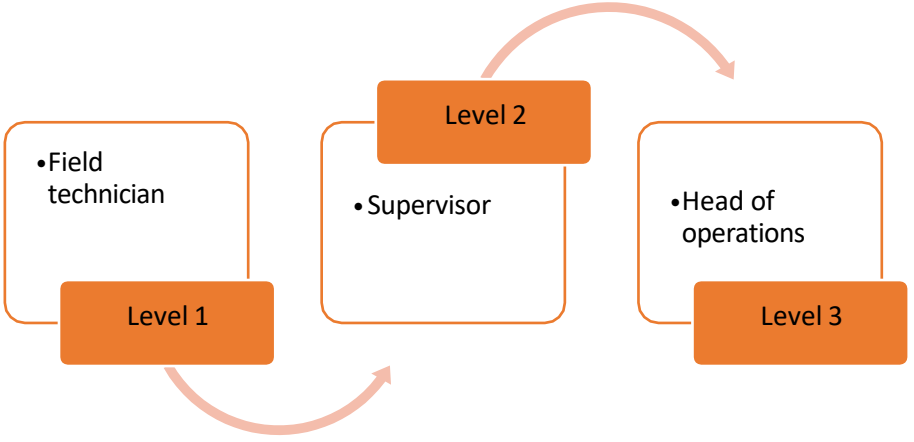


Fig. 4.1.1: Levels of Escalation Matrix

- Tell them that if there is an escalation plan in place, the technicians would know whom to contact next and how to contact them when required.
- Explain to them that an escalation plan refers to a set of protocols and procedures to be followed to deal with potential problems.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants to what they mean by escalation. Explain by giving an example. Then provide the solution as:
    - Escalation matrix is a process of set protocols and procedures which defines the steps while handling any potential dispute and/or problem.
  - Ask the participants to discuss some of the cases in which escalation matrix needs to be prepared. Then provide the solution as:
    - Operational (scheduling, service cancellations, etc.)
    - Logistical (delivery, in transit missing products, etc.)
    - Technical (error messages, etc.)
  - Ask the participants what kind of information can they get from an escalation matrix form. Then provide the solution as:
    - Scheduling
    - Obtaining Instructions
    - Customer Satisfaction
    - Service Information
    - Obtaining materials
    - Performance issues
    - Service cancellations

UNIT 4.2: Problem Solving

Unit Objectives

After the completion of this unit, the participant will be able to:

After the completion of this unit, the participant will be able to:

1. Describe common network faults like No Service, degraded service, and intermittent connectivity, and their root causes.
2. Describe the common causes of broadband service disruptions (signal loss, attenuation, interference).
3. Identify various network troubleshooting techniques, including speed tests, ping tests, and trace routes.
4. Explain the use of AI-based predictive maintenance and remote diagnostic tools in broadband troubleshooting..

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia

Say

Good Morning and warm welcome to this training program. Before we begin this session on problem solving, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on problem solving.

Ask

Ask the participants whether they know about problem solving.

Notes for Facilitation

- Tell the participants about the problem solving process and its steps. Use the following pointers to explain the steps:
  - The first step in a problem solving process is to identify the problem.
  - Then, gather details about the problem and its possible solution. The more data you have the better decision-making you can do.
  - Third step is to analyse the problem. You may need to use mathematical or statistical tools to arrive at a point, which will help you to take a decision.
  - Develop alternatives, which will help to have a plan B in case plan A does not work.
  - Finally, choose the best option.
- Then, tell the participants about some benefits of problem solving, such as:
  - It is based upon previous knowledge and they will learn from it.
  - It will help them to understand the process and suggest improvements by eliminating the waste.
  - It requires them to be thorough with the process and also be updated with the new developments.
  - Critical and reflective thinking will help to identify the process disruptions and the reasons for it.
  - Analyse the reasons for the delay and how the improvements can be done.
  - The problem solving process can be defined as given in the following figure:

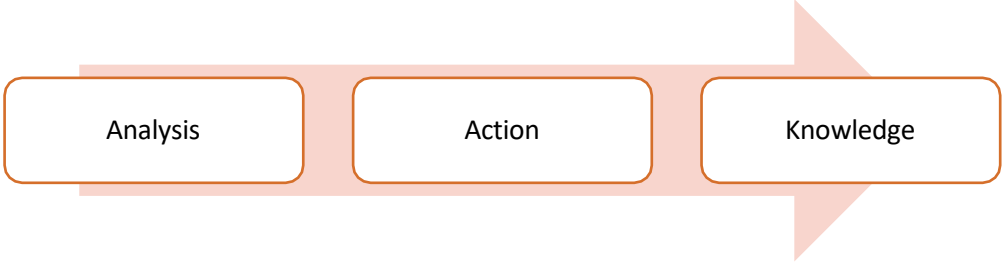


Fig. 4.2.1: Problem solving

- Explain the importance of solving a customer's problem/issue as soon as possible.
- Explain the correct way of behaving when a customer reports a problem.

Role Play

- Ask two participants to enact a role play.
- One of them should act as a broadband technician and the second one should act as his/her customer.
- The situation is that the customer has complained that he is not able to connect to internet.
- Ask them to enact the interaction between the two of them.

Time

- Set five minutes as the time limit of the role play.
- Ensure that the role play finishes within the time limit.

Notes for Facilitation

- Explain the importance of solving the customer's problem in the right manner.
- At the end of the role play activity, illustrate the significance of every point, one by one.
- Ask two other volunteers to play the roles of a broadband technician and a customer.
- Tell the person acting as the broadband technician to enact an incorrect way of doing something, for example putting the blame on the customer.
- Ask the person playing the role of a customer how he/she felt when the broadband technician was standing too close to him/her.
- Explain to the rest of the participants the correct distance to be maintained while interacting with a customer.
- In this way, ask different people to do small role plays to explain the dos and don'ts to the participants.
- Explain the guidelines they should follow to solve customer's problem.
- Explain that even after they have solved the customer problem, they should make it a point to follow-up with the customer. This will ensure customer satisfaction and also give them a visibility in case there are some additional issues.
- Discuss the problem solving checklist with them, briefly explaining each point.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
    - Ask the participants what they mean by problem solving. Then provide the solution as:
        - Typically, customers want that their problems should be easy to report, quickly acknowledged and timely acted upon with compassion and fairness. Addressing these issues is problem solving.
    - Ask the participants to list the problems they can encounter in their work life.
        - Check the steps by which they can solve their problems.
    - Ask the participants, to prepare a checklist for solving a problem. Then provide the solution as:
        - Exhibit your understanding towards the problem and respect urgency.
        - Explain briefly in a layman's term the cause and action plan for the customer's problem.
        - Share the time frame with the customer and take his/her verbal agreement on the same.
        - Inform about the cost involved in fixing the customer's issue in case he/she is not covered under warranty. It is advised to always give a quote in writing to avoid conflicts at the time of payment.
        - Be patient and informative while explaining the cause of the problem to the customer and never argue if he retaliates.

UNIT 4.3: Identiying and repairing faulty Cables and Connectors

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Understand how to identify faulty cables and connectors correctly
2. Show how to replace faulty connectors and damaged cables.
3. Show how to take readings at splitter points and terminated cable ends.
4. Demonstrate how to rectify signal leakage, cable faults, and interference in a broadband network.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Connectors such as RJ-11, RJ-45
- Cat 3 cable or Cat 5 cable, Rollover cable
- Wire stripping and crimping tools

Say

Good Morning and warm welcome to this training program. Before we begin this session on cables and connectors, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on cables and connectors.

Notes for Facilitation

- Do a quick recap of cables and connectors.
- Tell them that cables are hardware devices used to connect one network device such as computers to other network devices such as printers, scanners.
- Tell them that the most common cables used in networking are the twisted pair cable, coaxial cable, and optical fibre cable.

- Tell them that the most common type of network cable is unshielded twisted pair (UTP) which contains eight wires split into four pairs. Each wire is covered in a coloured plastic coating. The colours are:
  - Green
  - Orange
  - Blue
  - Brown

Demonstrate

- Strip a UTP cable to show individually coloured wires.
- Identifying an RJ-45 straight-through cable
- Identifying an RJ-45 crossover cable
- Identifying an RJ-45 rollover cable

Notes for Facilitation

- Tell them how cables and connectors go through a lot of wear and tear and explain them the possible issues.
  - Loose cable connections at Switches and Outlets
  - Wire Connections Made with Electrical Tape
  - Two or More Wires Under One Screw Terminal
  - Loose Connections on Circuit Breaker Terminals
  - Faulty Neutral Wire Connections at Circuit Breaker Panels
- Also explain to them the possible solutions to these issues.
- Explain them what OTDR is.
- Demonstrate them how to test a fiber optic cable.
- Explain them how Signal level meters are used for installation as wells as for finding faulta and for timely maintenance.
- Explain them the various types of Signal Level Meters, namely CCTV, Satellite & CATV Signal Level Meters.
- Tell them that, depending on the wiring of the cables and their intended use, the network cables can be categorised as:
  - Straight-through Wired Cables
  - Crossover Wired Cables
  - Rollover Wired Cables
- Tell them that the straight-through cables have the same pin assignment on each end, that is, Pin 1 connector A goes to Pin 1 on connector B, Pin 2 to Pin 2 and so on. These cables are used to connect the client to a host. Example of straight-through cables is Cat 5e patch cables.

- Tell them that the cable used to connect a computer with a router is known as rollover cable. It is not meant to carry data rather it creates an interface with the device.
- Tell them that it is called rollover because it has opposite pin assignments on each side of the cable. The wire that connects to pin 1 at one end goes to pin 8 at the other end, the wire that goes to pin 2 and the first end goes to pin 7 and so on.
- Tell them that a connector is an electro-mechanical device used to connect or disconnect a circuit. Connectors are of different sizes, shapes and quality levels.
- Tell them that connectors can be categorised on the basis of their physical appearance and mating properties as:
    - Male connectors such as jacks and plugs
    - Female connectors such as sockets and ports
- Tell them that some common connector types used in broadband are as follows:
    - RJ-11: Used for analog telephone lines
    - RJ-45: Used for Ethernet
    - RJ-49: Use for ISDN
- Tell them that RJ stands for Registered Jack.
- Tell them that an RJ-45 connector is used for connecting ends of Ethernet cables. It consists of eight connectors for eight pins.
- Explain the way to identify an RJ-45 straight-through cable.
- Explain the way to identify an RJ-45 crossover cable.
- Explain the way to identify an RJ-45 rollover cable.

Demonstrate

- Connecting a cable to an RJ-45 connector.

Notes for Facilitation

- Explain to the participants the process of connecting a Cat 3 or a Cat 5 cable to an RJ-45 connector.
- Tell them that the basic step is to ensure that they have the required cables, connectors and tools.
- Tell them to work carefully to make sure that there is no damage to the wires or the connector.
- Tell them to use only specific tools for crimping.
- Tell them to make sure that the cable sheathing is completely inside the connector where it can be locked into place.
- Tell them to make sure that the wires go all the way to the end part of the connector.
- Tell them that after they have connected the cable to an RJ-45 connector, they should use a cable tester to ensure that the cable is working properly.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
    - Ask the participants how to identify that cables and connectors are correctly placed. Then provide the solution as:
        - A crossover cable can be identified by comparing the two modular ends of it. The leftmost coloured wire (pin 1) at one end of the cable goes to the pin 3 at the other end of the cable. The coloured wire of pin 2 at one end of the cable, goes to pin 6 at the other end of the cable.
        - A rollover cable is identified by holding each of its end and ensuring that the colour of the wires on the outside of the left-hand plug and on the right side are same.
    - Ask the participants, list the steps to connect cables correctly. Then provide the solution as:
        - Cut the outer jacket of the wire by about 1 -1.5 inches by using a wire stripper.
        - Before installing the wire, arrange them in the order in which they are supposed to go in the RJ45 connector.
        - After the wires are arranged in the specified order, cut them at least ½ inch from the point which will be used for installation.
        - 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.
        - Specific tool should be used for crimping the cable. To check the connection, tug the cable slightly. Accordingly crimp again, if required.
    - Ask the participants, list the steps to connect the connectors correctly.
      Then provide the solution as:
        - Cut the outer jacket of the wire
        - Cut the wire into 1 and 1/2 inch in length
        - RJ45 connector
        - Cable installed in RJ45 connector

- Before installing the wire, arrange them in the order in which they are supposed to go in the RJ45 connector.
- After the wires are arranged in the specified order, cut them at least ½ inch from the point which will be used for installation.
- 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.
- Specific tool should be used for crimping the cable. To check the connection, tug the cable slightly. Accordingly crimp again, if required.

- Ask the participants, list the steps to connect the connectors correctly. Then provide the solution as:
  - Cut the outer jacket of the wire
  - Cut the wire into 1 and 1/2 inch in length
  - RJ45 connector
  - Cable installed in RJ45 connector
- Ask the participants, what is an optoelectronic instrument for understanding the character of an optical fiber. Then provide the solution as Optical Time-Domain Reflectometer (OTDR).
- Ask the participants to name the two types of Signal Level Meters. Then provide the solution as: CCTV Signal Level Meters and Satellite & CATV Signal Level Meters.

UNIT 4.4: Electro Magnetic Interference (EMI) and Compatibility (EMC)

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain broadband communication systems and signal transmission principles.
2. Describe signal loss, attenuation, and interference factors affecting network performance.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Speaker
- Cell phone

Say

Good Morning and warm welcome to this training program. Before we begin this session on importance of EMI and EMC, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on importance of EMI and EMC.

Demonstrate

- The principle of EMI by placing a cell phone next to the speaker and observing the static produced by the speaker during an incoming call.

Notes for Facilitation

- Explain to the participants that EMI stands for Electromagnetic Interference.
- Tell them that it is a phenomenon which occurs when electromagnetic fields caused by an electronic device interferes with the operation of another electronic device in its vicinity.
- Some common examples of EMI in everyday life are as follows:
  - Disturbance in audio signals on a radio when an airplane flies at a low altitude
  - Travellers requested to switch-off cell phones during take-off and landing of an airplane
- Tell them that the effects of EMI can be minimised by:
  - Moving away from the source of EMI
  - Moving the equipment away from the range of EMI
  - Installing a good electrical ground system and by shielding the equipment
  - Using EMI cancellation mechanisms such as shielding
- Tell them that if an equipment is not properly shielded from EMI, it will not function properly.
- EMI shielding ensures that the electronic device/system remains fully operational and runs without interference.
- Explain to the participants that EMC stands for Electromagnetic Compatibility.
- Tell them that electromagnetic compatibility aims to control EMI in order to lessen the risk of equipment damage.
- Tell them that EMC means that a device is compatible with its electromagnetic environment. The levels of EMI emitted by the device does not cause interference in the working of other devices near it.
- Give an example that:
  - A speaker and a cell phone are not electromagnetically compatible. So, when there is an incoming call or message, the speaker produces a static sound as the EMI waves emitted by the phone interfere with the speaker's coils.
- Explain that the difference between EMI and EMC is that EMI stands for radiation emitted by a device and EMC is the ability of a device to work in presence of a radiation.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants what they understand by the term EMI. Explain with example. Then provide the solution as:
    - EM waves are radiated from mostly every device which can affect the working of the nearby wireless or RF systems. This phenomenon is referred to as EMI.
  - Ask the participants what they understand by the term EMC. Explain with example. Then provide the solution as:
    - EMC is the electric noises produced by every device passes through cables, which can affect the working of adjoining devices connected to the same electric system.

- Ask the participants if they know the difference between EMI and EMC. Then provide the solution as:
  - EMI stands for radiation emitted by a device and EMC is the ability of a device to work in presence of a radiation.

UNIT 4.5: Crimping and Soldering

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate the process of re-connectorization or crimping of cable pairs.
2. Show how to perform crimping and soldering techniques ensuring proper connectivity.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Cables and connectors
- Soldering tools and equipment
- Crimping tools and equipment

Say

Good Morning and warm welcome to this training program. Before we begin this session on crimping and soldering, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on crimping and soldering.

Ask

- Ask the participants if they have seen soldering iron.
- Ask them if they know what a solder and flux is.

Demonstrate

- The soldering process

Notes for Facilitation

- Inform the participants that soldering is a process of joining two or more objects, which are usually made of metal, by melting and putting solder which acts as a filler, into the joint.
- Inform them that soldering iron is used to heat up the joint to such an extent that the solder is melted, and then the melted solder flows around the joint making it secured and protected.
- Explain that the four key elements in soldering are:
  - Iron
  - Solder
  - Flux
  - Component
- Define solder to them as a metal alloy that is used to form a permanent bond between the metal pieces, which are to be joined using soldering.
- Further tell them that the function of flux is to facilitate the process of soldering.
- Explain that the flux performs very critical function in soldering such as:
  - Removing metal oxide
  - Preventing re-oxidation
  - Reducing surface tension
  - Ensuring a smooth solder finish
- Explain to them the various steps involved in soldering as follows:

  Step 1: Heat up the soldering iron sufficiently.

  Step 2: Clean the soldering iron with a damp sponge, if it is dirty. If using a soldering station, adjust its temperature.

  Step 3: Apply suitable flux to remove any type of oxide when soldering.

  Step 4: Coat the soldering iron's tip with a thin layer of solder. This process of tinning helps in transferring of heat between the tip and the component to be soldered.

  Step 5: Use pliers for bending the lead of the component is to be soldered so that it can easily be embedded on the board.

  Step 6: Hold the soldering iron and place the iron tip in a way so that it touches both the surface and the lead of the component.

  Step 7: Touch the solder to the iron tip and move that around the joint by keeping the iron tip fixed. Let the solder melt and flow till the joint is covered.

  Step 8: Remove the iron after removing the solder and make sure the joint is kept stationary till it cools down.
- Explain the precautions that need to be followed while soldering.

- Explain that to ensure good soldering, they must keep the following points in mind:
  - Heat the solder iron at required temperature. Poor heating or overheating will lead to defects in soldering.
  - Apply correct amount of solder.
  - Do not move the wire until the solder has solidified.
  - Be careful when releasing the solder iron.
  - Visually check to confirm the quality of solder.
- Explain the disadvantages of the soldering process.

Demonstrate

- The crimping process

Notes for Facilitation

- Inform the participants that crimping is a process of joining two pieces of metal, generally a wire and a connector, together by deforming one of them and enabling one to hold the other. The resultant deformity is known as a crimp.
- Explain the steps of crimping process as shown in the following image:

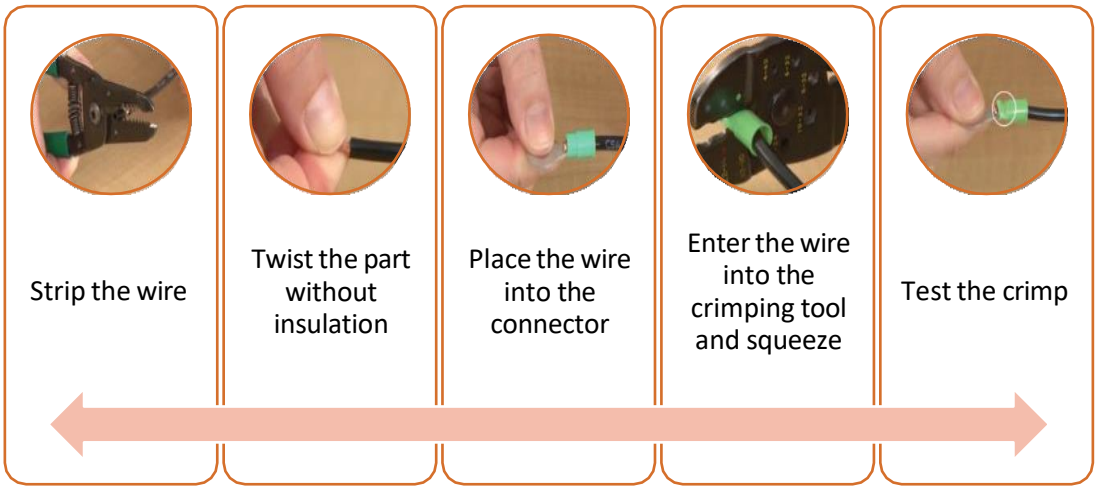


Fig. 4.5.1: Steps of Crimping

- Explain the various reasons why crimping is the preferred method to terminate connectors on coax cable.
- Explain the disadvantages of the crimping method.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants what they mean by crimping. Explain with example. Then provide the solution as:
    - Crimping is a process of joining two pieces of metal, generally a wire and a connector, together by deforming one of them and enabling one to hold the other.

- Ask the participants what they mean by soldering. Explain with example. Then provide the solution as:
  - Soldering is a process of joining two or more objects, which are usually made of metal, by melting and putting solder which acts as a filler, into the joint.
- Ask the participants how they will ensure that crimping and soldering have been done properly. Explain with example. Then provide the solution as:
  - By checking the deformity in the connection and testing the connection by passing power supply.
- Ask the participants to name the tools used in Soldering. Then provide the solution as: soldering station, soldering gun
- Ask the participants, what connections are the methods Crimping and Soldering used to establish. Then provide the solution as: Reliable cable

UNIT 4.6: Troubleshooting of Cable and Connector

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Demonstrate how to check for signal loss, interference, and attenuation using signal level meters.
2. Show how to analyze CPE logs using software tools to detect faults.
3. Show how to diagnose broadband faults using network diagnostic tools (ping, traceroute, OTDR).

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Router connected to a device/devices and to power supply.

Say

Good Morning and warm welcome to this training program. Before we begin this session on troubleshooting of cable and connector, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on troubleshooting of cable and connector.

Notes for Facilitation

- Start the session by asking the participants if they know the meaning of troubleshooting.
- Tell them that troubleshooting refers to the process of systematically searching for the source of a problem with the purpose of solving it to make a product or a process operational again.
- Tell them that every troubleshooting process consists of the following six steps:
    - Define the problem
    - Collect information
    - Identify cause of failure

- Design and implement problem solving plan
- Analyse implementation results
- Document the changes

- Go over these points one by one with the participants.
- Explain each step with the help of related examples.

Ask

- Ask the participants if they can list some problems that can come up during first start-up.

Demonstrate

- Troubleshooting the problems that can come up during first start-up.

Notes for Facilitation

- Write down all the problems shared by the participants on the whiteboard.
- Go over the problems one by one.
- Invite the participants to share the solution, if they know.
- Go over the step-by-step solution for each problem.
- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants to list various kinds of problems associated with cable and connectors. Explain with example. Then provide the solution as:
    - The cable is not connected in proper manner.
    - The cable is damaged.
  - Ask the participants how to troubleshoot problems associated with cables and connectors. Explain with example. Then provide the solution as:
    - Ensure the device is connected in accurate manner.
    - Check plugs and connectors
    - Ensure there is no physical damage to the cable.
    - Ensure device is connected accurately.

UNIT 4.7: Troubleshooting of CPE (Modem, Router, Switch)

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain the working of diagnostic tools, including signal level meters (SLMs), Optical Time-Domain Reflectometers (OTDRs), and AI-based troubleshooting tools.
2. Show how to access CPE software for diagnostics and troubleshooting.
3. Demonstrate how to perform CPE firmware updates, resets, and reconfigurations to restore connectivity.
4. Show how to assist customers remotely using AI-driven diagnostic tools.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia
- Cable modem
- Router
- Switch

Say

Good Morning and warm welcome to this training program. Before we begin this session on troubleshooting of CPE, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on troubleshooting of CPE.

Ask

- Ask the participants if they can tell what the status lights on the front panel of a modem depict.
- Ask the participants if they can tell about the connections in the rear panel of a modem.

Demonstrate

- The connections on the front and rear panel of the modem
- Troubleshooting broadband connection

Notes for Facilitation

- Show a cable modem to the participants.
- Explain the front and back panel of the modem.
- Explain the meaning of various status lights and what do they mean when they blink, when they are steady, and when they are off.
- Explain the steps of troubleshooting connectivity problems.

Notes for Facilitation

- Show a router to the participants. The following image depicts the status lights on top of the panel:

Fig. 4.7.1: Front panel of router

- Explain the meaning of status lights on the front side panel with the help of the following figure:

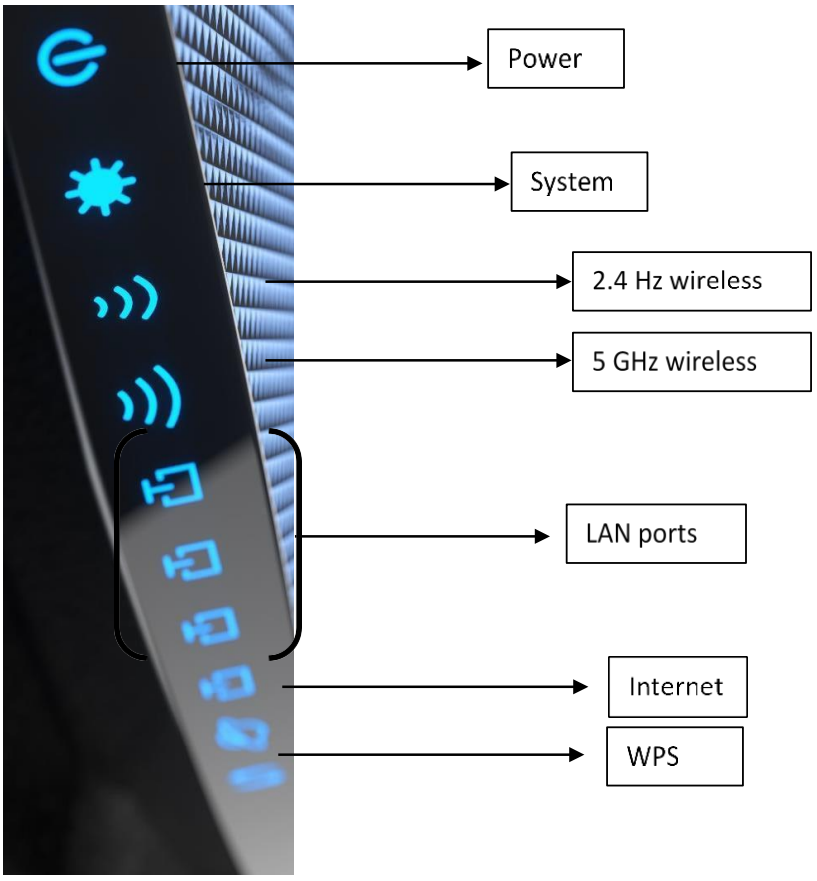


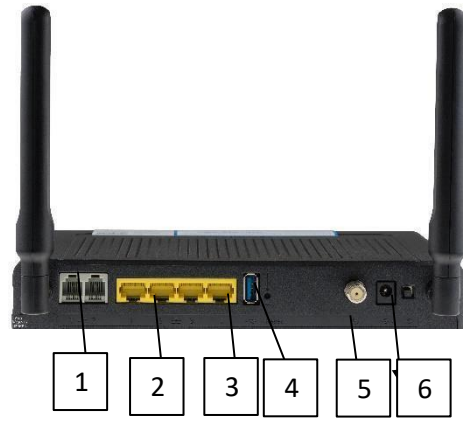
Fig. 4.7.2: Status lights on front panel of router

- Explain the meaning of various status lights and what do they mean when they blink, when they are steady, and when they are off with the help of the following table:

Name	Off	Flashing	Steady
Power	Power is off		Power is connected
System	Router has system error	Router is working properly	Router is initializing
2.4 GHz	Wireless function disabled	Wireless function enabled	
5 GHz	Wireless function disabled	Wireless function enabled	
LAN ports	No device linked	Data being sent	Device linked
Internet	No Ethernet cable is connected	Data being sent or received	Ready to transmit data
WPS	No WPS connection	WPS currently in use	Wireless security enabled

Table 4.7.1: Meaning of various status lights

- Show the back panel of the router to the participants.
- Explain the meaning of connections on the back panel with the help of the following figure:



Number	Stands for
1	Internet port
2	4 LAN ports
3	USB port
4	Wi/Fi On/Off button
5	AC power adapter outlet
6	Power On/Off switch

Fig. 4.7.3: Back panel of router

- Explain the steps of troubleshooting connectivity problems.

Ask

- Ask the participants if they can tell about the ports present on a network switch.

Demonstrate

- The ports on the rear panel of the network switch
- Troubleshooting broadband connection

Notes for Facilitation

•Show a network switch to the participants. The following image depicts the ports on the rear panel of the network switch:

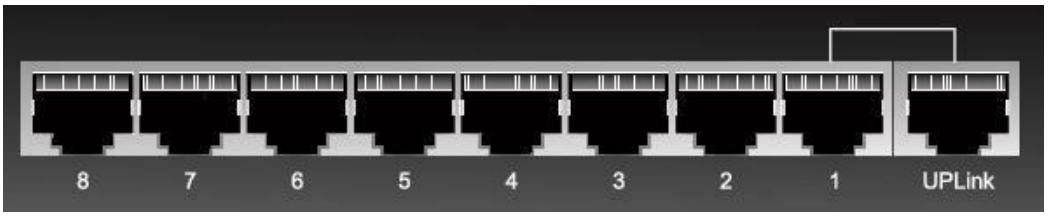


Fig. 4.7.4: Back panel of network switch

- Explain to the participants that a network switch contains 8, 10, 24, 48 number of Ethernet ports.
- Tell that that in addition to these ports there is one or many uplink ports also.
- Explain that an uplink port is a special port that can reverse the transmission and receive the circuit of any twisted pair cable attached to it.
- Explain that some of the common router and switch problems and their solutions are as follows:

Problem	Cause	Solution
The switch port indicates that the device is connected	Connection is not patched through	Check that switch port is activated Check that connection is patched
Unable to get an IP address	No address received from DHCP server	Check the NIC settings
Incorrect VLAN assignment	Switches are not properly configured	Check the switch configurations
Duplex mismatch	In the connection one side is operating in full duplex and other device in half duplex	Set all connections on the network to auto-negotiate
Slow application performance	Check for packet loss on the network	Check for Ethernet errors
Bad or improper cable type	Cable lower than Cat 5 used	Replace the cable

Table 4.7.2: Common router and switch problems

- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants to list the process to diagnose a cable modem. Then provide the solution as:
    - Check Power
    - Check Send/Receive

- Check Online
- Check PC/ Activity
- Check Standby.

- Ask the participants, to list the steps to be followed to troubleshoot cable modem indicator. Explain with example. Then provide the solution as:

Modem Light	**Status**	**Problem**	**Solution**
Power	OFF	Show no power.	Confirm the supply of 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.

- Ask the participants, to list the steps to be followed to troubleshoot cable broadband connection. Then provide the solution as:
  - 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.

UNIT 4.8: Troubleshooting Configuration and Connectivity

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Explain best practices for CPE configuration, firmware updates, and network security.
2. Show how to analyze connectivity test results, including latency, throughput, and packet loss.
3. Demonstrate how to configure LAN/Wi-Fi connectivity, including SSID and security settings.
4. Demonstrate how to enable Quality of Service (QoS) settings to prioritize network traffic based on user needs.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia

Say

Good Morning and warm welcome to this training program. Before we begin this session on troubleshooting configuration and connectivity, let us revise the previous session.

Do

- Begin with revising the things explained in previous session.
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on troubleshooting configuration and connectivity.

Demonstrate

- Troubleshooting configuration and connectivity process
- Run the network configuration and troubleshooting commands

Notes for Facilitation

- Explain the steps of troubleshooting wireless network connection problems.
- Tell them that they should take the following steps:
  - Check LAN and WAN connections
  - Ensure that the Wi-Fi adapter is enabled
  - Verify AP and router settings

  - Check the TCP/IP settings
  - Check network connection with Ping
  - Check wireless-specific issues
  - Check for any security mismatch
  - Check intermittent network connectivity issues such as poor signal strength, RF interference and so on
- Go over each step one by one and discuss the steps.
- Ask the participants to take part in the discussion and offer solutions.
- Write every point on the whiteboard and add whatever points are missing.
- Explain that any network configuration problem can be resolved by using the following commands:
  - Ping
  - nslookup
  - traceroute
  - host
  - netstat
  - ARP
  - Ipconfig
- Tell them that the ping command helps in ensuring that the network connection is established between a host and destined computer and in determining the speed of the connection.
- Tell them that the nslookup command helps in fetching the IP address or the domain name from DNS records
- Tell them that the traceroute command helps in getting the route of a packet.
- Tell them that the host command helps in finding the domain name associated with the IP address or find IP address associated with domain name.
- Tell them that the netstat command helps in displaying the routing table, connection information, status of ports, and so on.
- Tell them that the ARP command helps in determining the MAC address associated with an IP address.
- Tell them that the ipconfig command helps in displaying the IP address and netmask of a network interface.
- Run each command one by one and show the results to the participants.

- Exercise Handling Strategy – **The solution for the exercise is given as:**
  - Ask the participants, to list the problems commonly associated with connectivity and configuration. Then provide the solution as:
    - No data transfer.
    - Can't connect to some servers
    - No coaxial cable connection
    - Scanning for the upstream frequency.
    - Scanning for the network connection.
    - Transmitting or receiving data
    - Modem is in standby mode (the other indicators are OFF)
  - Ask the participants how they will troubleshoot connectivity and configuration problems. Then provide the solution as:
    - It is possible that servers on the internet are down temporarily. Try to open a connection to the server after some time.
    - You can also check connection with a server; it will give you: IP address, a trace route from your system.
    - Check all connections of the cable and reset the modem.
    - Push the standby-button at the top.
    - Computer to the server you can't connect to and the time the trace route has been done.
    - Unplug Ethernet or USB cable from computer and reconnect cable. Make sure the PC/ Activity indicator is blinking.

UNIT 4.9: Troubleshooting and Repairing of client's Broadband Connection Service

Unit Objectives

After the completion of this unit, the participant will be able to:

1. Show how to identify faults such as No Service, degraded service, and intermittent connectivity.
2. Show how to perform a broadband speed test and interpret the results.
3. Demonstrate how to document troubleshooting steps, test results, and repairs in the system database.

Resources to be Used

- Available objects such as a duster, pen, notebook, projector and other teaching aids
- Presentation slides
- Multimedia

Say

Good Morning and warm welcome to this training program. Before we begin this session on troubleshooting the connection, let us revise the previous session.

Do

- Begin with revising the things explained in previous session. Ask the following questions:
- Encourage the participants to give answers, if they have any doubt clarify it and tell them about what they are going to study in this session.

Say

Let us start this session on troubleshooting the connection.

Notes for Facilitation

- Explain to the participants some common causes of Broken Internet Connection such as Slow Connection, No Connection at all, Service Fluctuations, Equipment Failure and Operator error.

- Exercise Handling Strategy– The solution for the exercise is given as:
  - Ask the participants, to list a few common causes of broken Internet Connection. Then provide the solution as:
    - Slow Connection
    - No Connection at all
    - Service Fluctuations
    - Equipment Failure
    - Operator error
  - Ask the participants to name a few things to check while diagnosing Internet connection. Then provide the solution as:
    - Check equipment like the modem, the router, the line, and your device or computer
    - Check for functioning of website
    - Use Ping command
    - Check for DNS server problems
    - Check Internet package

Exercise

Answers to exercises for PHB:

Short Answer Questions:

1. **Role of OTDR & Signal Level Meters:**
   - OTDR detects fiber faults, breaks, and signal loss by measuring reflection and distance.
   - Signal Level Meters check signal strength, noise levels, and quality in copper/coax/fiber networks.
2. **Common causes of intermittent connectivity:**
   - Loose or damaged cables/connectors, high interference, faulty CPE, overloaded network, moisture in joints, improper configuration.
3. **AI-based diagnostic tools for predictive maintenance:**
   - Analyze performance patterns, detect anomalies early, predict failures, and recommend proactive repairs.
4. **Steps to perform CPE firmware update:**
   - Log in to CPE interface → Check for firmware update → Download/update → Reboot device → Verify connectivity.
5. **Importance of proper documentation:**
   - Helps future troubleshooting, ensures accuracy, maintains service history, and supports quality assurance.

Multiple Choice Questions (MCQs):

1. d) All of the above
2. b) Identify the path taken by packets and locate network delays
3. b) OTDR
4. b) CPE configuration and connectivity
5. c) Predict potential faults and assist remote troubleshooting

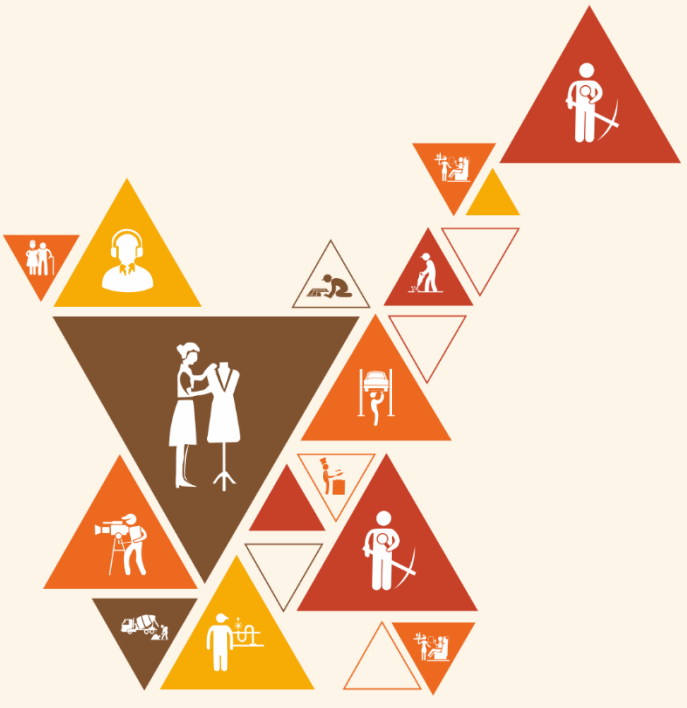
Fill in the Blanks

1. intermittent fault
2. OTDR
3. speed test (or network performance test)
4. Crimping
5. accountability and traceability

Notes

5. Follow Sustainable Practices in Telecom Infrastructure Installation

Unit 5.1- Environmental Sustainability and Waste Management in the Telecommunications Industry



TEL/N9105

Key Learning Outcomes

After the completion of this module, the participant will be able to:

1. Determine the methods used to diagnose and rectify wiring faults in wireless networks.
2. Explain the process of troubleshooting and repairing Wi-Fi backhaul equipment operating at 5 GHz.
3. Describe the procedures for troubleshooting and restoring Wi-Fi access points operating at 2.4 GHz.
4. Discuss the steps involved in carrying out documentation and restoring the worksite after wireless network fault rectification.

UNIT 5.1: Environmental Sustainability and Waste Management in the Telecommunications Industry

Unit Objectives

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

1. Explain national and international environmental laws and regulations governing telecom infrastructure installation.
2. Describe e-waste management and recycling policies applicable to telecom sites.
3. Identify occupational safety and health standards related to environmental practices.
4. List recyclable and refurbishable telecom components and their proper handling techniques.
5. Define methods for reducing electronic waste through responsible procurement and reuse.
6. Explain advancements in eco-friendly telecom infrastructure and the use of renewable energy sources.
7. Elucidate techniques for optimizing energy consumption in telecom operations.
8. Describe proper disposal methods for hazardous and non-hazardous waste.
9. Explain procedures for collaborating with authorized agencies for waste collection and disposal.
10. Identify best practices for reducing the carbon footprint of telecom installations.
11. Show how to identify telecom components suitable for recycling or refurbishment.
12. Demonstrate the process of sorting electronic and non-electronic waste according to disposal protocols.
13. Show the correct labeling and storage of recyclable and refurbishable components.
14. Demonstrate the safe handling and disposal of hazardous and non-hazardous waste.
15. Show the proper coordination process with authorized e-waste recycling units or disposal agencies.
16. Demonstrate the use of energy-efficient tools and equipment during telecom installations.
17. Show how to optimize infrastructure placement to minimize energy consumption.
18. Demonstrate the maintenance of records for waste disposal and sustainability measures.
19. Show how to guide team members on sustainable practices and encourage environmentally responsible habits.

Resources to be Used

Participant handbook, pen, pencil, notepad, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, sample e-waste bins, labels, PPE (gloves, masks), and demonstration components.

Notes For Facilitation

In this unit, we will discuss environmental sustainability practices and waste management procedures followed in the telecom sector.

Say

Good Morning everyone, and welcome back!
In this session, we will explore how the telecom industry is adopting sustainable practices and managing waste responsibly. As future broadband technicians, your role in keeping our environment clean and safe is extremely important.

Ask

Ask the participants the following questions:

- Why do you think sustainability is important in the telecom sector?
- Have you ever seen or handled e-waste before?

What challenges did you notice?Write down the trainees' answers on the whiteboard or flipchart.
Use their responses as a starting point to explain today's lesson.

Elaborate

In this session, we will discuss the following points:

- Environmental Sustainability in Telecom Industry
- Environmental Laws and Regulations in Telecommunications.
- E-Waste in the Telecom Industry
- E-Waste Management Process in the Telecom Industry
- Occupational Safety in Environmental Practices for Telecom E-Waste Management
- Energy Optimization in Telecom Operations
- Reducing the Carbon Footprint in Telecom
- Documentation and Compliance Tracking in Telecom Environmental Management

Say

Let us now participate in an activity to explore these topics more deeply.

Activity

Duration: 30 minutes

Resources: Sample components (cables, adapters, packaging materials), e-waste bins, labels, gloves, markers, projector, laptop, whiteboard.

Steps:

1. Divide the class into small groups.
2. Give each group a mix of telecom-related items (e.g., cable scraps, old router parts, batteries, plastic packaging).
3. Ask them to sort the items into:
    - Recyclable
    - Refurbishable
    - Hazardous waste
    - General waste
4. Display a checklist on the projector for guidance.
5. After all groups finish, reveal the correct sorting categories and explain the reasoning behind each decision.

Do

- Ask a student to maintain scores or observations on the whiteboard.
- Write down important points shared by trainees.
- Add your own insights based on industry best practices.
- Encourage every student to engage in discussions and participate in sorting activities.
- Ask one participant to summarize the key learnings of the session.
- Maintain positive energy and show enthusiasm for sustainability practices.

Activity

Duration: 25 minutes

Resources: Laptop, projector, sample telecom equipment (router/ONT), power meter (if available), pictures/videos of solar-powered telecom sites, whiteboard, markers.

Steps:

1. Divide the class into small groups.
2. Play a short video or show images demonstrating energy-efficient telecom practices such as:
3. Use of solar panels
    - Smart cooling techniques
    - Low-power CPE devices
    - Optimized equipment placement to reduce heat load

Provide each group with a scenario—for example:“A broadband installation site has high energy consumption due to poor equipment placement. Suggest three improvements.”

4. Ask the groups to discuss and write down their solutions.
5. Invite one member from each group to present their recommendations.
6. Summarize the key practical techniques used in the industry to save energy.

Do

- Ask a trainee to note down the key energy-saving suggestions shared by each group on the whiteboard.
- Highlight the practical feasibility of each idea and relate them to real telecom installation scenarios.
- Add your own insights—especially where small changes (like repositioning equipment or using smart adapters) can lead to big energy savings.
- Encourage quieter students to share their thoughts or add to the discussion.
- Ask one participant to briefly recap the energy-efficiency techniques discussed in the activity.
- Reinforce the importance of using energy-efficient tools and practicing mindful consumption during field installations.

Notes for Facilitation

- Ask trainees if they have any questions or doubts regarding waste handling or environmental laws.
- Encourage peer learning by inviting other trainees to answer queries.
- Remind participants to read the related section in their participant manual.
- Reinforce the importance of safe handling, labeling, and correct segregation while working on telecom sites.

Exercise

Answers to exercises for PHB

Multiple-Choice Questions (MCQs)

b) To avoid damage to the cable corec) Duct laying method
b) Cable winch machine
b) To avoid excessive friction and damage
b) Using approved cable ties or clamps

Descriptive Questions

1. Step-by-step procedure for direct burial cable laying

- Conduct a site survey and mark the cable route.
- Excavate the trench to the required depth.
- Lay a layer of sand or soft soil at the base.
- Place the cable carefully without exceeding bend radius.
- Cover the cable with sand and protective tiles/warning tape.
- Backfill the trench and compact the soil.
- Test cable continuity and performance after installation.

2. Safety precautions during underground cable laying

- Ensure all underground utilities (water, gas, electricity) are identified before digging.
- Use PPE: gloves, safety shoes, helmets, eye protection.
- Maintain safe distance from live electrical cables.
- Use proper tools for excavation and lifting.
- Avoid working in wet or unstable soil conditions.
- Ensure trench shoring to prevent collapse.

3. Difference between aerial and underground cable laying

- Cost: Aerial is cheaper; underground is more expensive due to excavation and protection materials.
- Durability: Underground cables are safer from weather and vandalism; aerial cables are more exposed.
- Maintenance: Aerial cables are easy to access and repair; underground maintenance is difficult, costly, and time-consuming.

4. Role and importance of cable jointing and termination

- Ensures continuity and reliable signal/power transfer.
- Provides mechanical and environmental protection at connection points.
- Reduces losses, electrical faults, and downtime.
- Maintains safety by insulating and securing conductors properly.

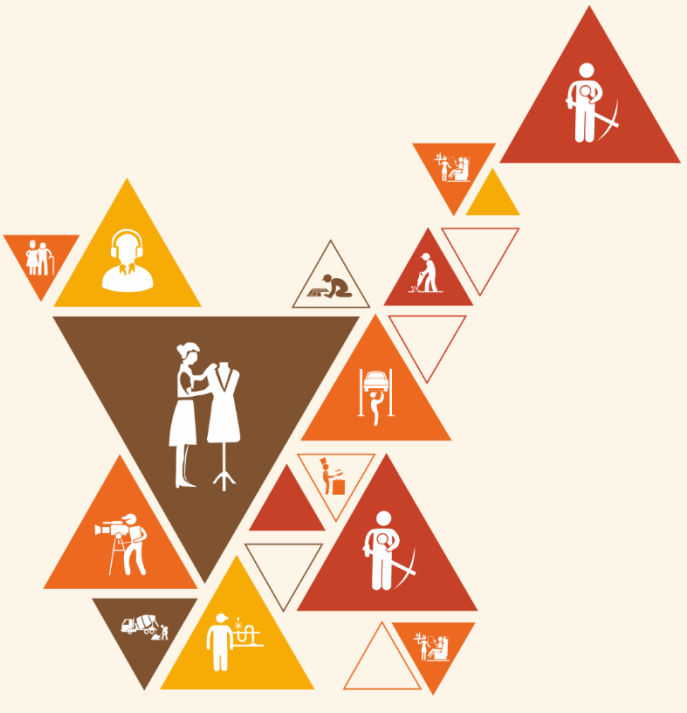
5. Common challenges in urban cable laying & solutions

- Limited space: Use micro-trenching and duct methods.
- Traffic congestion: Work during off-peak hours and use proper barricading.
- Utility congestion: Conduct detailed utility mapping and use cable locators.
- Permission and coordination issues: Work closely with local authorities and utility providers.
- Obstructions like buildings, pipelines: Use directional drilling or rerouting techniques.

Notes

6. Employability Skills (30 Hours)

It is recommended that all training include the appropriate. Employability Skills Module. Content for the same can be accessed https://www.skillindiadigital.gov.in/content/list



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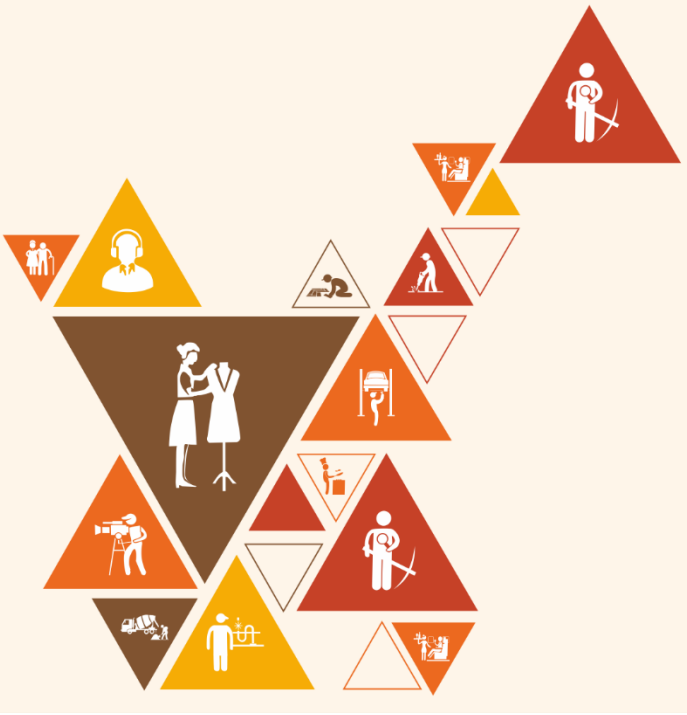
7. Annexure

Annexure I: Training Delivery Plan

Annexure II: Assessment Criteria

Annexure III: List of QR Codes used in PHB



Annexure - I
Training Delivery Plan

Training Delivery Plan			
Program Name:	Broadband Technician		
Qualification Pack Name & Ref. ID	TEL/Q0102		
Version No.	5.0	**Version Update Date**	08-05-2025
Pre-requisites to Training	Ability to troubleshoot and solve problems, colour vision, manual dexterity, strong customer service skills and bookkeeping skills, familiarity with workforce management software, ping tools.		
Training Outcomes	By the end of this program, the participants will be able to: • Explain the key steps involved in coordinating the installation and configuration of broadband network infrastructure. • Discuss the importance of preventive maintenance and planned repair activities to ensure uninterrupted broadband service. • Describe the process of diagnosing and troubleshooting faults in broadband network components, including Customer Premises Equipment (CPE). • Elucidate the role of cybersecurity best practices in broadband operations and their impact on network security. • Elucidate the role of sustainability practices in telecom cabling operations and their impact on the environment. • Discuss the Employability and Entrepreneurship Skills.		

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
1	Lay cable/system wiring and install equipment at customer premises (Theory- 50:00 Practical- 40:00)	Introduction to the Telecom Sector and the Role of Broadband Technician	• Explain the importance of Telecom Sector. • Discuss the roles and responsibilities of a Broadband Technician.	TEL/N0111	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Laptop with software like MS Office and internet, Whiteboard, Marker, Projector	T: 05:00 P: 00:00
		Prepare for wiring and equipment installation	• Explain how to collect work requirements, tools, equipment, and materials required for installation, ensuring availability of PoE-compatible components • Explain the need of visiting site/customer premises for installation, assessing feasibility for PoE-supported devices • Show how to inspect indoor and outdoor cable routes to ensure they are free of electrical hazards and interference sources	TEL/N0111 PC1, PC2, PC4, PC5		Types of cables (OFC, UTP, STP, Twisted Pair etc.) and connectors (RJ-45, RJ-11 etc.), crimping tools, soldering tools and splicing tools, signal level meters /OTDR, voltmeter, digital multimeter, digital clamp meter, signal tester, electrical drill, ladder, spanner, screwdriver set, nut driver set, bolt remover, cutter, angle finder, Wiring layout, Instruction manual, Service Manual/ User Manuals, Customer Registration, Program Authentication Form, CustomerFeedback form	T: 04:00 P: 04:00
		Cable and Connectors	• Identify different sizes, colors, and categories of network cables, including CAT5e, CAT6, CAT6A, and fiber optic cables. • Describe the types of cables (OFC, UTP, STP, Twisted Pair, etc.) and connectors (RJ-45, RJ-11, SC, LC, etc.).	TEL/N0111 PC3, KU1, KU2, KU3			T: 04:00 P: 04:00
		Analysis of installation enviornment	• Discuss the significance of visiting site/customer premises for installation • Explain how to analyse installation environment and customer requirements to select the correct type of cables and connectors	TEL/N0111 PC2,PC3			T: 04:00 P: 04:00
		Verify the cabling requirement	• Explain how to inspect indoor and outdoor cable route to ensure that the route is free of electrical hazards • Discuss the ways to verify that the cable running length is within the permissible limit to ensure continuity and designed throughput • Discuss the ways to verify that the equipment installation location is near power point and has proper signal coverage	TEL/N0111 PC4,PC5, PC6			T: 04:00 P: 04:00
		Explain ways to undertake wiring	• Explain how to install structured wiring (interior and exterior) from PoP to customer premises •Elaborate perform cable splicing and crimping wherever required •Explain how to perform neat wiring and clipping within customer premises • Demonstrate the use of appropriate connectors and ensure that the cables are terminated properly • Elucidate how to perform fault clearance	TEL/N0111 PC7,PC8, PC9,PC10,PC11,PC12,PC13,PC14			T: 04:00 P: 04:00
		Explain ways to install system hardware	•Discuss how to test the cable and joints for transmission loss and strength, re-terminate if loss exceeds prescribed limits •Elaborate how to install equipment such as modem, router and/or switch • Demonstrate and explain the use of equipment to customers	TEL/N0111 PC7,PC8, PC9,PC10,PC11,PC12,PC13,PC14			T: 04:00 P: 04:00

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
		Equipment Installation Procedures	•Show how to conduct a site survey at customer premises to assess installation feasibility for PoE-supported devices. •Show how to analyze the installation environment and select appropriate cables, connectors, and PoE injectors/switches. •Demonstrate how to inspect indoor and outdoor cable routes to avoid electrical hazards and interference sources.	TEL/N0111 PC13, PC14 PC15			T: 04:00 P: 04:00
		UPS and Its Types	•Describe the process of installing, replacing, and managing UPS systems to ensure a stable power supply for network infrastructure.	TEL/N0111 PC16, PC17,			T: 04:00 P: 03:00
		Ensure the checks for voltage, current, earthing and battery	•Discuss how to perform checks for voltage, current and earthing •Explain ways to perform checks for battery in case of a defective UPS	TEL/N0111 PC16, PC17			T: 04:00 P: 03:00
		Ensure the ways to install/ replace UPS	•Demonstrate way to install/replace UPS as per manufacturer's instructions •Use appropriate measures to route the power supply through the UPS •Discuss way to calculate equipment load and compare it with UPS rating	TEL/N0111 PC18,PC19, PC20			T: 04:00 P: 03:00
		Cleaning up of work site and completion of documentation	•Explain the significance of dispose of the installation waste properly and restoration of work site •Show how to record the details of installation, test results and update plans •Exemplify way to complete all installation documents and get customer signof	TEL/N0111 PC 21,PC22 PC23			T: 03:00 P: 03:00
2	Configuring Equipment and Establishing Wireless Network Connectivity (Theory-30:00 Practical-60:00)	Discuss ways to configure CPE	•Demonstrate ways to connect up laptop/PC, smart/ip TV and other customer device to the CPE and establish connectivity •Explain Customer Premise Equipment (CPE) settings using default login credentials •Describe wired and wireless CPE configurations, including VLAN, NAT, and QoS settings.	TEL/N011 2 PC1,PC2, PC3, PC4	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Types of cables (OFC, UTP, STP, Twisted Pair etc.) and connectors (RJ- 45, RJ-11 etc.), crimping tools, soldering tools and splicing tools, signal level meters /OTDR, voltmeter, digital multimeter, digital clamp meter, signal tester, electrical drill,	T: 03:00 P: 05:00
		Network Topologies	•Describe how to integrate smart home systems (Amazon Alexa, Google Home, Apple HomeKit) with broadband networks. •Explain cybersecurity fundamentals, including securing home networks, firewall configurations, and threat mitigation strategies.	TEL/N0112 KU5, KU6			T: 03:00 P: 05:00

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
		Troubleshooting	• Explain the escalation matrix for troubleshooting major network failures and handling emergencies.	TEL/N0112 PC5		ladder, spanner, screwdriver set, nut driver set, bolt remover, cutter, angle finder, Wiring layout, Instruction manual, Service Manual/ User Manuals, Customer Registration	T: 0200 P: 05:00
		Establishing Connectivity	• Demonstrate how to ping the service provider gateway and analyze response time for troubleshooting. • Show how to analyze connectivity test results, including latency, throughput, and packet loss. • Demonstrate how to configure LAN/Wi-Fi connectivity, including SSID and security settings.	TEL/N0112 PC9, PC10, PC11			T: 02:00 P: 05:00
		Connectivity of CPE and End User Devices	• Show how to connect a laptop/PC, smart/IP TV, IoT devices, and other customer devices to the CPE and establish connectivity. • Show how to configure the CPE with base settings, including IP, gateway, mask, NAT, QoS, and enable IPv6 support. • Demonstrate setting up a VPN or Internet Lease Line (ILL) based on customer requirements.	TEL/N0112 PC7, PC8			T: 03:00 P: 05:00
		Configuration Testing	• Demonstrate how to ping the service provider gateway and analyze response time for troubleshooting. • Show how to analyze connectivity test results, including latency, throughput, and packet loss. • Show how to ping the CPE from an end-user device, analyze the response, and optimize network settings for stability.	TEL/N0112 PC13, PC14 PC15, PC16, PC17, PC18			T: 02:00 P: 05:00
		Configuration Testing	• Demonstrate how to enable Quality of Service (QoS) settings to prioritize network traffic based on user needs. • Demonstrate how to record CPE configuration settings, including network security configurations and VPN/ILL setups.	TEL/N0112 PC13, PC14 PC15, PC16, PC17, PC18			T: 02:00 P: 05:00
		Configuration Testing	• Show how to document end-user device configurations, including IP allocation and firewall settings. • Demonstrate how to record the pinging procedure and expected result parameters for troubleshooting reference.	TEL/N0112 PC13, PC14 PC15, PC16, PC17, PC18			T: 02:00 P: 05:00
		Comprehension and Interpretation of Technical Data	• Demonstrate how to guide customers in monitoring network activity and updating firmware for security and performance improvements.	TEL/N0112 KU8			T: 02:00 P: 05:00

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
		Level 1 and 2 Diagnostics	• .Discuss Level 1 and 2 diagnostics for resolving common network issues efficiently	TEL/N0112 KU11			T: 03:00 P: 05:00
		Record configuration setting	• State ways to record CPE configuration settings • Discuss recording of end user device configuration settings •Explain record pinging procedure and expected result parameters	TEL/N0112 PC9,PC10			T: 03:00 P: 05:00
		Steps taken for testing by customer	• Demonstrate process of performing speed test and record the data throughputs and show customer that they are as per committed plan • Brief customer on basic trouble- shooting steps/self help	TEL/N0112 PC11,PC12,PC13			T: 03:00 P: 05:00
3	Troubleshoot and rectify faults (Theory- 30:00 Practical- 60:00)	Escalation Matrix	• Explain escalation procedures and risk factors for unresolved broadband issues.	TEL/N0113 KU14	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion		T: 02:00 P: 05:00
		Problem Solving	•Describe common network faults like No Service, degraded service, and intermittent connectivity, and their root causes. • Describe the common causes of broadband service disruptions (signal loss, attenuation, interference). • Identify various network troubleshooting techniques, including speed tests, ping tests, and trace routes. • Explain the use of AI-based predictive maintenance and remote diagnostic tools in broadband troubleshooting.	TEL/N0113 PC1, PC2		Types of cables (OFC, UTP, STP, Twisted Pair etc.) and connectors (RJ- 45, RJ-11 etc.), crimping tools, soldering tools and splicing tools, signal level meters /OTDR, voltmeter, digital multimeter, digital clamp meter, signal tester, electrical drill, ladder, spanner, screwdriver set, nut driver set, bolt remover, cutter, angle finder, Wiring layout, Instruction manual, Service Manual/ User Manuals, Customer Registration, Program Authentication Form, CustomerFeedback form	T: 03:00 P: 05:00
		Identifying and Repairing Faulty Cables and Connectors	• Show how to replace faulty connectors and damaged cables. • Show how to take readings at splitter points and terminated cable ends. • Demonstrate how to rectify signal leakage, cable faults, and interference in a broadband network.	TEL/N0113 PC3 PC4			T: 03:00 P: 05:00
		Electro Magnetic Interference (EMI) and Electro Magnetic Compatibility (EMC)	• Explain broadband communication systems and signal transmission principles. • Describe signal loss, attenuation, and interference factors affecting network performance	TEL/N0113 KU1, PC5			T: 03:00 P: 05:00

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
		Crimping and Soldering	• Demonstrate the process of re-connectorization or crimping of cable pairs. • Show how to perform crimping and soldering techniques ensuring proper connectivity.	TEL/N0113 PC4			T: 03:00 P: 05:00
		Troubleshooting of Cable and Connector	• Demonstrate how to check for signal loss, interference, and attenuation using signal level meters. • Show how to diagnose broadband faults using network diagnostic tools (ping, traceroute, OTDR).	TEL/N0113 PC11, KU6			T: 03:00 P: 05:00
		Working of diagnostic tools	• Explain the working of diagnostic tools, including signal level meters (SLMs), Optical Time-Domain Reflectometers (OTDRs), and AI-based troubleshooting tools.	TEL/N0113 PC13, KU6			T: 03:00 P: 05:00
		Troubleshooting of CPE (Modem, Router, Switch)	• Show how to access CPE software for diagnostics and troubleshooting. • Demonstrate how to perform CPE firmware updates, resets, and reconfigurations to restore connectivity.	TEL/N0113 PC7, PC8			T: 02:00 P: 05:00
		Troubleshooting of Configuration and Connectivity CPE faults	• Explain best practices for CPE configuration, firmware updates, and network security. • Show how to analyze connectivity test results, including latency, throughput, and packet loss.	TEL/N0113 PC9			T: 02:00 P: 05:00
		Configure LAN/Wifi and QoS	• Demonstrate how to configure LAN/Wi-Fi connectivity, including SSID and security settings. • Demonstrate how to enable Quality of Service (QoS) settings to prioritize network traffic based on user needs.	TEL/N0113 KU7, KU8			T: 02:00 P: 05:00
		Troubleshooting and Repairing of Client's Broadband Service	• Show how to identify faults such as No Service, degraded service, and intermittent connectivity. • Show how to perform a broadband speed test and interpret the results.	TEL/N0113 PC16			T: 02:00 P: 05:00
		Document troubleshooting steps	• Demonstrate how to document troubleshooting steps, test results, and repairs in the system database.	TEL/N0113 PC16, PC17S			T: 02:00 P: 05:00

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
4	Follow sustainable practices in telecom infrastructure installation (Theory- 10:00 Practical- 20:00)	Segregate recyclable and refurbishable components	• identify telecom components suitable for recycling or refurbishment • .Explain how to sort electronic and non-electronic waste based on disposal protocols • .Show how to label and store recyclable and refurbishable components separately	TEL/N0113 PC1, PC2, PC3	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Types of cables (OFC, UTP, STP, Twisted Pair etc.) and connectors (RJ-45, RJ-11 etc.), crimping tools, soldering tools and splicing tools, signal level meters /OTDR, voltmeter, digital multimeter, digital clamp meter, signal tester, electrical drill, ladder, spanner, screwdriver set, nut driver set, bolt remover, cutter, angle finder, Wiring layout, Instruction manual, Service Manual/ User Manuals, Customer Registration, Program Authentication Form, CustomerFeedback form	T: 02:30 P: 05:00
		Dispose of waste & Use Energy-Efficient Methods	•Explain how to follow approved procedures for the safe disposal of hazardous and non-hazardous waste • Discuss how to coordinate with authorized e-waste recycling units or certified disposal agencies •Show how to select and use energy-efficient tools and equipment during telecom installations	TEL/N0113 PC4, PC5, PC7			T: 02:30 P: 05:00
		Follow environmental standards and compliance guidelines	• .Discuss how to adhere to national and international environmental regulations for telecom infrastructure installation • Explain how to maintain records of waste disposal, recycling, and sustainability measures	TEL/N0113 PC10, PC11, PC12, PC13			T: 02:30 P: 05:00
		Guide team members	• Explain how to guide team members on sustainable telecom installation guidelines and practices • .Discuss how to encourage environmentally responsible work habits	TEL/N0113 PC14, PC15			T: 02:30 P: 05:00
5	Employability Skills (Theory- 30 hours)	Employability Skills		DGT/VSQ/N0101			T: 30 hrs

Annexure II

Assessment Criteria

CRITERIA FOR ASSESSMENT OF TRAINEES

(For Updated 'Assessment Criteria', please refer to Qualification Pack of this Job role available at
https://www.nqr.gov.in/)

Assessment Criteria for "Broadband Technician"	
Job Role	Broadband Technician
Qualification Pack	TEL/Q0102
Sector Skill Council	Telecom Sector Skill Council

Guidelines for Assessment

1. Criteria for assessment for each Qualification Pack will be created by the Sector Skill Council. Each Performance Criteria (PC) will be assigned marks proportional to its importance in NOS. SSC will also lay down proportion of marks for Theory and Skills Practical for each PC.
2. The assessment for the theory part will be based on knowledge bank of questions created by the SSC.
3. Assessment will be conducted for all compulsory NOS, and where applicable, on the selected elective/option NOS/set of NOS.
4. 4a. Individual assessment agencies will create unique question papers for theory part for each candidate at each examination/training center. (as per assessment criteria below).
   4b. Individual assessment agencies will create unique evaluations for skill practical part for every student at each examination/training center based on this criterion.
5. To pass the Qualification Pack, every trainee should score a minimum of 70% of aggregate marks to successfully clear the assessment.
6. In case of successfully passing only certain number of NOS's, the trainee is eligible to take subsequent assessment on the balance NOS's to pass the Qualification Pack.

NOS/Module Name	Assessment Criteria for Performance Criteria/Learning Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N0111: Lay cable/system wiring and install equipment at customer premises	Prepare for wiring and equipment installation	6	12	-	5
	PC1. collect work requirements, tools, equipment, and materials required for installation, ensuring availability of PoE-compatible components	1	2	-	1
	PC2 visit site/customer premises for installation, assessing feasibility for PoE-supported devices	1	2	-	1
	PC3. analyze the installation environment and customer requirements to select the correct type of cables, connectors, and PoE injectors/switches	1	2	-	1
	PC4. inspect indoor and outdoor cable routes to ensure they are free of electrical hazards and interference sources	1	2	-	1
	PC5. verify that the cable running length is within permissible limits to maintain signal continuity and throughput, considering power transmission for PoE devices	1	2	-	0.5
	PC6. ensure the equipment installation location is near a power point, has proper signal coverage, and supports PoE power budgets	1	2	-	0.5
	Undertake wiring and install system hardware	11	22	-	8
	PC7. install structured wiring (interior and exterior) from PoP to customer premises, integrating PoE network elements as required	1.5	2.5	-	1
	PC8. perform cable splicing and crimping, ensuring proper termination for both standard and PoE-enabled cables	1.5	2.5	-	1
	PC9. perform neat wiring and clipping within customer premises, adhering to structured cabling norms	1.5	2.5	-	1
	PC10. use appropriate connectors and terminate cables securely, ensuring PoE-supported devices receive stable power and data signals	1	2.5	-	1
	PC11. perform immediate fault clearance if connectivity or power issues arise during installation	1	2.5	-	1
	PC12. test cables and joints for transmission loss and signal strength, re-terminating if loss exceeds prescribed limits	1.5	2.5	-	1
	PC13. install equipment such as modems, routers, PoE switches, IP cameras, and VoIP phones, ensuring proper connectivity	1	2.5	-	1
	PC14. configure and verify the functionality of PoE-supported devices to ensure seamless integration	1	2.5	-	0.5
	PC15. explain the use of installed equipment to customers, including PoE-enabled devices	1	2	-	0.5
	Install/replace UPS and check domestic power supply	10	10	-	5
	PC16. perform voltage, current, and earthing checks to ensure a stable power supply	2	2	-	1
	PC17. inspect and replace UPS batteries in case of failure, ensuring uninterrupted power for network equipment	2	2	-	1
	PC18. install/replace UPS as per manufacturer's instructions	2	2	-	1
	PC19. route the power supply through UPS to protect network infrastructure	2	2	-	1
	PC20. calculate equipment load and compare it with UPS capacity to prevent overloading	2	2	-	1
	Clean up worksite and complete documentation	3	6	-	2
	PC21. dispose of installation waste properly and restore the worksite	1	2	-	1
	PC22. record installation details, test results, and update network plans, including PoE device configurations	1	2	-	0.5
	PC23. complete installation documents and obtain customer sign-off	1	2	-	0.5
	Total Marks	**30**	**50**	**-**	**20**

NOS/Module Name	Assessment Criteria for Performance Criteria/Learning Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N0112: Configure customer premises equipment and establish broadband connectivity	Configure CPE	10	15	-	5
	PC1. connect a laptop/PC, smart/IP TV, IoT devices, and other customer devices to the CPE and establish connectivity	2	3	-	1
	PC2. access Customer Premises Equipment (CPE) settings using default login credentials and update them for security	2	3	-	1
	PC3. configure CPE as per base settings (IP, gateway, mask, NAT, QoS, etc.) and enable IPv6 support	2	3	-	1
	PC4. set up VPN or Internet Lease Line (ILL) configurations as per customer requirements	2	3	-	1
	PC5. follow basic cybersecurity settings such as strong password policies, firewalls, and MAC filtering	2	3	-	1
	Connect CPE to the service provider gateway and end-user devices	14	21	-	9
	PC6. verify that all cables and connectors are properly plugged in and functional	2	3	-	1.5
	PC7. ping the service provider gateway and analyze response time for troubleshooting	2	3	-	1.5
	PC8. analyze connectivity test results for latency, throughput, and packet loss parameters	2	3	-	1.5
	PC9. configure end-user devices to establish LAN/Wi-Fi connectivity with CPE, including SSID and security settings	2	3	-	1.5
	PC10. ping CPE from the end-user device, analyze the response, and optimize network settings for stability	2	3	-	1
	PC11. enable Quality of Service (QoS) settings to prioritize network traffic based on user needs	2	3	-	1
	PC12. integrate broadband with smart home systems like Amazon Alexa, Google Home, or Apple HomeKit	2	3	-	1
	Record configuration settings and testing steps for the customer	6	14	-	6
	PC13. record CPE configuration settings, including network security configurations and VPN/ILL setups	1	3	-	1
	PC14. record end-user device configuration settings, including IP allocation and firewall settings	1	2	-	1
	PC15. document the pinging procedure and expected result parameters for troubleshooting reference	1	2	-	1
	PC16. perform a speed test, record throughput data, and demonstrate performance as per the subscribed plan	1	3	-	1
	PC17. brief the customer on basic troubleshooting steps/self-help techniques, including cybersecurity best practices	1	2	-	1
	PC18. provide guidance on monitoring network activity and updating firmware for security and performance improvements	1	2	-	1
	Total Marks	**30**	**50**	**-**	**20**

NOS/Module Name	Assessment Criteria for Performance Criteria/Learning Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N0113: Troubleshoot and rectify faults	*Troubleshoot and repair cable, connector, and CPE faults*	*18*	*27*	*-*	*9*
	PC1. identify the root cause of faults, including No Service, service degradation, and intermittent connectivity issues	2	3	-	1
	PC2. use signal level meters, OTDR, or AI-based diagnostic tools to test cabling and identify faults	2	3	-	1
	PC3. repair or replace faulty connectors and damaged cables using industry-standard tools and techniques	2	3	-	1
	PC4. perform re-connectorization/crimping of cable pairs or replace cables to restore connectivity	2	3	-	1
	PC5. connect CPE to a laptop, CPU, or portable device for diagnostics and troubleshooting	2	3	-	1
	PC6. access the CPE through an appropriate browser/software application, run diagnostic tests, and analyze logs	2	3	-	1
	PC7. install or update CPE access software if required for troubleshooting or configuration	2	3	-	1
	PC8. reset, reconfigure, or update firmware/software settings on CPE to resolve faults	2	3	-	1
	PC9. utilize remote configuration and diagnostic tools to identify and troubleshoot faults without an on-site visit	2	3	-	1
	Troubleshoot and restore broadband service	*9*	*16*	*-*	*8*
	PC10. diagnose and repair faults between customer equipment and the optical node using AI-assisted analysis	2	3	-	1.5
	PC11. identify and rectify signal loss, interference, or line attenuation using advanced measurement tools	2	3	-	1.5
	PC12. take readings at splitter points and terminated ends to determine signal integrity and continuity	2	3	-	1.5
	PC13. conduct network troubleshooting, including ping tests, trace routes, and speed tests, using remote diagnostic tools	1	2	-	1.5
	PC14. detect and document system, drop, and in-house signal leakage for resolution	1	3	-	1
	PC15. assist customers in resolving issues using remote configuration tools and AI-driven troubleshooting guidance	1	2	-	1
	Document work and clean the site	*3*	*7*	*-*	*3*
	PC16. log troubleshooting steps, fault isolation procedures, and test results in the system database	1	3	-	1
	PC17. record all repairs, replacements, and software updates performed on CPE or network components	1	2	-	1
	PC18. restore any modifications made to the worksite and ensure customer satisfaction	1	2	-	1
	Total Marks	**30**	**50**	**-**	**20**

NOS/Module Name	Assessment Criteria for Performance Criteria/Learning Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N9105: Follow sustainable practices in telecom infrastructure installation	Segregate recyclable and refurbishable components	6	12	-	6
	PC1. identify telecom components suitable for recycling or refurbishment	2	4	-	2
	PC2. sort electronic and non-electronic waste based on disposal protocols	2	4	-	2
	PC3. label and store recyclable and refurbishable components separately	2	4	-	2
	Dispose of waste	6	10	-	5
	PC4. follow approved procedures for the safe disposal of hazardous and non-hazardous waste	2	4	-	2
	PC5. coordinate with authorized e-waste recycling units or certified disposal agencies	2	3	-	2
	PC6. handle batteries, cables, and electronic circuits safely to prevent environmental hazards	2	3	-	1
	Use Energy-Efficient Methods	6	10	-	3
	PC7. select and use energy-efficient tools and equipment during telecom installations	2	4	-	1
	PC8. apply best practices to minimize energy consumption	2	3	-	1
	PC9. position and install telecom infrastructure to optimize efficiency and sustainability	2	3	-	1
	Follow environmental standards and compliance guidelines	8	12	-	4
	PC10. adhere to national and international environmental regulations for telecom infrastructure installation	2	3	-	1
	PC11. maintain records of waste disposal, recycling, and sustainability measures	2	3	-	1
	PC12. assist in periodic audits to assess compliance with green standards	2	3	-	1
	PC13. follow workplace sustainability protocols and report non-compliance	2	3	-	1
	Guide team members	4	6	-	2
	PC14. guide team members on sustainable telecom installation guidelines and practices	2	3	-	1
	PC15. encourage environmentally responsible work habits	2	3	-	1
	Total Marks	**30**	**50**	**-**	**20**

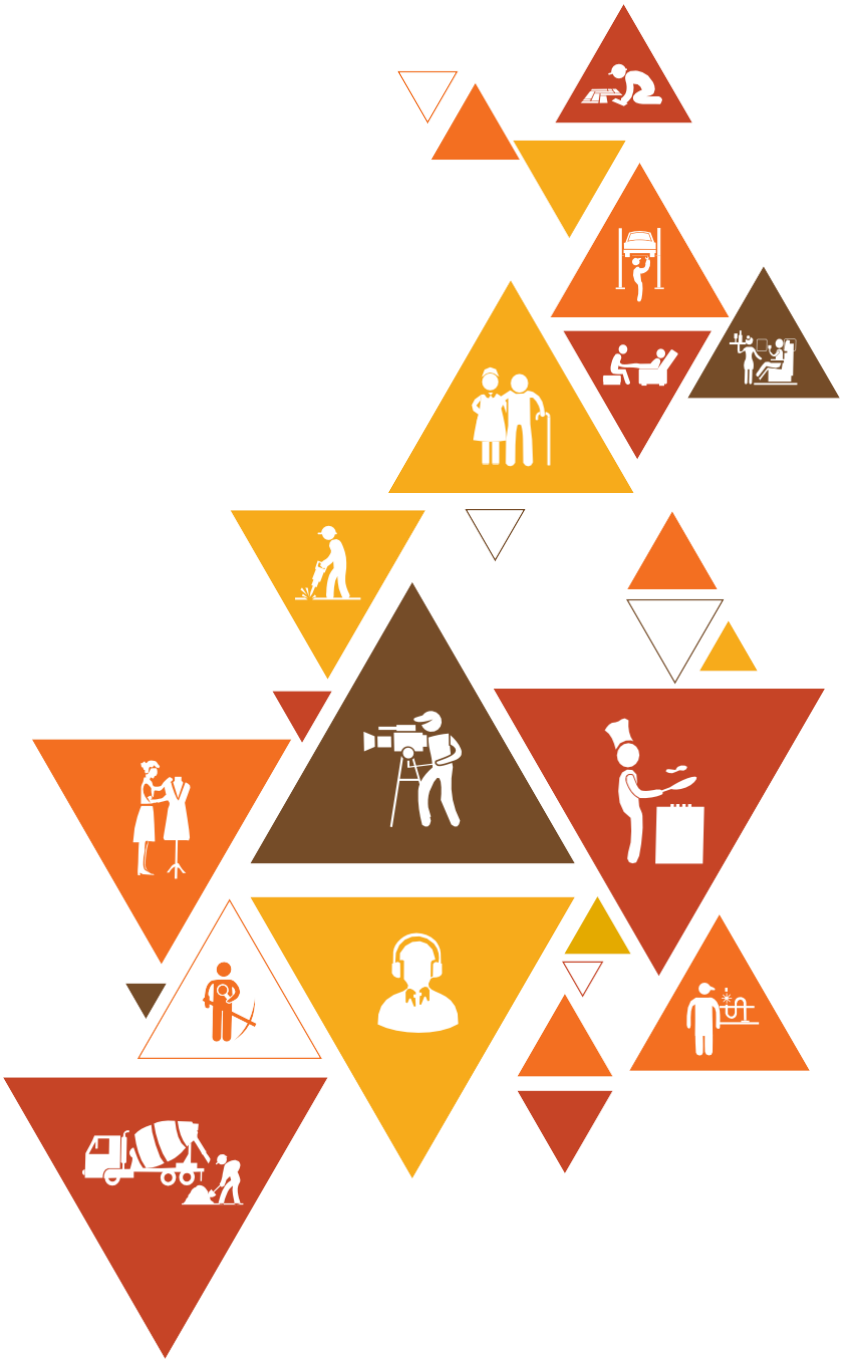
NOS/Module Name	Assessment Criteria for Performance Criteria/Learning Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
DGT/VSQ/N0101: Employability Skills (30 Hours)	Introduction to Employability Skills	1	1	-	-
	PC1. understand the significance of employability skills in meeting the job requirements	-	-	-	-
	Constitutional values – Citizenship	1	1	-	-
	PC2. identify constitutional values, civic rights, duties, personal values and ethics and environmentally sustainable practices	-	-	-	-
	Becoming a Professional in the 21st Century	1	3	-	-
	PC3. explain 21st Century Skills such as Self- Awareness, Behavior Skills, Positive attitude, self-motivation, problem-solving, creative thinking, time management, social and cultural awareness, emotional awareness, continuous learning mindset etc.	-	-	-	-
	Basic English Skills	2	3	-	-
	PC4. speak with others using some basic English phrases or sentences	-	-	-	-
	Communication Skills	1	1	-	-
	PC5. follow good manners while communicating with others	-	-	-	-
	PC6. work with others in a team	-	-	-	-
	Diversity & Inclusion	1	1	-	-
	PC7. communicate and behave appropriately with all genders and PwD	-	-	-	-
	PC8. report any issues related to sexual harassment	-	-	-	-
	Financial and Legal Literacy	3	4	-	-
	PC9. use various financial products and services safely and securely	-	-	-	-
	PC10. calculate income, expenses, savings etc.	-	-	-	-
	PC11. approach the concerned authorities for any exploitation as per legal rights and laws	-	-	-	-
	Essential Digital Skills	4	6	-	-
	PC12. operate digital devices and use its features and applications securely and safely	-	-	-	-
	PC13. use internet and social media platforms securely and safely	-	-	-	-
	Entrepreneurship	3	5	-	-
	PC14. identify and assess opportunities for potential business	-	-	-	-
	PC15. identify sources for arranging money and associated financial and legal challenges	-	-	-	-
	Customer Service	2	2	-	-
	PC16. identify different types of customers	-	-	-	-
	PC17. identify customer needs and address them appropriately	-	-	-	-
	PC18. follow appropriate hygiene and grooming standards	-	-	-	-
	Getting ready for apprenticeship & Jobs	1	3	-	-
	PC19. create a basic biodata	-	-	-	-
	PC20. search for suitable jobs and apply	-	-	-	-
	PC21. identify and register apprenticeship opportunities as per requirement	-	-	-	-
	Total Marks	**30**	**50**	**-**	**20**
Grand Total		140	230	-	80

Annexure - III

QR Codes –Video Links

Chapter No.	Unit Name	Topic	URL Links	QR code (s)
Chapter 2: Lay Cable/System Wiring and Install Equipment at Customer Premises	Unit 2.3- Customer Premise Equipment	Difference between hub, router, and switch	https://www.youtube.com/watch?v=1z0ULvg_pW8&ab_channel=PowerCertAnimatedVideos	
		How to install a router	https://youtu.be/dm4d2LZC2dk	
	Unit 2.6 - Checking of Voltage, Current and Earthing	Use of Multimeter and revise electricity basics	https://www.youtube.com/watch?v=r_migcta_Is	
Chapter 3: Configuring Equipment and Establishing Wireless Network Connectivity	Unit 3.1 - Network Topologies	Network Topology	https://www.youtube.com/watch?v=uSKdjjw5zow	
	Unit 3.5 - Comprehension and Interpretation of Technical Data	Interpreting Technical Data	https://www.youtube.com/watch?v=Hm6Urf8ng3M	
	Unit 3.6 - Executing Speed Test and Analyze	How to perform speed test	https://www.youtube.com/watch?v=ad4tTK43VKc&ab_channel=Maxis	
Chapter 4: Troubleshoot and Rectify Faults	Unit 4.1 - Escalation Matrix	What Is An Escalation Matrix?	https://www.youtube.com/watch?v=opB5oOvB3cI	

Chapter No.	Unit Name	Topic	URL Links	QR code (s)
Chapter 4: Troubleshoot and Rectify Faults	Unit 4.3 - Identifying and Repairing Faulty Cables and Connectors	Explaining Optical Time Domain Reflectometry (OTDR) Testing Method	https://www.youtube.com/watch?v=sDLci29nl-g	
	Unit 4.4 - Electro Magnetic Interference (EMI) and Electro Magnetic Compatibility (EMC)	EMI - Electromagnetic Interference and EMC - Electromagnetic Compatibility Explained	https://www.youtube.com/watch?v=I88Qzdahn_o	
	Unit 4.7 - Troubleshooting of CPE (Modem, Router, Switch)	Modem, Router, Switch, Hub and Access Point: What's the Difference?	https://www.youtube.com/watch?v=39zXmf61McI	



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Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

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