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Facilitator Guide

Sector
Telecom

Sub-Sector
Network Managed Services

Occupation
Network Operation and Maintenance

Reference ID: **TEL/Q6210,** Version 4.0
NSFQ Level: **4**

Telecom Technician - IoT Devices/Systems

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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

Acknowledgement

Telecom Sector Skill Council would like to express its gratitude to all the individuals and institutions who contributed in different ways towards the preparation of this “Facilitator Guide”. Without their contribution it could not have been completed. Special thanks are extended to those who collaborated in the preparation of its different modules. Sincere appreciation is also extended to all who provided peer review for these modules.

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

This 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

In the last five years, the growth of the Indian telecommunications sector has outpaced the overall economic growth. This sector is poised for strong growth of about 15 percent in short term during 2013–17, driven by growth in organised retail, technological advancements, changing consumer preferences and government support. With over 1000 million subscribers, India is the second largest telecom market in the world.

The sector currently employs over 2.08 million employees and is slated to employ more than 4.16 million employees by 2022. This implies additional creation of ~2.1 million jobs in the nine-year period.

This Facilitator Guide is designed to impart theoretical and practical skill training to students for becoming a Telecom Technician – IoT Devices/Systems. Telecom Technician in the Telecom industry is also known as IoT installation and service technician.

IoT installation and service technician is responsible for on-site installation and configuration of IoT devices (nodes), setup of communication links between nodes and controller (gateway) and further to central servers or devices through external communication links on Wi-Fi, 3G/4G networks on GSM/CDMA. The technician also undertakes first level of troubleshooting.

This Facilitator Guide is based on Telecom Technician – IoT Devices/Systems Qualification Pack (TEL/Q6210) & includes the following National Occupational Standards (NOSs)

1. Install and Configure devices at customer premises(TEL/N6234)
2. Perform Level 1 Troubleshooting of IoT devices (TEL/N6236)
3. Organize work and resources as per Health and Safety Standards (TEL/N9101)
4. Interact effectively with Team members and Customers (TEL/9102)
5. DGT/VSQ/N0102 Employability Skills (60 Hours)

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

Post this training, the participant will be able to keep sites live 24x7 through site maintenance.

We hope that this Facilitator Guide will provide a sound learning support to our young friends to build an attractive career in the telecom industry.

Symbols Used

Ask


Demonstrate


Facilitation Notes


Learning Outcomes


Notes


Objectives


Do


Practical


Summary


Activity


Explain


Say

Example


Resources

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7. Employability skills-60 hours (DGT/VSQ/N0102)

The book on New Employability Skills is available at the following

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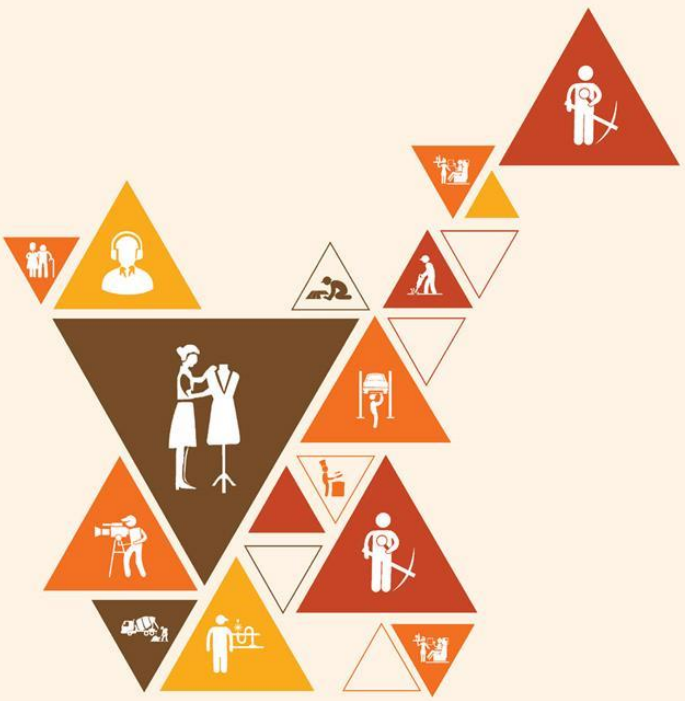
1. Roles and Responsibilities of Telecom Technician-IOT Devices/System

Unit 1.1 – Basics of Micro-processor Boards and Microcontroller Units
Unit 1.2 – Functioning of Sensors and Actuators
Unit 1.3 – Application of Communication Protocols in Internet of Things
Unit 1.4 – Micro-controller Boards, PIN Configurations and Their Interconnectivity
Unit 1.5 – Understand Edge Devices
Unit 1.6 – Nodes and Gateways
Unit 1.7 – Cloud Computing



TEL/N6234

Key Learning Outcomes

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

- Explain the basics of IoT
- Identify the applications of IoT in current world
- Explain the basics of microprocessors and microcontrollers
- Describe different processor boards and their applications
- Explain how IoT works for roadside assistance and smart cities
- List various types of sensors
- Identify the importance of actuators
- Explain the basic programming of a microcontroller board
- List various short-range wireless communications systems
- Identify the protocols used for communication in IoT
- Compare different communication technologies
- Identify the components of a microcontroller board
- Describe the layout of various development board
- Explain the functions of edge devices
- Identify the different types of edge devices
- Explain nodes
- Describe gateway architecture
- List the steps in setting up an IoT framework
- Explain the concept of cloud computing
- List the characteristics of cloud computing
- Explain how cloud computing is related to business analytics
- Explain the advantages of cloud utilization

UNIT 1.1: Basics of Micro-Processor Boards and Microcontroller Units

Unit Objectives

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

- Explain the basics of IoT
- Identify the applications of IoT in current world
- Explain the basics of microprocessors and microcontrollers
- Describe different processor boards and their applications
- Explain how IoT works for roadside assistance and smart cities

Resources to be Used

- Objects such as a duster, pen, notebook and so on
- Microprocessor chip
- Arduino and Raspberry Pi board

Ask

- Ask the participants whether they have heard about Internet of Things (IoT).
- Ask them, if they know about the IoT initiatives taken by the Government.

Notes for Facilitation

- Start the session by telling the participants about the Digital India program. Tell them that the campaign was launched by the Government of India to make the Government services electronically available to the citizens by increasing Internet connectivity, providing advanced online infrastructure and empowering the people in the field of technology.
- Tell them what Internet of Things is.
- Explain that IoT is a network of small devices enabling people to exchange data. This also results in improved data collection and management.
- Explain the IoT concept as shown in the following image and tell that the small devices such as cameras, watches, laptops, and other devices are interconnected and can be controlled by a mobile device:

Fig. 1.1.1: IoT concept

- Also, tell them that the 'things' in IoT, may include smart phones, sensors built into vehicles, radio-frequency identification (RFID) chips, medical devices, buildings or anything that needs to be monitored.
- Tell them that the initiatives taken by the Government include setting up of 100 smart cities and automating the industries such as energy, health and so on by means of remotely connected devices.
- Tell them how telecom sector is involved in implementing the IoT infrastructure.

Explain

- Explain the IoT applications one by one.

Notes for Facilitation

- Tell them about the applications of IoT by drawing the following figure on the board:

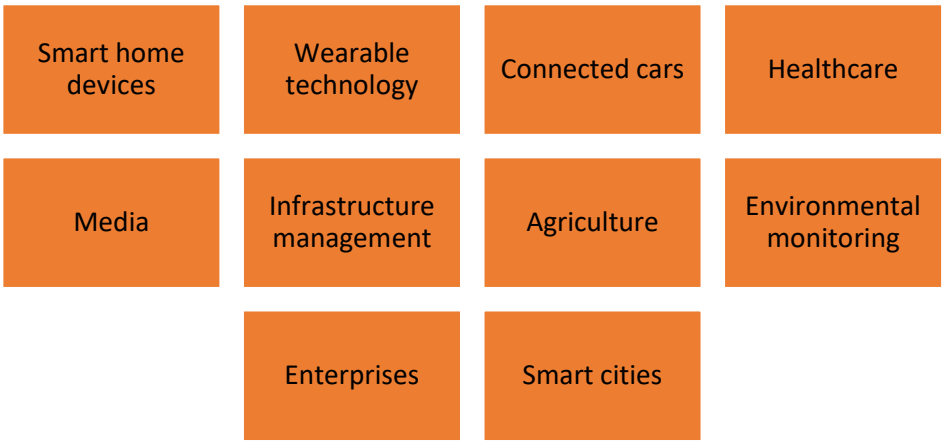


Fig 1.1.2: Various applications of IoT

- Explain the applications one by one with examples.
- Tell them that smart home technology provides security, comfort and convenience to the owners of the home by enabling them to control the active devices via a smart home app on their smartphones or any other device connected to the network. The following image shows a home automation app on the screen of a tablet:

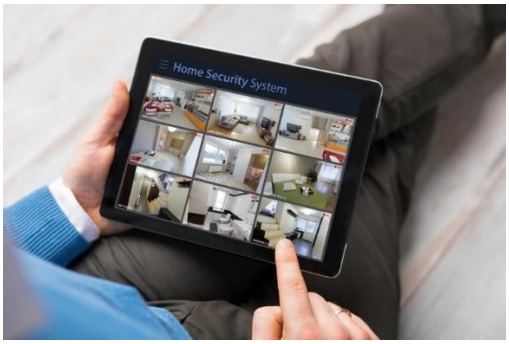


Fig 1.1.3: Home automation app on a tablet

- Explain to them some examples of smart home technologies:
  - Smart TVs can be controlled through applications like music and on-demand video by connecting them to the Internet. Some smart TVs can also be controlled by voice or gesture.
  - Smart lighting systems can adjust lighting by detecting the occupants in the room.
  - Residents can monitor their homes from a distance with smart security cameras.
- Tell them that most of the organisations monitor customer data and marketing trends through mobile apps. IoT applications are used in production and distribution operations for tracking the product flow and business locations.
- Also, explain to them how infrastructure is controlled and managed by IoT applications.
- Tell them that IoT also provides productive ways to cultivate soil and increase livestock level by offering data. The applications can deliver information about factors such as follows:
  - 24×7 visibility into soil and crop health
  - Storage conditions
  - Energy consumption level
  - Machinery in use
  - Animal behaviour
- Also, explain the benefits of using IoT apps as follows:
  - Farmers can be alerted of irregular conditions such as high acidity of the soil. It gives the farmer the time to produce better crops.
  - Farmers gain knowledge about the soil moisture and nutrients, and determine the fertilizer profiles based on soil chemistry as shown in the following image:

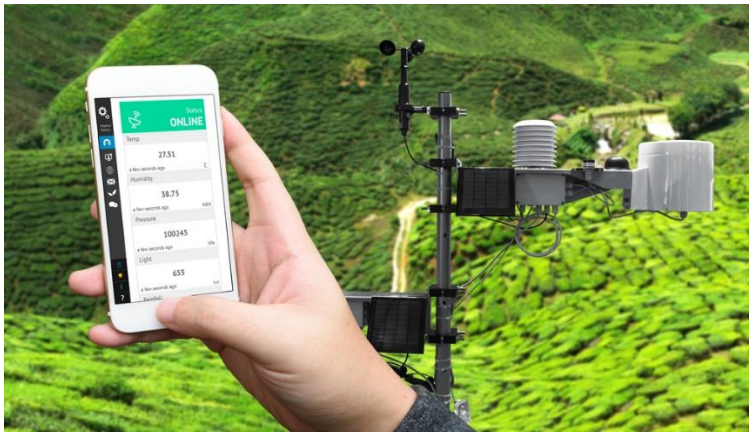


Fig 1.1.4: Knowledge of moisture and nutrients in the soil through mobile phone

  - Self-driving tractors can be controlled remotely, which provides significant savings in labour costs.
- IoT involves everything from monitoring levels of ozone in a meat packing facility to monitoring national forests for smoke.

- Tell them the use cases of IoT environment monitoring with the help of the following figure:

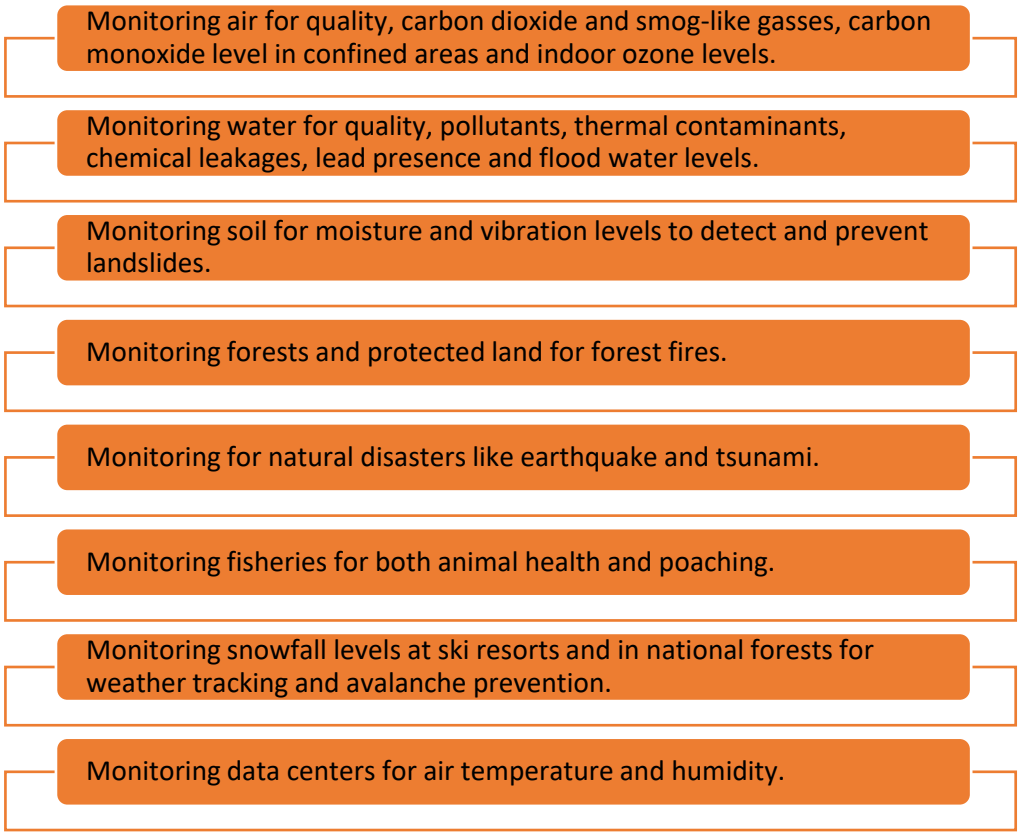


Fig 1.1.5: IoT use cases in environment monitoring

- Tell them that IoT applications are used in enterprises in tracking assets, managing quality, operating the automated assembly line and optimizing the resource and the process.
- Explain to the participants about the wearable technologies. Also, give them an example by telling them that a customer can pay bills via the smart phones. The following image shows a customer making a payment using a smart phone:

Fig 1.1.6: A customer making payment using a smart phone

- Tell the participants that patient and capital equipment tracking through the use of IoT tagging is one example of IoT use case utilized in health care facilities. Using low-cost tags can improve health outcomes and operational efficiency.

For example, if a patient X is physically in the hospital, the health care providers and the hospital staff can immediately know where the patient is at all times and seamlessly associate that patient with his/her medical information.

- Give them another example. Tell that if people want to improve their fitness or lose weight in a sustainable way, an IoT-enabled device will help them to do so. They may wear smart glasses that record their food choices, the portion size and the calories; which are then automatically sent as data to an app or to their health care provider. The app or the provider can take this information and either run it through data processing or analyse it further to create a plan unique to the individual. The doctor may note, for example, that a patient is eating too few leafy greens and too many carbs. Suggestions for different and healthier choices can be sent regularly to a smartphone or an email account to nudge the patient's behaviour in a different direction. Using IoT-enabled devices in this process saves time and hassle for the patient, and it allows the health care apps or the doctors to prescribe actionable steps to keep the patient on track toward his or her goals.
- Explain the role of IoT in telecom sector.

Ask

- Ask the participants what they know about microprocessors and microcontrollers.
- Ask them to tell one application of each of them.
- Ask them if they have heard about Arduino and Raspberry Pi boards.

Explain

- Explain microprocessors and microcontrollers.
- Explain various processor boards.

Notes for Facilitation

- Show the participants a microprocessor chip and tell that it is a complete computation engine, fabricated on a single chip.
- Tell them that the processing power of a microprocessor depends on characteristics such as clock speed, instruction set and word size.
  - **Clock Speed** – The speed of execution of instructions
  - **Word Size** – Single instruction number of bit processed by a processor
  - **Instruction Set** – Set of commands for the digital machine to perform certain operation. Every microprocessor has three important components which determine the overall functioning of the computer/mobile device/machine.
- Tell them that the following are the components which are vital for the smooth functioning of any microprocessor chip.
  - **CPU** – Very Large Scale Integrated Circuit (VLSI) which decodes and performs arithmetic, logical and memory sequencing operations
  - **Bus** – Internal connections of microprocessor chip which carry data

- **Memory** – Microprocessor has volatile Random-Access Memory (RAM) and non-volatile Read Only Memory (ROM).

- Also, tell that some known brands of microprocessors are Pentium, K6, PowerPC, Sparc and so on.
- Tell them about the basic components of a microprocessor with the help of the following figure:

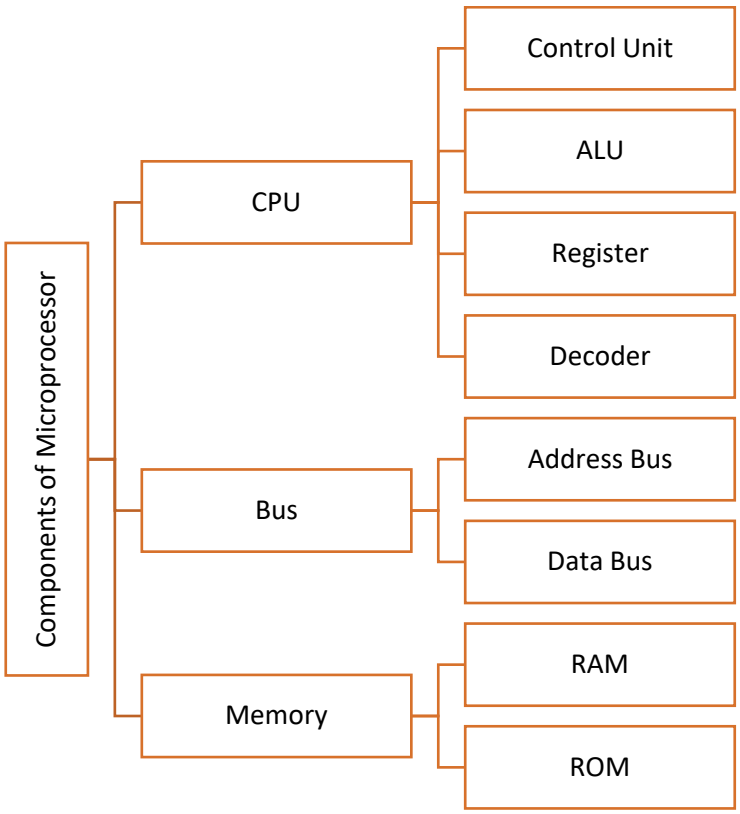


Fig 1.1.7: Basic components of microprocessor

- Tell them about the components of a microcontroller.
- Also, explain various types of microcontrollers.
- Tell the participants that generally, a microcontroller comprises of the following components:
  - **CPU**– Microcontroller's brain which retrieves, decodes and processes the information
  - **Memory**– ROM/RAM (EPROM or EEPROM) to store data and information in an understandable format
  - **I/O Ports**– To create an interface between peripheral devices such as printers
  - **Timers** – To control timing operations such as clock functions, frequency modulations, generating oscillations and so on.
- Explain to them that depending on the architecture and memory requirements, a microcontroller can be classified as follows:
  - **8-bits** – Intel 8031/8051 microcontroller capable of executing logic and arithmetic operations
  - **16-bits** – Higher performance microcontroller with more accuracy in performing operations; example, Intel 8096
  - **32-bits** – Microcontroller for automatic actuated hardware like automated machines in office.

- Tell them the types of microcontrollers can be classified as follows:
  - **8051 Microcontroller** – This has universally accepted 8-bit microcontroller configuration which uses Flash, NV-RAM and UV-EPROM. It has an on-chip crystal oscillator and a 2-pin input-output port.
  - **Peripheral Interface Controller (PIC) Microcontroller** - PIC developed by Microchip Technology earlier had ROM or EPROM for program storage. The current generation models have flash memory which can be reprogrammed. The microcontroller comes in 8-bit, 16-bit and 32-bit models.
  - **Advanced Virtual RISC (AVR) Microcontroller** – AVR microcontroller is an 8-bit solitary chip microcontroller having non-volatile programmable flash memory. To eliminate requirement of external memory, the AVR microcontroller has SRAM, flash and EEPROM integrated in a single chip
- Tell them the differences between microprocessors and microcontroller boards.
- Explain to them about the processor boards and show them the Arduino and Raspberry Pi board.
- Tell them about the customized single board platform. Also, tell them the difference between single board computer and the microcontroller board.
- Tell that a single board computer (SBC) is a printed circuit board (PCB), combined with a microcontroller as processor, and many other components, required to work like a small computer. Microcontrollers require external hardware and interfacing chipsets for communication whereas SBCs have them built on their PCBs.
- Explain the architecture of Intelligent Transport System (ITS).
- Tell them that IoT framework is fundamentally built on a data centric architecture called Data Tweet Framework. This helps in disengaging the dependency of the data silos in the end user IoT network.
- Give them an example of the on-board unit (OBU) of a vehicle which includes a software module to initiate specific user requests. The handing out and storage layer mechanism are positioned in the Road Side Unit (RSU), which is then connected to a cloud for long-term data storage and automatic service supervision.
- Tell them that to make roadside assistance system a practical solution, there can be three main layers for connected vehicle solutions. The same are as follows:
  - **Sensing Layer** – Interact with the driver and act as an interface for in-vehicle interaction with speed sensors, RFID, cameras, microwave detection technology, infrared sensing equipment or payment gateways
  - **Communication Layer** – For real-time secure communication from vehicle terminal to the service layer on public or private networks like 3G/4G, Wi-Fi or optical fibre
  - **Service Layer** – Usage of applications by means of cloud computing technologies, data analytics and data and information processing. Huge amount of data and information pertaining to commercial vehicle scenario and transportation information is processed.

- Show them the following figure which shows the components of an intelligent roadside assistance framework:

Application Layer
- Resource discovery
- Actuation/sensing
- Query/push/security

Processing and Storage Layer/Access Control
- Data processing
- Resource registration and management
- Data dissemination

Perception Layer
- RFID
- Sensor
- Global positioning system (GPS) and ZigBee

Fig 1.1.8: Intelligent roadside assistance framework

- Tell them about some examples of ITS in India with the help of the following figure:

Advanced Traffic Management System (ATIS), a fully automated traffic regulatory management system incorporates the use of automatic number plate readers and surveillance cameras.

The Traffic People provides real time traffic updates to the users.

Advanced Public Transportation System monitors the frequency of the transports, delay, arrival time and so on, so that the passengers need not wait for transport.

Electronic Toll Collection removes the toll payment violation. If a car is registered in a toll payment program, the account related to the card is automatically debited when it crosses the toll.

Advanced Parking Management tells a car about the vacant place for parking and the way to it.

Fig 1.1.9: Some examples of ITS in India

Answers for exercises in PHB

- Exercise Handling Strategy:
  1. Ask any two of the participants randomly to answer the question. The answers may be:
     - Health Monitoring Application
     - Home Alarm System
  2. Ask any two of the participants randomly to tell the differences. The differences are:

Microprocessor	Microcontroller
Microprocessors have only few integrated circuits or CPU units.	Microcontrollers have a processor core, ROM, RAM, I/O pins and so on.
Processing speed of microprocessors is above 1 GHz.	Processing speed of microcontrollers is about 8 MHz to 50 MHz.
No power saving system with external components, so power consumption is high.	Power saving system, like idle mode or power saving mode for low consumption of power.
Bulky and preferred for larger applications.	Compact, favourable and efficient system for small products and applications.
Tasks performed are software development.	Tasks performed are limited and generally less complex.
Based on von Neumann model where program and data are stored in same memory module.	Based on Harvard architecture where program memory and data memory are separate.

  3. Randomly ask any two of the participants to tell examples one by one. The suggestions are:
     - Healthcare: Use of smart pills (or ingestible sensors), insulin delivery devices, connected inhalers, smart beds, robotic surgeons, fitness trackers and biosensors.
     - Enterprise: RFID tags to manage inventory, driverless trucks, robotic assembly and so on.

UNIT 1.2: Functioning of Sensors and Actuators

Unit Objectives

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

- List various types of sensors
- Identify the importance of actuators
- Explain the basic programming of a microcontroller board

Resources to be Used

- Available objects such as a duster, pen, notebook and soon
- Different sensors and actuators

Ask

- Ask the participants if they can tell some applications of a sensor.
- Ask them whether they can name 2-3 types of sensors.

Explain

- Explain to the participants about different types of sensors.

Notes for Facilitation

- Start the session by asking the participants about sensors.
- Tell them that a sensor is a device that detects any change in the various factors of physical environment and responds to it. The factors could be motion, light, heat, moisture, pressure or any other environmental phenomena.
- Explain that a signal is generated from the sensor as an output which is transmitted over a network electronically, for further processing.
- Tell them about the applications of different types of sensors and their applications. The following figure shows some types of sensors:

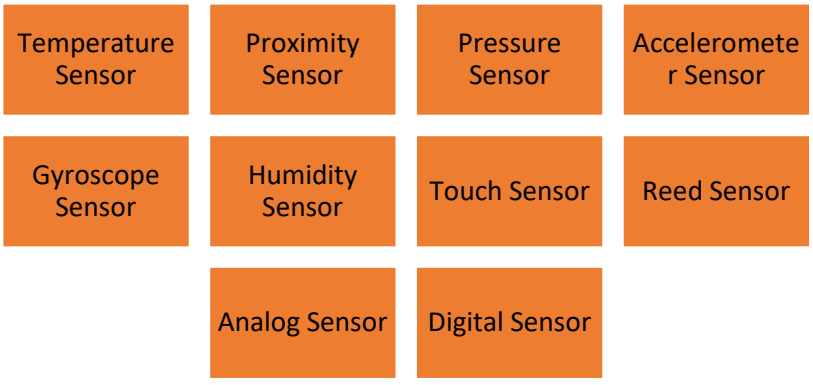


Fig 1.2.1: Some types of sensors

- Briefly explain different types of the temperature sensors, such as follows:
  - Thermocouples
  - Resistive Temperature Sensors
  - Infrared Sensors
  - Thermometers
  - Change of State Sensors
  - Silicone Diode Sensors.
- Tell them that the different types of temperature sensors used these days are as follows:
  - Thermocouples – These sensors measure temperature change with change in output voltage.
  - Resistive Temperature Sensors – These sensors measure temperature change due to variation in resistance level.
  - Infrared Sensors – These are non-contact sensors which detect temperature by beaming IR light on the desired object.
  - Thermometers – These are liquid expansion sensors that use mercury to measure the temperature levels.
  - Change of State Sensors – These measure change in state of material due to temperature variation.
  - Silicone Diode Sensors – These measure temperature changes at a very low range.
- Tell them that proximity sensors include the following:
  - **Inductive Sensors** – Used for non-contact detection of metallic objects; these types of sensors detect ferrous targets which are thicker than 1mm by creating a symmetrical magnetic field radiating from the ferrite core
  - **Capacitive Sensors** – To detect metallic and non-metallic objects (liquid, solid or in powder form) using conductive plates
  - **Photoelectric Sensors** – To detect target objects having 1mm or less thickness at a maximum distance of 60m. The emitter sends an infrared light or visible light to the receiver, and based on the amount of light received the output is determined
  - **Through Beam Sensors** – Uses photoelectric signal to detect any object in between the emitter and the receiver
  - **Retro Reflective Sensors –**Directs a laser, infrared or visible light at the reflector which beams it back at the receiver; If there is any object in between, it is detected as the light path is broken
  - **Diffuse Sensors** – Beam of light is directed and diffused in all directions, and when any object comes in the range, the desired action is initiated by the sensor
  - **Ultrasonic Sensors** – Use sound waves to detect objects in long range detection; typically used in automated production processes to detect glass, plastic, continuous fluid, sheet metal or wood stacks
- Tell them that different types of pressure measurement devices can be classified as follows:
  - **Absolute Pressure Measurement** – Measurement of pressure level in vacuum conditions; used for determining the barometric or altitude pressure measurements

- **Differential Pressure Measurement** – Measuring pressure of two varied positions measured in pound per square inch; used for monitoring pressure level of fluid in manufacturing industry to maintain the homogeneity of flow
- **Gauge Pressure Measurement** – To measure the pressure at a specific point as compared to the atmospheric pressure; for example, it is used to measure air pressure in car tires or blood pressure levels in human body

- Explain them that ultrasonic sensor is used to evaluate the attributes of a target. It generates high-frequency-sound waves by interpreting the echoes from radio waves or sound waves from the target.
- Also, tell them that, ultrasonic transducer is used for converting energy into ultrasound waves which are above human hearing range.
- Explain the applications of pressure sensors and accelerometer sensors. Tell them about the types of accelerometer sensors
- Accelerometer sensors are based on either capacitive sensing or piezoelectric effect which measures the displacement of the mass proportional to acceleration. The difference in both are as follows:
  - **Capacitive** – Known for high accuracy, this sensing mechanism uses electrically charged plates to measure the voltage output
  - **Piezoelectric** – Compressing crystal resulting in accumulation of charge on opposite polarity which can be measured.
- Explain to them, the difference between gyroscope and accelerometer sensor.
  Gyroscope sensors can be of the following types:
  - **Rotary Gyroscope** – Uses law of conservation of angular momentum to measure angular velocity
  - **Vibration Structure Gyroscope** – Microelectromechanical (MEMS) devices which use multiple rotating systems to detect directional and angular velocity
  - **Optical Gyroscope** – Contains no moving parts and uses a light source to emit two beams positioned on a circle to detect angular motion
- Tell them that the main difference lies in their application. The gyroscope can sense rotation, whereas the other cannot. Accelerometer can measure the orientation of a stationary item with relation to Earth's surface. When accelerating in a particular direction, the accelerometer is unable to distinguish between that and the acceleration provided through Earth's gravitational pull.
- Also, explain that the gyroscope maintains its level of effectiveness by being able to measure the rate of rotation around a particular axis. When gauging the rate of rotation around the roll axis of an aircraft, it identifies an actual value until the object stabilizes out. Using the key principles of angular momentum, the gyroscope helps indicate orientation. In comparison, the accelerometer measures linear acceleration based on vibration.
- Explain humidity sensors and touch sensors.
- Humidity sensors can be classified into the following three types:
  - Capacitive – Relative humidity is measured by detecting the metal oxide level changes on a metal oxide strip placed between two electrodes

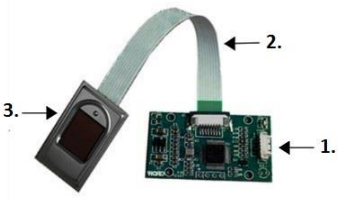
  - Resistive - With ions in salts the electrical impedance of atoms is measured, which in turn reflects the changing humidity level(s)
  - Thermal – Thermal sensors conducting electricity are used which calculate the difference between dry nitrogen in one sensor and ambient air in the other
- Tell them that touch sensors can be classified as follows:
  - **Resistive** – Relies on changing voltages on application of pressure on the surface to register a touch input
  - **Capacitive** – Has a glass overlay with conductive material which creates electrostatic charge on contact to perform the intended function
  - **Surface Acoustic Wave** – Uses two transducers and reflector on glass surface to beam waves which are detected to register touch input
  - **Infrared –** Uses LEDs and phototransistors to detect the absence of light from a particular coordinate to detect touch
  - **Optical Imaging** – Are infrared imaging sensors which detect the blocked light due to touch to locate the exact position of touch.
- Also, tell them that an oxygen sensor in the emission control system of a car detect the gasoline/oxygen ratio and generates a voltage. The voltage signal is read by a computer in the engine, and the balance of the mixture is adjusted, if required.
- Tell them that a photo sensor can detect the presence of ultraviolet (UV) energy and visible light.
- Tell that a motion detector is an electronic device which is used to detect the physical movement (motion) in a given area and it transforms motion into an electric signal; motion of any object or motion of human beings. Motion sensors in various systems including home security lights, automatic doors and bathroom fixtures typically send out some type of energy, such as microwaves, ultrasonic waves or light beams and detect the interruption in the flow of energy if something enters its path.

Explain

- Explain the working of sensors with actuators.
- Explain the importance of accuracy of sensors.

Notes for Facilitation

- Tell the participants that a sensor converts a physical parameter to an electrical signal and an actuator converts an electrical signal to a physical output.
- Show the following image which shows a fingerprint scanner on a PCB:



1. PCB for finger print sensing control
2. Wire for sensor and PCB connection
3. Finger print scanner plate

Fig 1.2.2 Finger print sensor PCB

- Briefly explain how a sensor works with an actuator. The following figure shows the sensor to actuator flow for a smoke detection system:

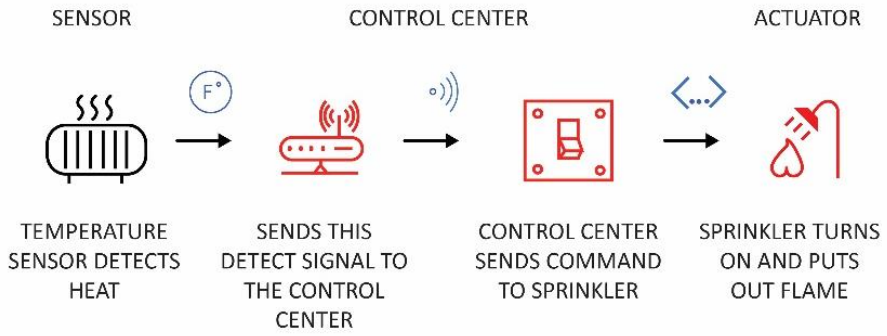


Fig 1.2.3: Sensor to actuator flow for a smoke detection system

- Tell them about the importance of accuracy and precision of a sensor with examples. For example, a temperature sensing system displays 22.0, 22.1 or 21.9 ˚C in three consecutive measurements, when the ambient temperature is 21.0 ˚C. The measurement is precise. But, if it displays 21.5, 21.0 and 20.5 ˚C, it will not be considered so precise, although the values are closer to the actual one.
- Tell them that accuracy of sensed data is paramount because critical decisions are made based on the analysis of this data. If there are more than acceptable errors in this data, the sensor data holds no value for the intended purpose.
- Tell them that factors that can affect sensor accuracy determine the amount of calibration needed for the sensor. These factors, also known as application variables, include temperature, gravity, obstructions (such as foam and dust) and turbulence.
- Briefly discuss about Arduino and Raspberry Pi board, related to the following points:
  - GPIO Pins
  - Processor speed
  - Power supply
  - Programming
  - Connectivity
- Also, tell them about the basics of programming and how to download and install Python.
- Exercise Handling Strategy:
  1. Ask the participants one by one to tell one application area of the given sensors. The application areas are:

Temperature Sensor	Food processing HVAC environmental control Medical devices Chemical handling
Pressure Sensor	Leak testing Level / depth sensing Flow sensing Altitude sensing

Touch Sensor	Mobile phones Laptops Musical instruments Foot pronation monitoring
Accelerometer Sensor	Measurement vibration on cars, machines, buildings, process control systems and safety installations
Proximity Sensor	Object detection Velocity measurements Positioning objects / containers Detection of liquid levels Distance measuring Machine Protection Edge detection of an object Detection of metal objects Positioning of equipment in stock Detection and filling quantities Obstacle detection Detection of materials Positioning fork lift truck

2. Ask a few participants one by one to tell the difference. Tell them the following differences:
   - The main difference lies in their application.
   - The gyroscope can sense rotation, whereas the other cannot. Accelerometer can measure the orientation of a stationary item with relation to Earth's surface. When accelerating in a particular direction, the accelerometer is unable to distinguish between that and the acceleration provided through Earth's gravitational pull.
   - A proximity sensor senses presence of an object in an area without any physical contact.

UNIT 1.3: Application of Communication Protocols in Internet of Things

Unit Objectives

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

- List various short-range wireless communications systems
- Identify the protocols used for communication in IoT
- Compare different communication technologies

Resources to be Used

- Available objects such as a duster, pen, notebook and so on
- A Bluetooth module and a wi-fi module if available

Ask

- Ask the participants if they know about wireless communication system.

Notes for Facilitation

- Start the session by giving an example of Bluetooth headphones. Tell them that this an example of short range wireless communication system.
- Briefly explain about short range wireless communication system.
- Tell them about various wireless communication technologies and their operating ranges. The following figure shows some common short range wireless technologies used these days:

Fig 1.3.1: Some common short range wireless technologies

- Briefly, explain the architecture of short range communication network which are as follows:
  - Point-to-point (P2P)
  - Star
  - Mesh.
- Tell them that P2P is a link between two endpoints that allow devices to communicate on a dedicated channel. Star network configurations include multiple nodes that connect to a central device; each node is unable to directly communicate with others only through the central device. These networks are easy to setup but if the central device fails than the network also fails.
- Also, tell that mesh networks consist of multiple nodes, each connecting to each other. This can be used for establishing consistent connection but there is a high amount of redundancy.

- Tell that hybrid networks are simply combinations of different topologies, but they are often very complex and expensive to setup.
- Briefly explain about various data transfer types and protocols used in IoT.
- Tell them about the flow of data collection with the help of the following figure:

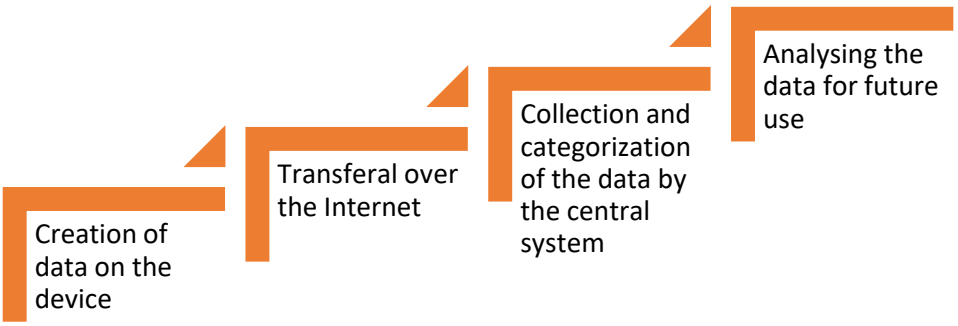
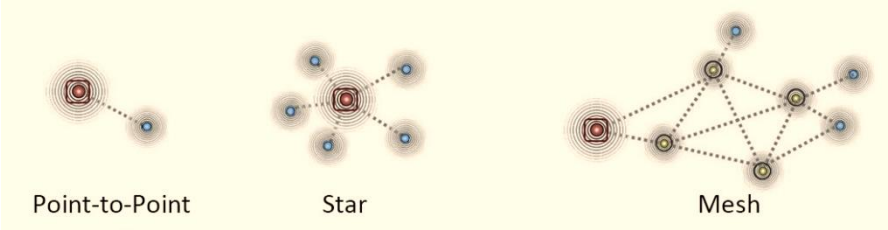


Fig 1.3.2: Flow of data collection

- Tell them that the most important IoT protocols are:
  - Constrained Application Protocol (CoAP): It is designed to be used between devices on the same constrained network, between devices and general nodes on the Internet and between devices on different constrained networks—both joined on the Internet. This protocol is especially designed for IoT systems based on HTTP protocols.
  - Message Queue Telemetry Transport (MQTT): It is mostly used for remote monitoring in IoT. Its primary task is to acquire data from many devices and transport it to the IT infrastructure. MQTT connects devices and networks with applications and middleware. A hub-and-spoke architecture is natural for MQTT. All the devices connect to data concentrator servers like IBM's new MessageSight appliance. MQTT protocols work on top of TCP to provide simple and reliable streams of data.
- Explain different wireless technologies and their characteristics, such as follows:
  - Band
  - Range
  - Standard
  - Power
  - Data Rate
  - Applications
- Tell them that Jaap Haartsen invented Bluetooth. Devices in which it is used widely include mobile phones, computers, and entertainment systems.
- Explain that every Bluetooth-enabled device has a built-in microchip that is capable of sending both voice and data signals. In this short-range communication system, one device functions as the master, while one or more other devices act like slaves. The master device uses link manager software to locate other Bluetooth devices in the vicinity and connects with them to send and receive data.

- Exercise Handling Strategy:
  1. Ask one of the participants to draw the following diagram on the board and write the name of the type of network. The types are as follows:



  2. Ask one participant to tell the difference. The differences between RFID and NFC are:
     - RFID refers to a communication technology in which digital data encoded in the RFID tag is identified by a device via radio waves. NFC is a communication technology that enables two or more electronic devices, like smartphones, to interact with each other and perform simple, safe, contactless data transfers, transactions, and data access.
     - RFID systems includes a reader, an antenna and a transponder or tag. NFC device can act as a reader as well as a tag in case of card emulation mode.
     - NFC is based on the RFID protocols.
  3. Draw a table on the board. Then ask the participants to fill the details one by one. The answer will be:

	Band	Data Rate
Wi-Fi	2.4 / 5 GHz	500Mbps-1Gbps
Bluetooth	2.4 GHz	1Mbps
NFC	13.56MHz	100–420kbps
ZigBee	2.4GHz	250kbps

UNIT 1.4: Micro-controller Boards PIN Configurations and Their Interconnectivity

Unit Objectives

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

- Identify the components of a microcontroller board
- Describe the layout of various development boards

Resources to be Used

- Available objects such as a duster, pen, notebook and so on
- Arduino UNO and Raspberry pi board

Ask

- Ask the participants whether they remember what a microcontroller is.

Notes for Facilitation

- Tell the participants why a microcontroller is important for IoT.
- Tell them that a microcontroller provides better firmware security, handles Boolean functions and has a higher speed. In IoT applications, size of the computing chip is important, therefore, microcontrollers are preferred as they have all the components integrated on-board.
- Tell them the general components of a microcontroller board with the help of the following figure:

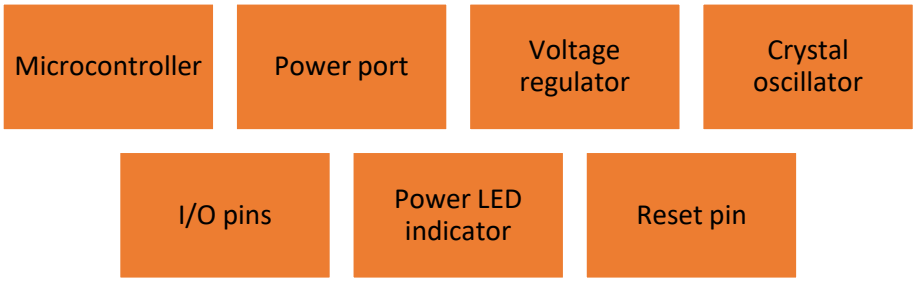


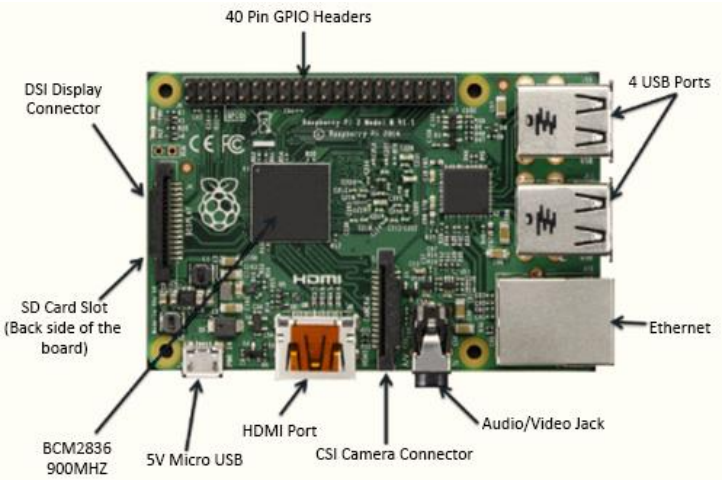
Fig 1.4.1: General components of a microcontroller board

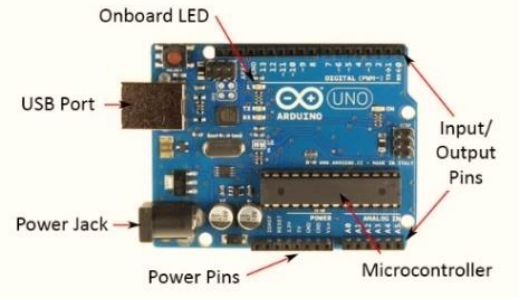
- Explain the basic components of a microcontroller one by one.
- Tell them that the board can be powered by a USB cable or an external power cable.
- Tell them that there are two types of voltage regulators:
  - Linear voltage regulator
  - Switching voltage regulator
- Tell them that voltage regulators come in different types, ranging from ones that are affordable to ones that are efficient in their function over a long period of time.

- Tell them that the types of oscillators used for electronic components of IoT based device circuits are linear oscillators like Hartley oscillator, phase-shift oscillator and Armstrong oscillator or Colpitts oscillator. Other type of oscillators are relaxation oscillators such as Royer oscillator, ring oscillator and voltage-controlled oscillator.
- Explain the specific components of an Arduino board.
- Tell them about the TX and RX LEDs of the Arduino board.
- Also, tell them about the following characteristics of an Arduino UNO board:
  - Microcontroller: ATmega328P
  - Flash memory of 32 KB
  - Operating Voltage: 5V
  - Input Voltage: 6-20V
  - Digital I/O Pins: 14 pins, out of which 6 pins provide pulse width modulation (PWM) output
  - Analog Input Pins: 6
  - DC Current per I/O Pin: 40 mA.
- Also, tell that Arduino boards are used for the following purposes:
  - RFID Sensed Device Access
  - Underground Cable Fault Detection
  - Industrial Appliances Control System Used in Decoding Dual Tone Multi-Frequency Signals via Global Service for Mobile (GSM) Network
  - Home Automation.
- Tell them about the components of Raspberry Pi board.
- In addition, tell them about the following features of a Raspberry Pi 3 board:
  - 1.2GHz, 64-bit quad-core ARMv8 processor
  - Connectivity options such as 802.11n Wireless LAN, Bluetooth 4.1 and Bluetooth Low Energy (BLE)
  - 4 USB ports and 40 GPIO pins
  - 1GB RAM
  - Full HDMI port
  - Audio jack and composite video
  - Camera interface and display interface
  - Micro SD card slot.
- Tell the following applications of Raspberry Pi board:
  - As it can support all programming languages, it is used in launching weight wed server.
  - Blogs/website can be managed as it can handle WordPress.
  - In automation industries, Raspberry Pi board-based robotics is used.
  - IOT applications are very easy to develop using Raspberry Pi.
- Tell them about Beagle Bone Black Development Board and tell the features of the board. The features are as follows:
  - 1GHz ARM Cortex-A8 processor
  - 512MB DDR3 RAM
  - 2GB on-board flash storage
  - NEON floating-point accelerator and 3D graphics accelerator

- 32-bit microcontrollers
- HDMI and 2x 46 pin headers
- USB client for power and communications
- USB host and Ethernet adapter

- Tell them that the main objective of the Adafruit Flora development board is to develop wearable electronic devices. The board is sewable, disk shaped and comprises of Arduino-compatible microcontroller.
- Further, tell them that the applications of Adafruit Flora development board are as follows:
  - Wearable thermometer
  - Electromagnetic field detecting dress, which is used to save from radiation by detecting EMF signals.
- Compare between the main types of microcontroller boards with respect to CPU, speed, memory, storage, power port, connectivity and so on.
- Exercise Handling Strategy:
  - For question 1 and 2: Ask the participants to label the parts in the notebook. Give them 15 minutes for each question. Then, tell the answers. The answers are as follows:





  - For question 3: Randomly ask one participant to tell the use of voltage regulator. The answer is as follows:
    - Regardless of the input voltage, the voltage regulator provides a fixed output to prevent any short circuits.
    - It generates stable output of the circuit in response to fluctuating input voltage
    - It prevents any voltage spikes in the microcontroller to prevent damage

UNIT 1.5: Edge Devices

Unit Objectives

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

- Explain the functions of edge devices
- Identify the different types of edge devices

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Ask

- Ask the participants if they have heard about edge devices.

Notes for Facilitation

- Tell the participants that an edge device is a networking device which connects LAN with an external WAN or the Internet.
- In addition, tell them that edge devices serve as entry points into an enterprise's primary network or a service provider's network.
- Further, tell them the examples of edge devices are as follows:
  - Routers
  - Multiplexers
  - Network access devices
  - Routing switches
  - Integrated access devices (IADs)
- Explain the functions of edge devices with the help of the following figure:

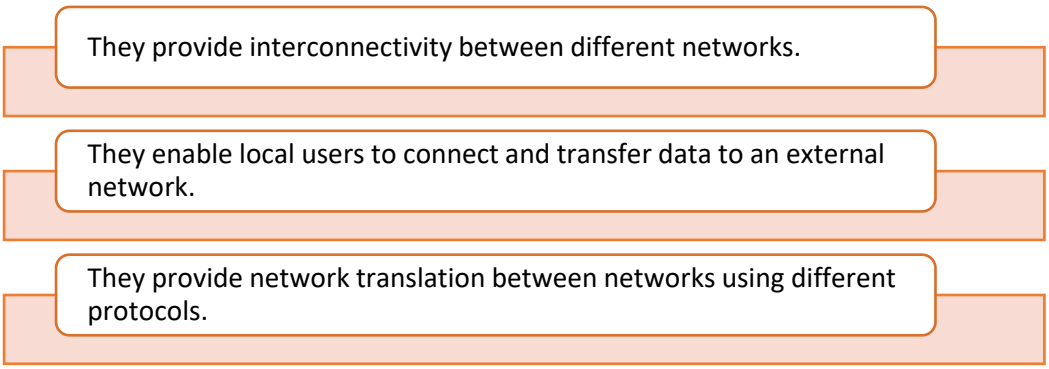


Fig 1.5.1: Functions of edge devices

- Briefly explain about edge routers and show them the following figure:

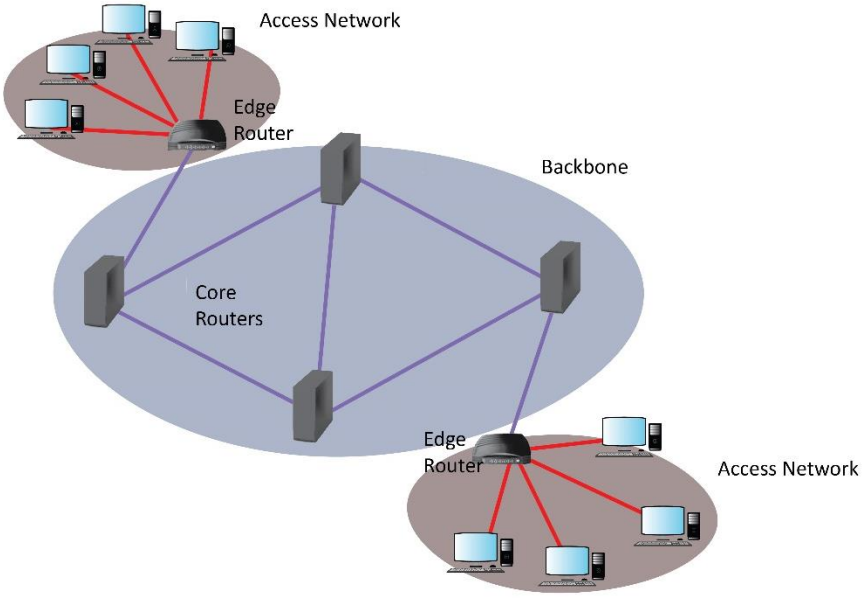


Fig 1.5.2: Concept of edge routers

- Also, tell them that there are two types of edge routers:
  - Subscriber edge router
  - Label edge router
- Explain multiplexer with the help of following figure:

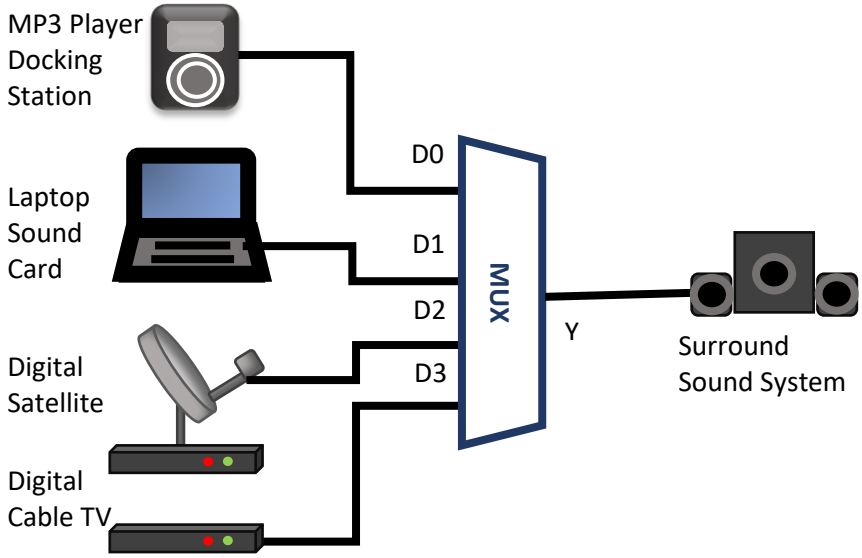


Fig 1.5.3: Concept of multiplexer

- Explain routing switch and its applications.
- Also, tell them about sensors and actuators as edge devices.
- Further, inform them how gateways work as edge devices.
- Tell them that a gateway works like an essential link in edge systems, between the external network and the local connection used by other devices in an environment, making it the key access point for network connectivity.
- Tell them that gateways connect legacy and new systems and enable data flow between edge devices and the cloud.

- Briefly, explain how the devices work as follows:
  - LAN edge
  - Service provider edge
  - Datacenter edge
- Explain the example of IoT- connected office building environment.

UNIT 1.6: Nodes and Gateways

Unit Objectives

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

- Explain nodes
- Describe gateway architecture
- List the steps in setting up an IoT framework

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Ask

- Ask the participants if they can remember anything about gateways.
- Ask them what they know about nodes.

Explain

- Explain nodes and gateways.
- Explain how they work in an IoT framework.

Notes for Facilitation

- Start the session by asking questions about nodes and gateways.
- Tell the participants that in telecommunications network, gateway is the networking hardware which interfaces with other network using a different protocol. The gateway devices can be protocol translators, impedance matching devices or signal translators. A computer program also acts as a gateway which can operate at any network layer.
- Tell the participants that a node is a device within a network which has the ability to send, receive or forward data.
- Tell that gateway connects two dissimilar networks.
- Further, briefly explain the IoT gateway and IoT nodes.
- In addition, tell them that an IoT gateway bridges the communication gap between IoT devices, sensors and the cloud.
- Also, tell that IoT gateway devices offer local processing and storage solutions as well as the ability to autonomously control field devices based on data input by sensors by systematically connecting the field and the cloud.
- Further, tell them that an edge gateway is placed at the intersection of various edge devices, between the external network and the local intranet used by the devices. Hence, the gateway is the key access point for network connectivity.

- Also, tell them that it is important to calibrate the following items based on the requirement of the application:
  - Range of the IoT sensors
  - Power demands
  - Performance
  - Scalability and security
- Briefly, explain the basic steps of setting up an IoT framework with the help of the following figure:

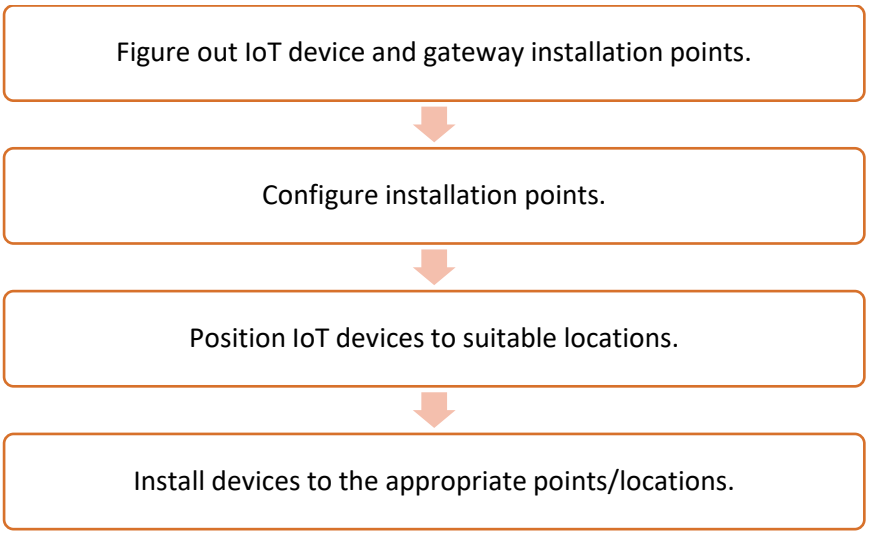


Fig 1.6.1: Basic steps of setting up an IoT framework

- Exercise Handling Strategy:
  1. Randomly ask the participants one by one to tell the steps. The steps are:
     - Figure out IoT device and gateway installation points.
     - Configure installation points.
     - Position IoT devices to suitable locations.
     - Install devices to the appropriate points/locations.
- Exercise Handling Strategy:
  2. Randomly ask the participants one by one to tell the names of the devices. The devices may be:
     - Routers
     - Routing switches
     - Multiplexers
     - MAN and WAN
     - Sensors, actuators and devices for automation
  3. Randomly ask one participant to tell the functions. The functions are:
     - Edge devices provide interconnectivity between different networks.
     - They enable local users to connect and transfer data to an external network.
     - They provide network translation between networks using different protocols.

UNIT 1.7: Cloud Computing

Unit Objectives

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

- Explain the concept of cloud computing
- List the characteristics of cloud computing
- Explain how cloud computing is related to business analytics
- Explain the advantages of cloud utilization

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Ask

- Ask the participants if they have heard anything about cloud computing.

Explain

- Explain cloud computing and its characteristics.
- Explain the relation of cloud computing and business analytics.

Notes for Facilitation

- Start the session by telling that a cloud provides remote access to a group of decentralized IT resources.
- Tell them that it refers to a distinct IT environment, designed to facilitate the remote provisioning of scalable and measured IT resources.
- In addition, tell them, how Internet and cloud are different. The following figure shows the differences between cloud and Internet:

A cloud is privately owned and it provides metered access to IT resources, whereas the Internet allows open access to Web-based IT resources.

Basically, Internet provides the access of content-based IT resources published through the World Wide Web. Resources based on cloud supply back-end processing capabilities along with user-based access to them.

It is not necessary for clouds to be Web-based. They can be based on any protocol that facilitates remote access to the IT resources.

Fig 1.7.1: Differences between cloud and Internet

- Explain the characteristics of cloud computing.
- Tell them that a cloud deployment model represents a particular cloud environment, distinguished by size, ownership and access.
- Briefly, explain to them about different cloud deployment models as follows:
  - Private cloud
  - Public cloud
  - Community cloud
  - Hybrid cloud
- Inform them that a public cloud is owned by a third-party cloud provider and it is publicly accessible.
- Also, tell that the cloud provider is accountable for the creation and maintenance of its IT resources.
- Show them the following figure representing the concept of public cloud:

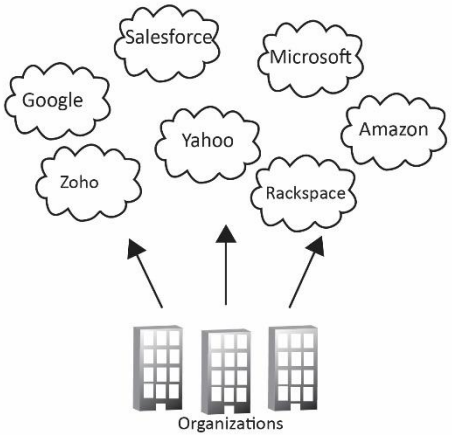


Fig 1.7.2: Concept of public cloud

- Explain that access to a community cloud is limited to a specific group of consumers. This may be jointly owned by the members or by a third-party cloud provider that is providing a public cloud with limited access.
- Show them the following figure representing the concept of community cloud:

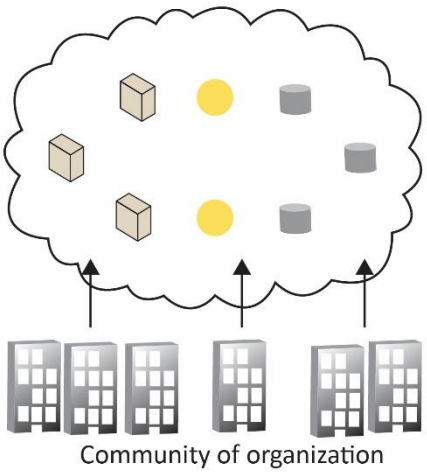


Fig 1.7.3: Concept of community cloud

- Also, explain the concept of private cloud by showing the following figure:

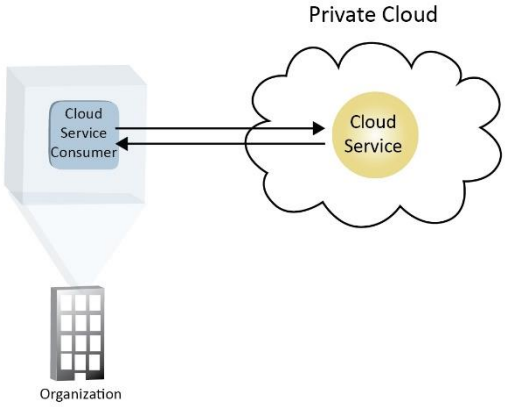


Fig 1.7.4: Concept of private cloud

- Tell them that the administration of a private cloud may be performed by internal or outsourced staff.
- Briefly, explain that a hybrid cloud is a combination of two or more different cloud deployment models.
- Also, show them a hybrid cloud model to explain its concept:

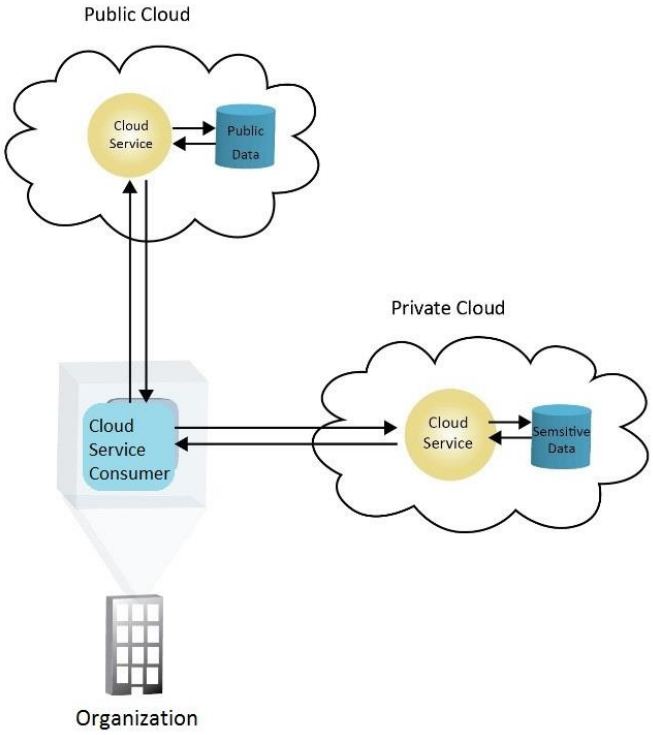


Fig 1.7.5: Concept of hybrid cloud

- Explain why cloud computing and storage is ideal for business analytics.
- Tell them the role of cloud in IoT framework.
- Briefly, explain the advantages of cloud.

- Exercise Handling Strategy:
  - Randomly ask the participants one by one to tell the characteristics.
    - Anytime access from anywhere
    - Data can be retrieved from any Internet enabled device
    - It allows resource pooling, means anyone can access and use the data for collaborating the information
    - It offers wide range of services as per the requirement
    - It is measurable in respect of storage, processing and users accessing data
  - Randomly ask any other participant, the advantages of cloud. The advantages are:
    - Fast, flexible deployment
    - Highly secure
    - Easy mobile access
    - Ease of sharing with customers and others outside the organization
- Practical solution:
  - Perform the prototyping of Raspberry Pi kit.

    Solution:

    1. Assemble the case and the Raspberry Pi that will provide an extra layer of physical protection.
    2. Attach the main female header socket to the Raspberry Pi.
       a. Put the connector flat on the bench with the board resting on it.
       b. Push the tack in the other side so it stays level and solder it.
       c. Take care that the soldering iron touches a pin and the Pi HAT at the same time,
       d. Repeat for the other 39 pins.
    3. Add the female pin header strips.
    4. Solder a couple of wires to connect the vertical headers to 5V and GND.
    5. Add the bread board to the top of the shield.

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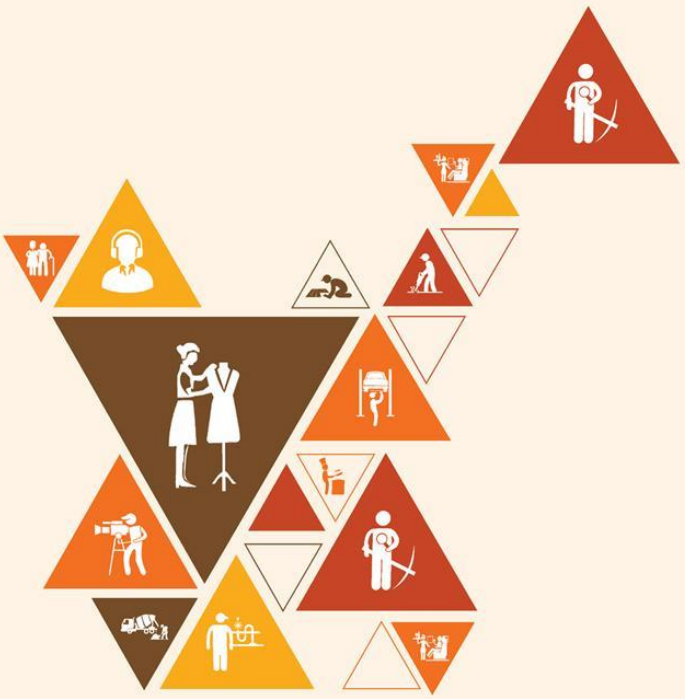
Telecom
Sector
Skill
Council

2. Install and Configure IOT Device

Unit 2.1 - Establishing Framework for Internet of Things
Unit 2.2 - Installing Gateway as per the Power Supply Requirements
Unit 2.3 - Establishing Communication between Nodes, Gateway and Servers
Unit 2.4 - Establishing Ethernet Connectivity
Unit 2.5 - Authentication and Access Control Mechanism
Unit 2.6 – Mounting the Devices at Desired Locations
Unit 2.7 – Performing Checks and Connections
Unit 2.8 – Connecting Micro controller Boards for Data Transfer and Connecting the Boards
Unit 2.9 – Installing Suitable Framework
Unit 2.10 – Transferring Software Code to On-board Microprocessor and Compiling Code to On-board Microprocessor
Unit 2.11 – Understanding Error Codes and Debug Software
Unit 2.12 – Functioning of Micro-controller and Attached Devices
Unit 2.13 – Initializing Nodes and Gateways
Unit 2.14 – Launching the Software on Nodes and Gateways
Unit 2.15 – Confirming Communication and Establishing Connectivity
Unit 2.16 – Controlling Edge Appliances and Hubs and Checking for Data Transfer and Confirming from the server End



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Key Learning Outcomes

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

- List the steps of installation of IoT framework
- Explain how to collect data
- List the input parameters for a sensor
- List the characteristics of power sources available for the nodes andĚ gateways
- Identify the characteristics of battery used for IoT framework
- Execute connection establishment between the nodes and gateways
- Explain the communication channels
- Describe wireless sensor network
- Explain sensor connectivity
- Identify the connectivity options
- Describe how to configure network setting
- List the steps of crimping
- Execute the establishment of Ethernet connection
- Identify the importance of authentication and authorization in IoT
- Explain access control system
- Identify the software interface characteristics
- List different software available for access control management
- Describe how to secure wireless connection
- Describe malware and DDoS attacks
- Explain how to choose the correct location for mounting
- Explain how to select resources such as power supply
- Explain the steps for surface preparation while mounting devices
- Identify the correct distance between the devices
- Describe signal and power loss during inter-device communication
- Evaluate the resource consumption of the set-up
- Identify the correct set of sources for power and other utilities
- Explain the connectivity between the devices
- Describe preparation of devices for transmission of data
- Explain power supply selection and grounding
- Identify post commissioning checks

UNIT 2.1: Establish an IoT Framework

Unit Objectives

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

- List the steps of installation of IoT framework
- Explain how to collect data
- List the input parameters for a sensor

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions.
- Ask the participants if they have any doubts.

Ask

- Ask the participants what they know about IoT.

Explain

- Explain IoT framework.
- Explain the suitable locations for installation IoT devices.

Notes for Facilitation

- Start the session by asking the participants some questions from the previous sessions.
- Tell them that, in simple terms, in IoT, the main concept is to connect an embedded system to the Internet.
- Tell that in an IoT framework, each device has a unique IP address. These devices or the endpoints are referred as 'things' and are located at the edge of an IoT network.

- Show them the following figure that is representing an embedded system in an IoT framework:

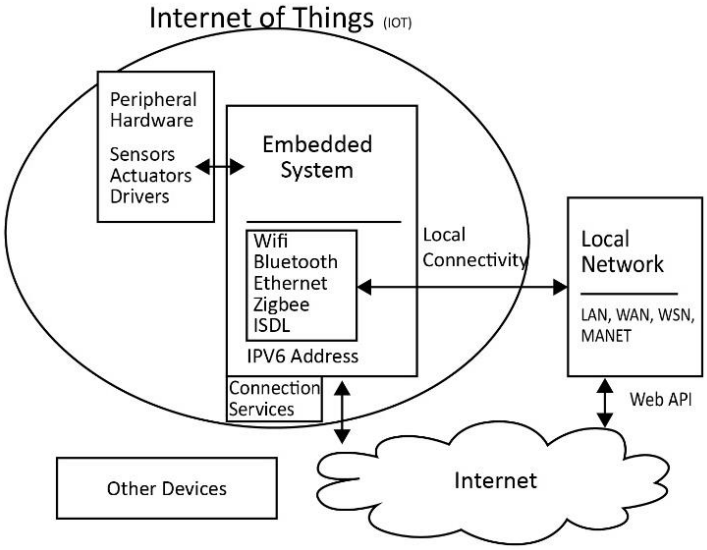

Fig 2.1.1: Embedded system in an IoT framework

- Tell them about motion sensor and show them one, if possible.
- Explain to them the steps of installing a framework for a sensor, one by one.
- Tell them the criteria for securing the IoT devices.
- Also, explain the constraints related to the installation of a motion sensor.
- In addition, tell them the location constraints for the installation of temperature sensors.
- Inform them about the constraints with the help of the following figure:

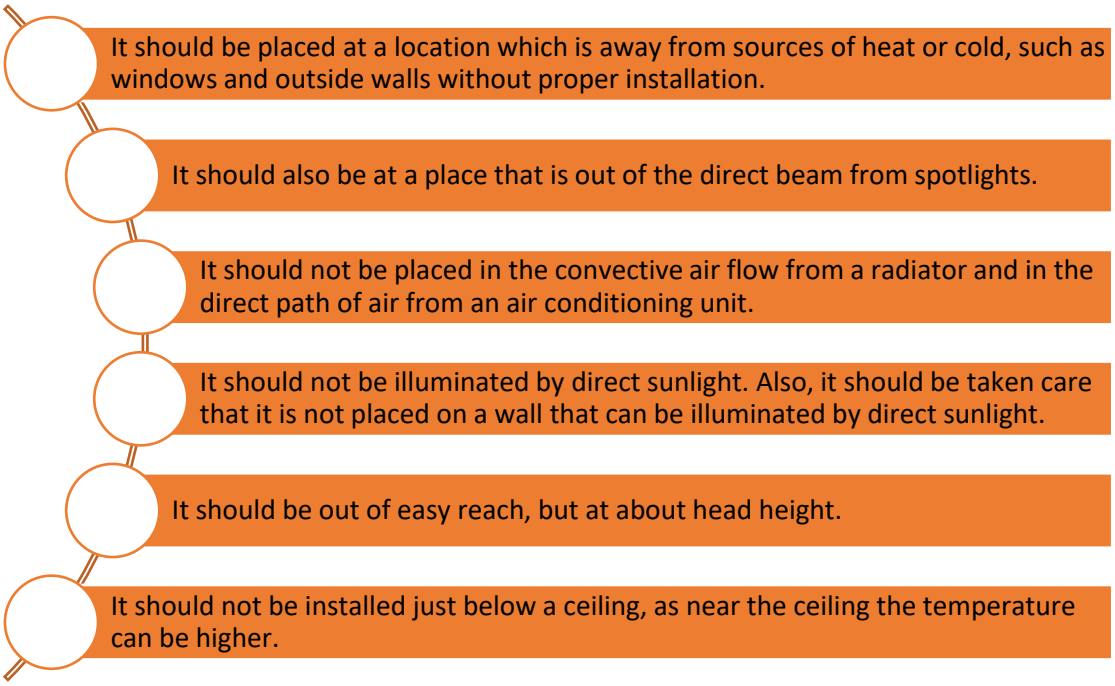

Fig 2.1.2: Location constraints for the installation of a temperature sensor

- Further, tell them that temperature and humidity sensors should be placed in open, centrally located spaces.

- Also, tell them that it is easier to detect objects that move sideways in front of a motion sensor, and more difficult to detect objects that move directly toward the front of the motion sensor. The following figure shows the direction of a motion sensor:

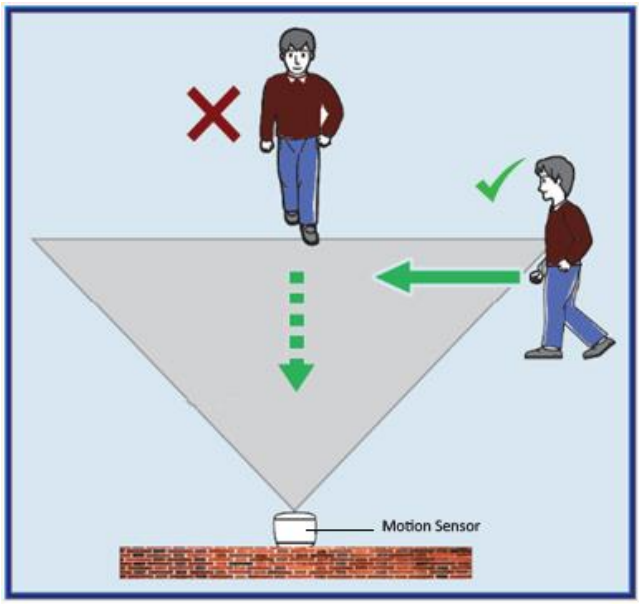

Fig 2.1.3: Direction of motion sensor

- Explain the steps for mounting a motion sensor.
- Also, inform them about the surfaces which should be avoided for mounting a sensor.
- Tell them how to connect the sensor to a power source. The power source may either be a battery or the main supply.
- Tell them that a technician needs to do the following actions:
  - Follow the electrical layout to connect the sensors
  - Make proper ground connection to the sensors
  - Secure the cables using cable trays
  - Ensure that the cable is not extended much for avoiding noise
  - Keep in mind that the sensors must be clipped round either the active or neutral AC wire, but not both of them. The following image shows the right and wrong way of clipping a sensor:

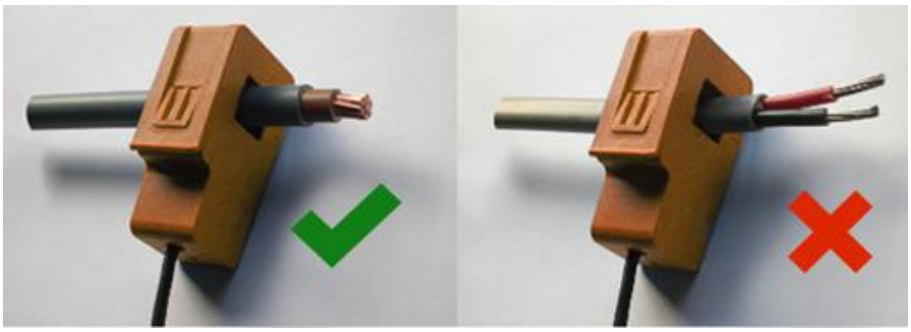

Fig. 2.1.4: Right and wrong way of clipping a sensor

- Explain how to connect the sensor with the system and also, tell them about configuring the sensors and testing them.

- Explain that the sensor must be tested from the desired location to check network status, before it gets fixed permanently. The following figure lists the checkpoints:

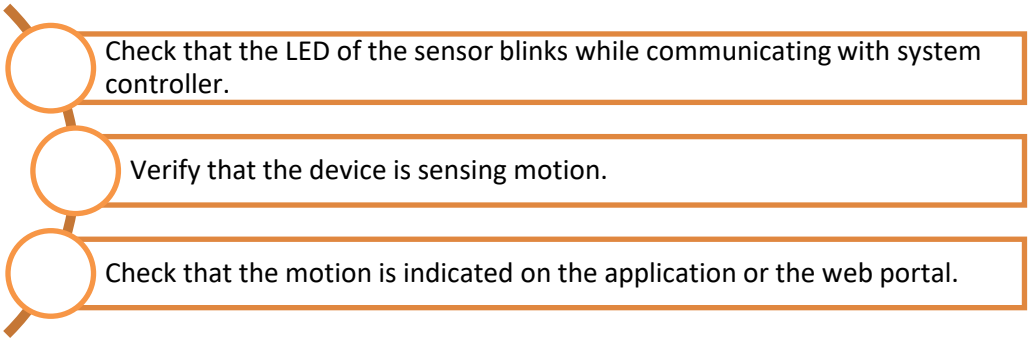

Fig. 2.1.5: Checkpoints for testing the sensor

- Tell them that they should check the indicators, signal strength and the network status visible on the sensor's display.

Explain

- Explain collation of installation points.
- Explain the sensor input parameters.

Notes for Facilitation

- Tell the participants that the data generated by the sensors must be collected at a common point, from where the data can be monitored and controlled.
- Explain the collation of installation points with the help of the following figure:

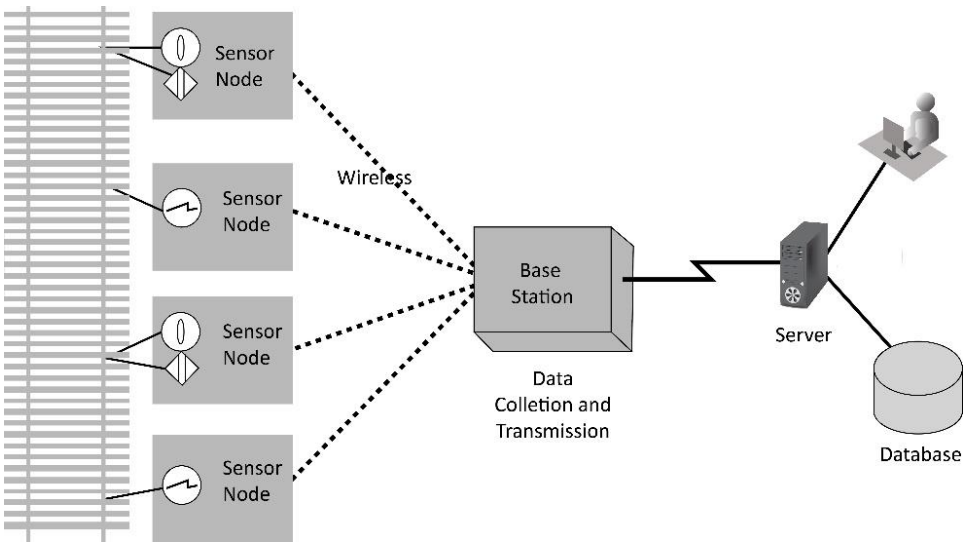

Fig 2.1.6: Collation of installation points

- Tell them that sensor nodes located in different places transmit the collected data to the base station via Bluetooth or Wi-Fi technology. The base station, then, forwards the data through general packet radio service (GPRS) or satellite to the central server.
- Explain the data creation stages and data collection systems briefly.

- Also, tell them about various input parameters of sensors such as the following:
  - ID
  - Description
  - Notification details
- Also, show them the following image which shows sensors input:

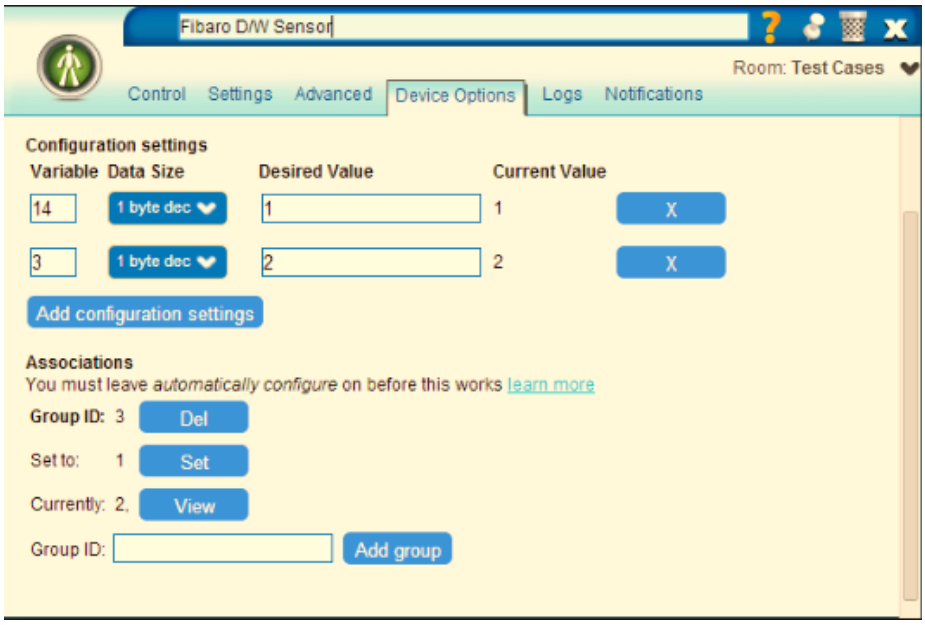

Fig 2.1.7: Sensor inputs

- Explain the importance of calibration of sensor data.
- Further, tell them that for temperature sensors, there are four adjustments that a good calibration can provide listed as follows:
  - Offset: All voltages are measured with respect to a reference. All devices operate at some operating voltage. Any displacements in these voltages, or any consistent errors during measurement, will produce consistent errors that affect all measurements. Offset corrections make these errors as small as possible.
  - Gain: The voltage that is measured is not really the voltage present on the sensor device. Amplifiers and attenuation between the sensor and the digitizing converter change the signal level. To recover the sensor information, restore the data to the original level accurately. Uncorrected gain errors tend to produce measurement errors that change consistently across the operating range.
  - Linearization: The relationship between measured voltage and sensed temperature is in general nonlinear and dependent on the physical properties of each sensor type. Over a limited range, a simple linear function is often a sufficient approximation, but a more complicated curve is necessary to describe the relationship accurately. For best accuracy, calibrate and adjust the coefficient values of the conversion function.
  - Unit Scaling: Convert the results to a common and useful representation. For example, present all temperature measurements in degrees C.

- Tell them that generally, two types of systems are there for data collection as shown in the following figure:

Proprietary Systems	Third-party Systems
•These systems are used to collect users' data, analyze that and send the reports to the users and the authorised third party. •The systems are maintained by the wearable vendors.	•These systems are used to to provide specific functionalities. •These systems can be developed and maintained by external entities.

Fig. 2.1.8: Data collection systems

- Exercise Handling Strategy:
  - Ask the participants one by one to tell the answers.
    1. False, True, True
    2. The input parameters are:
       - Sensor ID
       - Sensor Description
       - Alarm Notification
       - Worker ID
    3. The location constraints for mounting a sensor are:
       - It should not be installed in areas exposed to direct heat source or direct sunlight.
       - It should not be installed near an air discharge grill.
       - The installation surface should be flat and clean.
       - It should be out of easy reach, but at about head height.
       - It should not be installed just below the ceiling, as near the ceiling the temperature can be higher.

UNIT 2.2: Install Gateway as per the Power Supply Requirements

Unit Objectives

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

- List the characteristics of power sources available for the nodes and gateways
- Identify the characteristics of battery used for IoT framework
- Execute connection establishment between the nodes and gateways

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions and ask the participants if they have any doubts.

Explain

- Explain different characteristics of power sources.
- Explain how to connect the nodes and gateways to power sources.

Notes for Facilitation

- Start the session by explaining to the participants in brief about different power supply systems:
  - **DC Power Supply:** A power supply transmitting a constant voltage of DC current to its load is known as DC power supply. In power mains, depending on the design, an AC/DC source can power a DC power supply.
  - **AC Power Supply:** The wall outlet is the main supply that gives voltage to an AC power supply and brings it down to the required voltage along with some filtration.
    The division of AC supply is into three phase or single phase systems. The two differ in consistency of delivery between the two systems. Both frequency and voltage can be changed using an AC power supply.
- Explain to them that the devices in the IoT system and the gateway are powered by specialized batteries. The conventional batteries are not suitable for IoT devices as they have the following disadvantages:
  - Low power requirements
  - Various shapes and sizes
  - High range and frequency
  - Increasingly interconnected

- Tell them that power sources and the power supply circuit must have several key features to meet the criteria of the IoT devices as shown in the following figure:

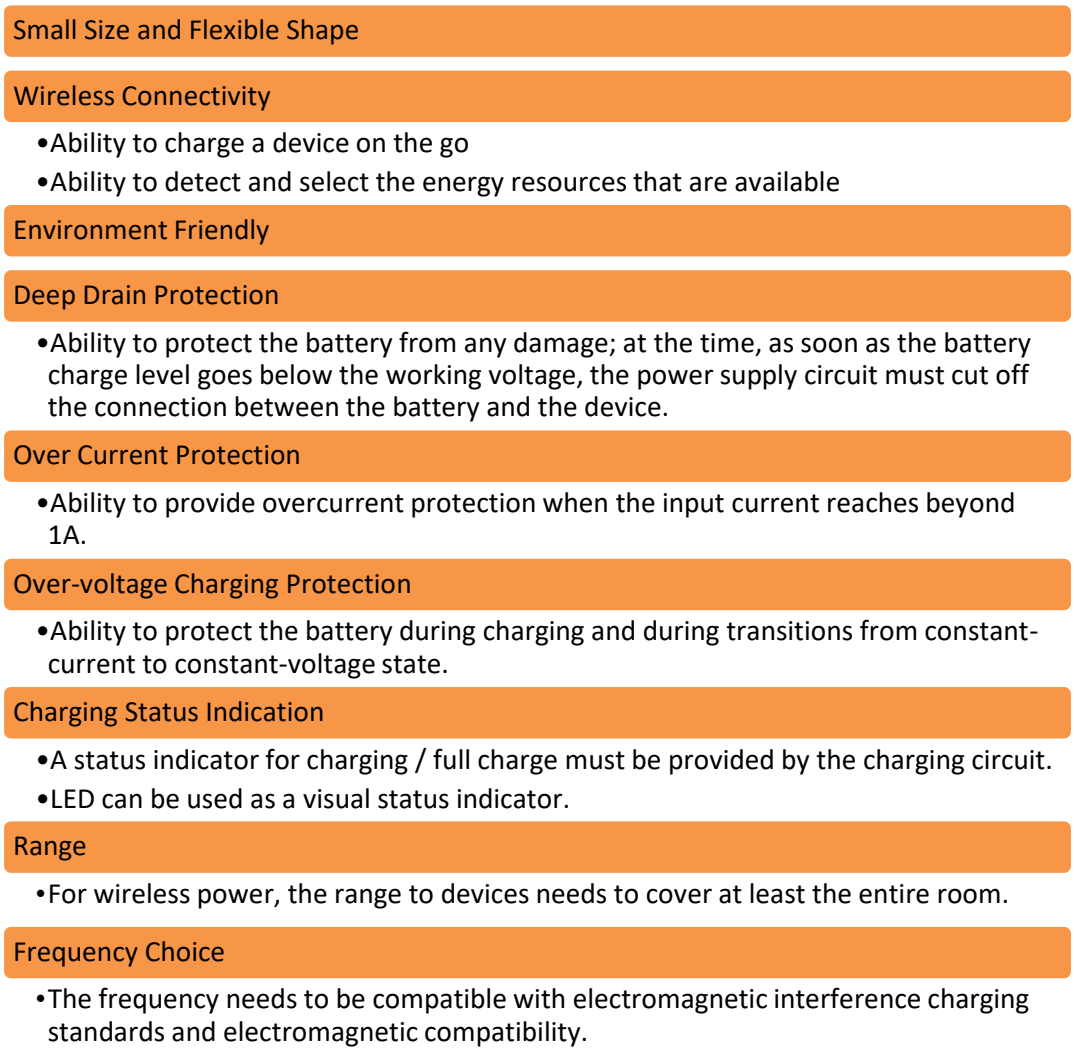

Fig. 2.2.1: Key features of power supply source and circuit

- Tell them that IoT devices are mainly powered by batteries.
- Tell them that it may be tempting to use a long-lasting battery. Every IoT gateway must have the ability to survive unpredictable power cycles and it must be able to restore itself to a minimum functional level afterward.
- Also, explain the selection criteria of a power source for the nodes and gateway devices in the IoT system.
- Further, tell them the features of a power supply source and a circuit.
- Tell them the characteristics of a battery.
- Explain how gateways are installed and connected to power sources.
- In addition, tell them the importance of choosing a suitable location for installing the gateway.
- Also, explain the criteria to remember while choosing the location of installing a gateway.
- Inform them that the nodes should be located within the rage of the gateway, so that they can communicate together.

- Say, it is also important to install the node and gateways within a stable network connection. Otherwise, they may not work properly.
- Explain the steps of connecting a power adapter to the gateway device.
- Also, tell them the result of using an incorrect power supply.
- Tell them that it should be kept in mind that failure to use the correct power supply and cord may cause electric shock, fire or product damage.
- In addition, tell them that they should not connect the power cord when the power supply is on, as it may lead to electric shock. Also, tell that they should take care while doing any electric work and they should not touch any wire and switches with wet hands.
- Explain to them how to connect the gateways and other IoT devices to the Internet connection via wired or wireless connection.
- Tell them that the status indicator light blinks when the gateway recognizes the connection but gets steady after a while.
- Tell them the importance of installing gateway relays.
- Explain to them the connection of the sensor and relay modules by showing the following figure :

For the relay module, there are three pins:	For the current sensor module, there are three pins:
•VCC to be connected to the Arduino voltage pin •GND to be connected to the Arduino ground pin •SIG to the specified pin number of the Arduino board.	•VCC to be connected to the Arduino voltage pin •GND to be connected to the Arduino ground pin •OUT to the analog pin of the Arduino board.

Fig. 2.2.2: Connection of the sensor and relay modules

- Tell them the criteria for a node location and also, explain how nodes are connected together, to the gateways and also to the power sources.
- Explain the importance of a plug-in nodes.
- Tell them that a Plug-In node is inserted into an extension cord or an electrical wall outlet. It is best to install the nodes at 15 inches to 4.5 feet above the ground.
- Further, explain the steps to make wired connection of DC nodes.
- Show them the connection diagram of a gateway module and explain the location of internal nodes, power points in the gateway and how the cables for nodes and Ethernet ports are connected.

- Give them an example of a lamp which is to be connected to a sensor. The following figure shows the simple wire diagram of connecting the nodes:

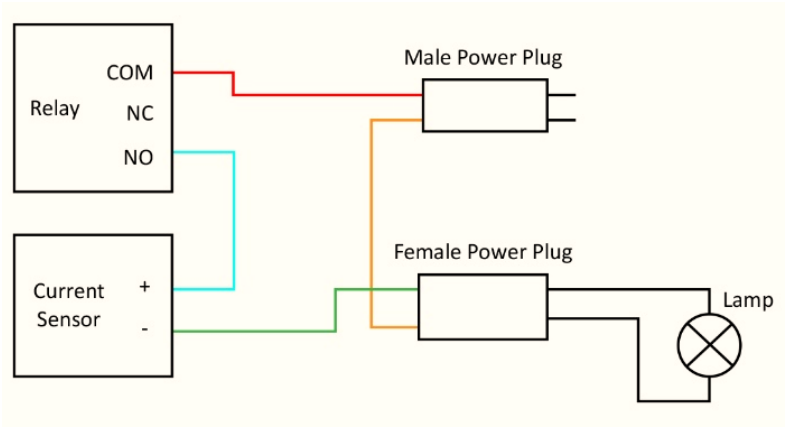

Fig. 2.2.3: Simple wire diagram of connecting the nodes

- Also, tell them to test the installation after the power source and Internet is connected to the nodes and gateways.
- Exercise Handling Strategy:
  - Ask the participants one by one to tell the answers.
    1. The characteristics of power source are:
       - Small Size and Flexible Shape
       - Wireless Connectivity
       - Environment Friendly
       - Deep Drain Protection
       - Over Current Protection
       - Over-voltage Charging Protection
       - Charging Status Indication and so on
    2. The steps to connect a device to the network are:
       - View the available Wi-Fi networks.
       - Select the Wi-Fi network name and connect.
       - Enter the Wi-Fi password.
    3. The places where a gateway device can be installed, are:
       - Within the range of the nodes
       - At least three feet away from the wireless devices
       - Discrete and locked locations to restrict physical access to the device
       - At least 4 feet off the ground
       - Near an Ethernet port or a Wi-Fi interface.

UNIT 2.3: Establishing Communication between Nodes, Gateway and Servers

Unit Objectives

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

- Explain the communication channels
- Describe wireless sensor network
- Explain sensor connectivity

Ask

- Enquire from the participants if they remember about various wireless communication technologies.

Notes for Facilitation

- Start the session by explaining to the participants about a network channel.
- Tell them about the following physical and wireless media:
  - **Wireless Local Area Network (WLAN)**

    A WLAN is used to connect two or more devices which are present over a short distance. WLAN is set up using a wireless distribution method. It provides a connection for Internet access through an access point. It is used in cities or towns to connect networks in two or more buildings without installing a wired link. The following figure shows a WLAN:

Fig. 2.3.1: WLAN

  - **Cellular Network**

    A cellular or mobile network is a network that is served by fixed-location transceiver. The fixed location is known as base station. This network is distributed over land areas which are known as cells. To avoid any disturbance, each neighbouring cell uses a different frequency. When the cells are joined, these provide network coverage over wide geographic area. This enables a number of portable devices to connect with each other in any network through a base station.

The following figure shows a cellular network:

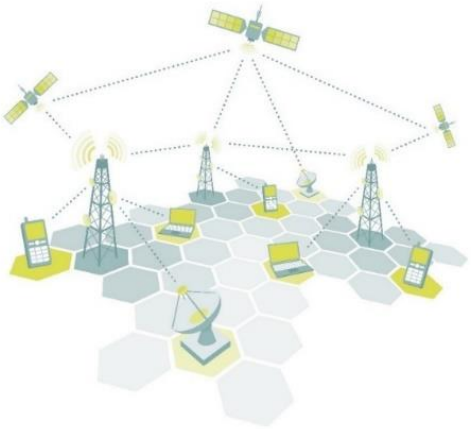

Fig. 2.3.2: Cellular technology

- **Bluetooth**

  Bluetooth provides a wireless technology standard to exchange data from any fixed or mobile device over a short distance and thus build a personal area network (PAN). The following figure shows a Bluetooth headset:

Fig. 2.3.3: Bluetooth

- **Near Field Communication (NFC)**

  It is a set of communication protocols which enables communication between two devices in range. NFC devices are specially used in contactless payment systems and allow mobile payment.

  NFC is a short-range wireless technology that requires a distance of 10 cm or less. It always involves an initiator that actively generates a radio-frequency field to power a passive target. NFC communication is possible when both the devices are powered. The following image shows an example of NFC technology:

Fig. 2.3.4: NFC technology

- Tell that Zigbee is based on the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4-based specification built for control and sensor networks. It is used in small, low-power digital radios, such as for home automation and other low-power low-bandwidth applications which are designed for small scale projects with wireless connection.
- Give the participants a brief overview of the evolution of the video surveillance technology.
- Explain that while choosing a channel, characteristics as shown in the following figure should be kept in mind:

Latency	Amount of time needed for information to propagate from source to destination through the channel.
Data Rate	Maximum rate (in bps) at which data can be transmitted over a given communication link, or channel.
Reliability	The probability that a data of size D is successfully transferred within a time period T.
Path Loss	Ratio of the power of the transmitted signal to the power of the same signal received by the receiver, on a given path.
Channel Bandwidth	Size of the range of frequencies that can be transmitted through a channel.
Channel Capacity	Amount of information per unit time handled by either a link or a node (system element). The messages transmitted may be either similar or different.

Fig 2.3.5: Characteristics of a communication channel

- Tell them about different cables used in communication networks with the help of the following figure:

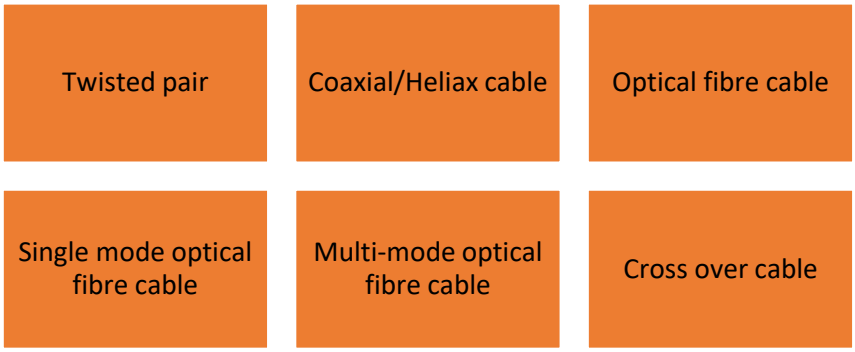

Fig 2.3.6: Different cables used in communication networks

- Also, explain different types of channels:
  - Point-to-Point
  - Point-to-Multipoint
  - Multiple Access
  - Relay
  - Interference
  - Unicast

- Broadcast
- Multicast.

- Then, brief them about the cloud framework.
- Briefly, explain two examples of cloud framework used these days:
  - Microsoft Azure
  - IBM cloud.
- Tell them that Azure Stream Analytics (ASA) supports either stream data or reference data as inputs, from either Azure Event Hubs or files from Azure Blob Storage.
- Also, tell them that event Hubs is a data integrator which is capable of consuming large volumes of events per second, enabling Azure to process vast amounts of data from connected applications or devices.
- Explain that ASA supports different types of outputs, such as follows:
  - Blob Storage
  - SQL Database
  - Event Hub
  - Power BI
  - Table Storage.
- In addition, give them a few more examples of cloud framework as shown in the following figure:

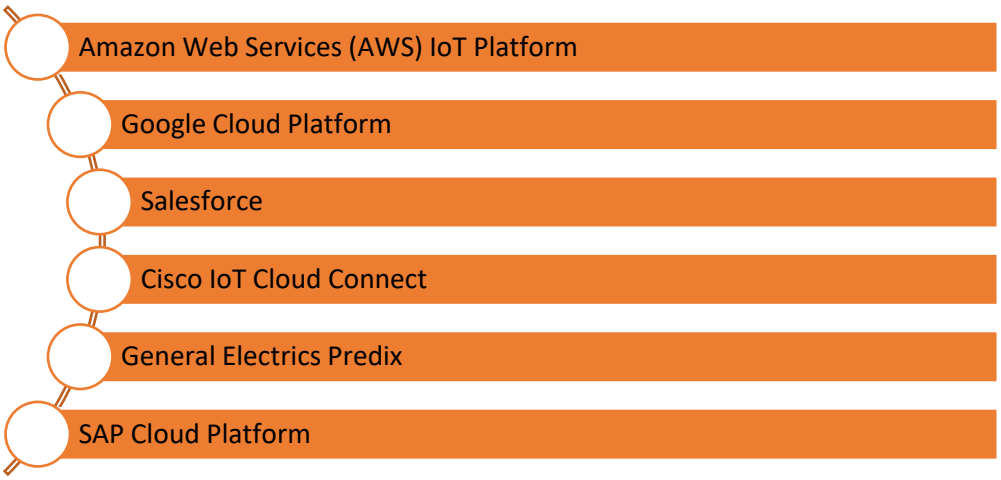

Fig 2.3.6: Examples of cloud framework

- Tell them that the IBM cloud framework includes several hardware and software coupled in Internet connected services. The following figure shows the contents of the package:

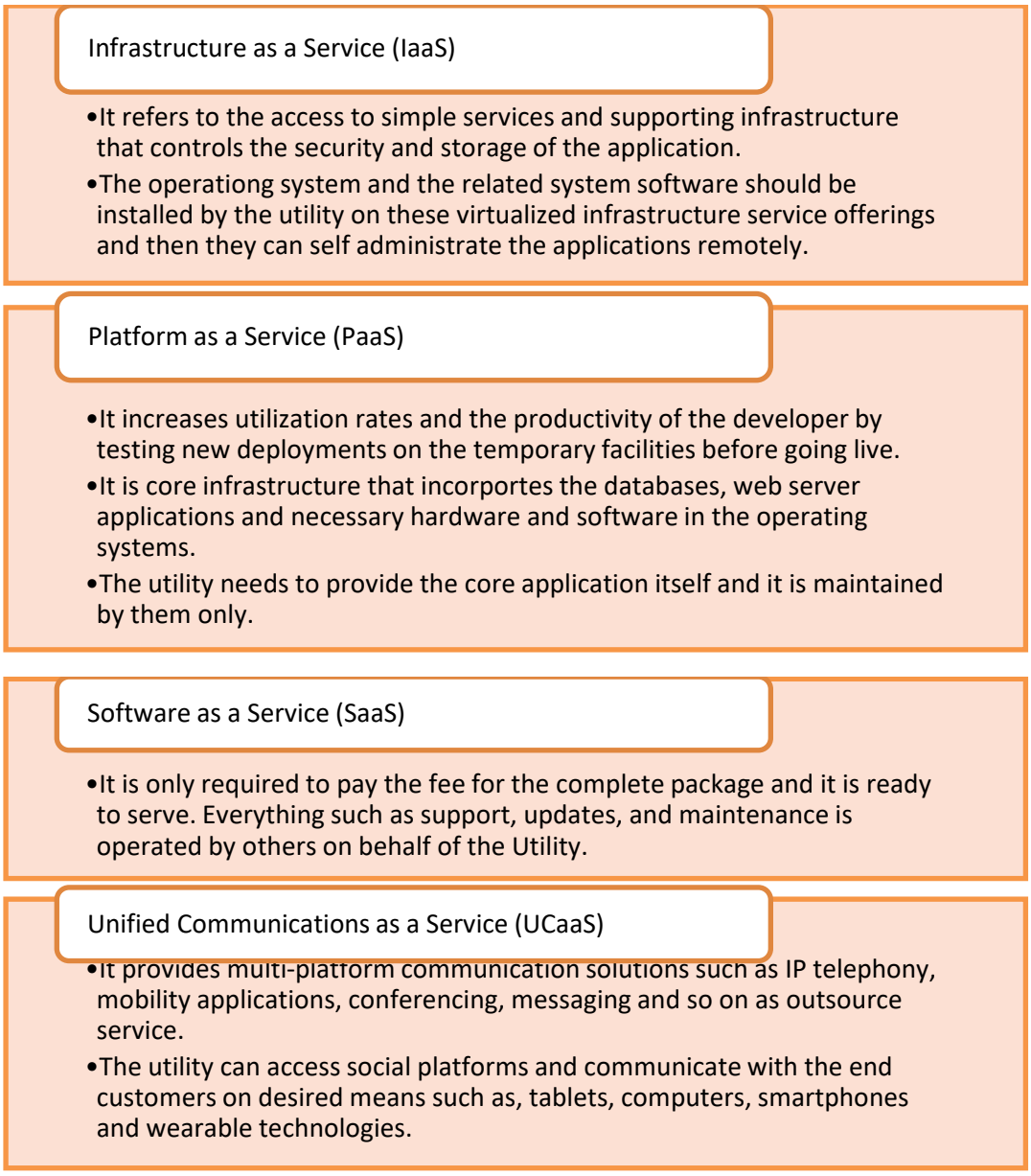

Fig. 2.3.7: Packages in the IBM cloud

- Also, explain how data management is done in cloud platforms.
- Tell them about wireless sensor nodes and its components. The following figure shows the components of a wireless sensor node:

Fig 2.3.8: Components of a wireless sensor nodes

- Tell them that there are different types of sensors as shown in the following figure:

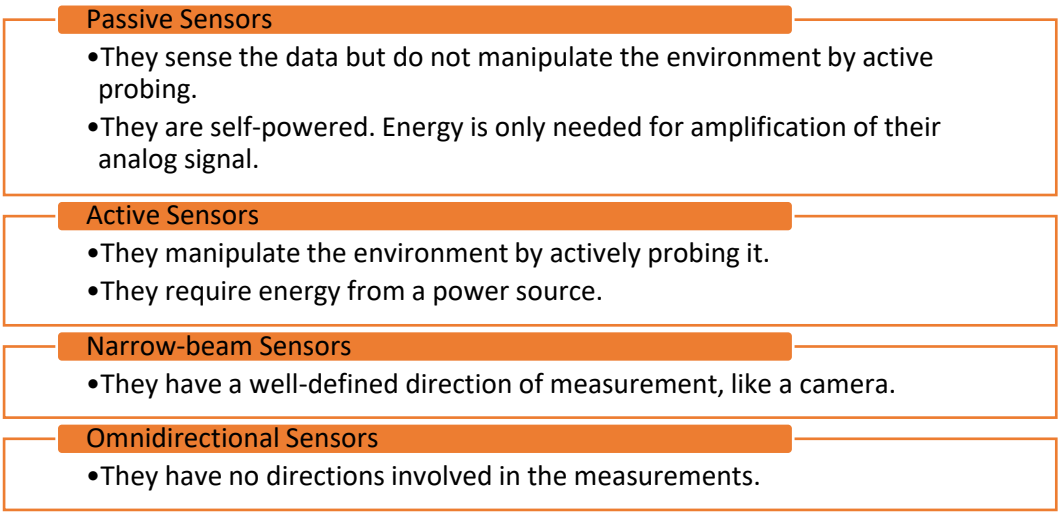

Fig. 2.3.9: Types of sensors

- Briefly, tell them about different sensor channel settings, such as the following:
  - Name
  - Unit ID
  - Rendering
  - Line colour
  - Limits
  - Error and warning messages
- Lastly, tell them about sensor connectivity and various communication technologies used to connect the sensors to the network.
- Also, tell them about the following protocols used by the IoT framework:
  - HTTP
  - MQTT
  - CoAP.
- Exercise Handling Strategy:
  - Randomly choose participants to answer the given questions.
  - Then, give the solutions and ask the participants to check if they had given the right answers.
  - Different types of communication channels are:
    - Point-to-Point
    - Point-to-Multipoint
    - Multiple Access
    - Relay
    - Interference
    - Unicast
    - Broadcast
    - Multicast

- WSN: In a wireless sensor network (WSN), various sensor nodes are connected. The structure of a sensor node consists of a controller, a transceiver, external memory, power source and sensors. The applications areas are health care monitoring, area monitoring, Earth sensing, forest fire detection and so on.
- Ask the participants to fill the details in the table one by one:

	Range	Bandwidth	Battery Life
PAN	Short	Narrow	Long
LAN	Intermediate	Broad	Short
WAN	Long	Intermediate/Broad	Intermediate
Wired Network	Long	Intermediate	Short

UNIT 2.4: Establishing Ethernet Connectivity

Unit Objectives

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

- Identify the connectivity options
- Describe how to configure network setting
- List the steps of crimping
- Execute the establishment of Ethernet connection

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions and ask the participants if they have any doubts.

Explain

- Explain various Ethernet connectivity options.

Notes for Facilitation

- Start the session by asking the participants some questions related to previous sessions.
- Tell them about the characteristics of Ethernet connectivity.
- Also, tell them the different types of Ethernet.
- Tell them that the Institute for Electrical and Electronic Engineers (IEEE) developed an Ethernet standard known as IEEE Standard 802.3. The standard outlines configuration rules of an Ethernet network. It mentions interaction between the network and the elements of Ethernet. Abiding by standards of IEEE, network protocols and equipment communicate efficiently.
- In addition, tell them the speed of different types of Ethernet:
  - Fast Ethernet (speed limit range 10 - 100 Mbps)
  - Gigabyte Ethernet (10 times faster than 100Base-T)
  - 10 Gigabyte Ethernet (speed limit 10Gbps)
- Also, tell them about different types of cables needed for various Ethernet connections.
- Explain to them what the letters and numbers in the different types of Ethernet actually mean.

- Show them the following figure which shows the coding of the Ethernet options:

10	at the beginning means the network operates at 10Mbps.
BASE	means the type of signaling used is baseband.
2 or 5	at the end indicates the maximum cable length in meters.
T	the end stands for twisted-pair cable.
X	at the end stands for full duplex-capable cable.
FL	at the end stands for fiber optic cable.

Fig. 2.4.1: Coding of Ethernet options

- Introduce various WLAN standards to them that are as follows:
  - 802.11
  - 802.11a
  - 802.11b
  - 802.11g
  - 802.11n.
- Explain the standards one by one.
- Also, tell them that real-world speeds of Ethernet wired network are very close to the theoretical speeds.
- In addition, tell them, 100BASE-T wired networks offer reliable and consistent data-rates when the cable length is less than 100 metres.
- Further, inform them that, in real life applications, Wi-Fi 802.11n standard achieves the rate of 60 Mbps, which is less than 1/10 of its Gross rate.
- Tell them that the interference and the speed of the home Wi-Fi network depends on the number of Wi-Fi-enabled IOT devices.
- Further, tell them that in a home IOT environment, when Wi-Fi (802.11n, 2.4GHz) is compared to wired 100BASE-T, the latter one provides more speed, reliability and security.
- Tell them that Orthogonal Frequency Division Multiplexing (OFDM) means breaking up information signals to numerous sub-signals that are slower and shifted by different frequencies at the same time.
- Explain to them about the steps of connecting a device through wired Ethernet connection.
- Tell them that to prepare the cable for the connection, stripping of wires and crimping is required.
- Tell them about the process of crimping.
- Also, tell them the steps of preparing an RJ-45 cable.
- Explain the steps of connecting a wired device via a wired Ethernet connection.
- Further, tell them the process of configuring the network settings.

- Tell them that for configuring the network settings, the following information is needed:

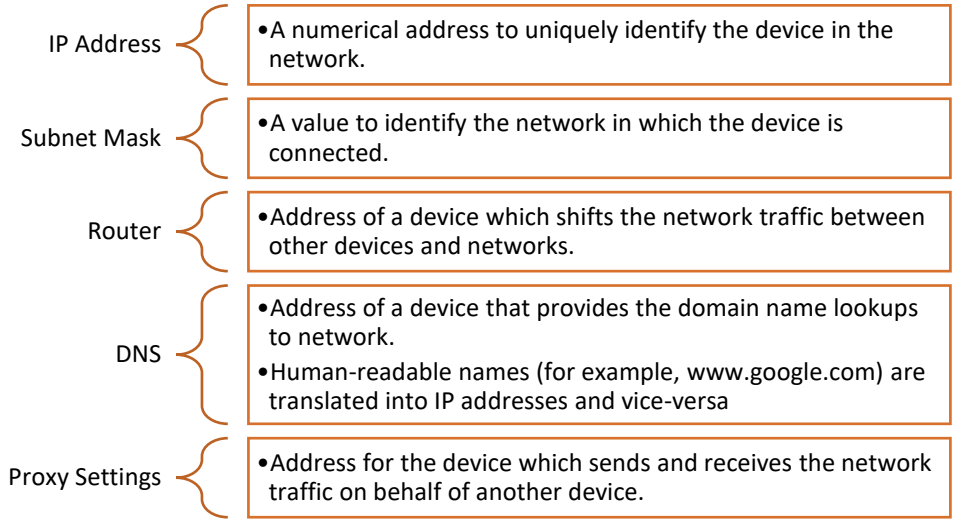

Fig. 2.4.2: Information needed for network settings

- Tell them about the challenges of Ethernet connectivity.
- Also, tell them, how to overcome the challenges.
- Exercise Handling Strategy:
  - Ask the participants to write the answers in their notebook.
  - Tell the answers and tell them to match their answers.
  - The answers are:
    - IP Address: A numerical address to uniquely identify the device in the network.
    - Subnet Mask: A value to identify the network in which the device is connected.
    - Router: Address of a device which shifts the network traffic between other devices and networks.
    - Proxy Settings: Address for the device which sends and receives the network traffic on behalf of another device.
  - Answer for the 2nd question;

Advantages of wireless connection over wired one
▪ Users can move around freely within the area of the network with their devices. ▪ Devices are not required to be cabled to a port for the connection. ▪ No cabling is needed, so cost of cabling is nil. ▪ Wireless networks can handle a large number of users as they are not limited by a specific number of connection ports.

Disadvantages of wireless connection over wired one
▪ It can require extra costs and equipment to set up. ▪ Setting up a wireless network may not seem easier to the people who are not experienced with computers. ▪ File-sharing transfer speeds are normally slower as compared to wired network. • Connections may get hampered by obstacles in between the connected devices and the network device. • Wireless networks are less secure. If they is not secured with a password, anyone in the range can access them.

UNIT 2.5: Authentication and Access Control Mechanism

Unit Objectives

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

- Identify the importance of authentication and authorization in IoT
- Explain access control system.
- Identify the software interface characteristics.
- List different software available for access control management.
- Describe how to secure wireless connection
- Describe malware and distributed denial of services (DDoS) attacks

Resources to be Used

- Available objects such as a duster, pen, notebook and soon

Do

- Revise the learning of the previous sessions and ask the participants if they have any doubts.

Explain

- Explain authentication and authorization and the importance of the two.
- Explain access control system architecture.
- Explain different access control software.

Notes for Facilitation

- Start the session by telling the participants that IoT is the future; it will be built to control everything from as insignificant as a thermostat to something as significant as a self-drive car. As the sheer number of IoT devices explodes in the business systems, companies /enterprises are becoming more vulnerable to cyber-attacks.
- Introduce the participants to authentication and authorization.
- Tell them that authentication is the process of proving the identity of a requester.
- Tell them that traditional security measures like firewalls and antimalware software are just not enough to protect this data, and they may not apply here. It is, therefore, vital to safeguard the collected data and IT professionals are more aware than ever before of the security risks surrounding the processing of data from the edge devices.
- Also, explain authentication with an example that, when a person logs in to a software after giving the username and password, it is authentication.

- Further, tell them that, for a biometric lock, a person puts his/her fingerprint on the system to enter into the room for which the lock is placed.
- Tell them that authorization is a process that verifies that a person has the specific access rights to a resource he/she has requested to use.
- Also, tell them that, for the biometric lock, the access is granted to the person, if he is authorised to it. Otherwise, the access is denied.
- Tell them why authentication and authorization process are important for the IoT devices.
- Explain how edge devices are authenticated.
- Also, tell them about the important points for securing the edge devices.
- Tell them that all the devices are connected through wireless networks to a mobile application or management software. The applications may be configured for the operations of various locks and controllers.
- Further, explain to them about the security challenges in authentication.
- In case of IoT, access control is needed to ensure that only authorized and trusted parties can:
  - access sensor data
  - update device software
- Explain that sensors command the actuators for performing any operation. Explain access control and how it works with the help of the following figure:

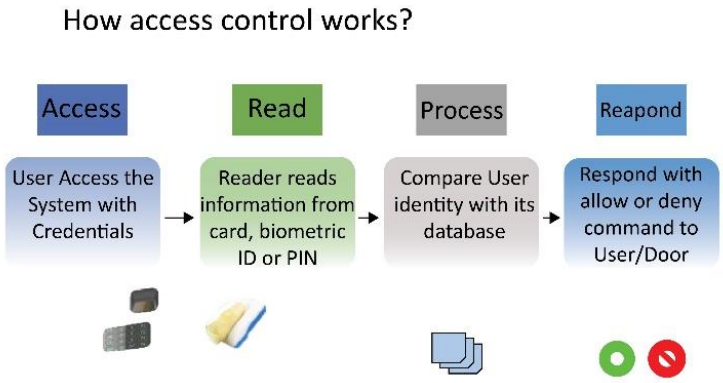

Fig 2.5.1: Working of access control system

- Tell them about the access control system architecture that can be of two types as follows:
  - Centralized
  - Distributed
- Explain the common features of access control systems.
- Also, tell them about the following tools and software available in the market:
  - Courion Access Assurance Suite
  - Oracle Identity Governance Suite
  - RSA Identity Management and Governance
  - SailPoint IdentityIQ
  - Identicard Access Control.
- Some other examples of access control system are as follows:
  - S2 Security Access Control
  - Salto Access Control

- Isonas Pure IP Access Control
- Bosch Access Control Systems
- ADT Access Control
- Kisi Access Control

- Explain the features of the third-party access control software one by one.
- Tell them that there are a lot of identity and access management (IAM) software available in the market. The common features of an access control solution are shown in the following figure:

The solution has the capability to address the security of IoT related data, including privacy invasion or damage to physical property. It should offer adaptive authentication, end-to-end data encryption, DOS /overload detection and so on for providing the security capabilities required for the advancement of IoT.

The solution supports adaptive authentication offering the organizations to modify the level of authentication for different devices and people.

The solutions may allow customers to self-manage the preferences such as granting their consent for sharing data and setting notification alerts.

It provides back up option to assure maximum security in case of a server hardware failure.

The interface may allow the monitors and the security cameras to be associated with selected alarms. In case of activation of the alarm, these provide real time video of the alarm occurrence.

It offers storage capabilities and reporting facilities for long-term events.

The solution may offer an optional feature for displaying messages when a request for access is made.

It should offer the operators to run a report for viewing the changes made to the records.

Fig. 2.5.2: Common features of an access control solution

- Tell them about the steps to be followed for installing the required software interface in the controlling device.
- Further, tell them how the wireless connection is secured by changing the configuration and settings.
- Tell them about malware and DDoS attacks.
- Tell them that malware is an inclusive term for all types of malicious software, such as viruses – programs that copy themselves throughout a computer or network.

- Tell them that the most common malwares which target the embedded devices are as follows:
  - Linux.Darlloz (aka Zollard)
  - Linux.Aidra / Linux.Lightaidra
  - Linux.Xorddos (aka XOR.DDos)
  - Linux.Gafgyt (aka GayFgt, Bashlite)
  - Linux.Ballpit (aka LizardStresser)
  - Linux.Moose
  - Linux.Dofloo (aka AES.DDoS, Mr. Black)
  - Linux.Pinscan / Linux.Pinscan.B (aka PNScan)
- Also, tell them about the symptoms that indicate a device is malware affected.
- Lastly, tell about the steps to detect the DDoS attack in a system.
- Exercise Handling Strategy:
  - Ask the participants to write the answers in their notebook.
  - Tell the answers and ask them to match their answers.
  - Some symptoms that indicate the device is malware affected, are:
    - The system is slowing down or crashes.
    - Annoying advertisements or unusual error messages are displayed.
    - Pop-up messages and unusual messages show unexpectedly.
    - There is increase in the Internet traffic.
    - The browser homepage changes and the security solution is disabled.
    - Control panel cannot be accessed.
    - Unfamiliar icons are visible on the desktop.
  - Tell that the steps depend on the type of the access control system. The steps of installing an access control system in an office place are:
    - Install the software and open it.
    - Edit the controller settings by entering the network details and product details.
    - Edit the device or machine settings.
    - Create the time zone settings as per requirement.
    - Fill the employee records.
    - Click on a row to create or update the employee details.
    - Connect the device and select the time zone and upload it to the machine.
    - Upload the user rights to the device.
    - Generate report.
  - Practical solution:

    Install a BMP280 temperature and pressure sensor on an Arduino.
    1. Connect the VCC to 3.3V, GND to GND, SCL to A5, and SDA to A4BMP280 pins to the Arduino respectively.
    2. Connect the Arduino to a PC.
    3. To begin reading sensor data, download Adafruit_BMP280 libraries.
    4. Download the following libraries:
       - Adafruit Unified Sensors
       - Adafruit BMP 280 Library

5. Place the above downloaded libraries in the *Arduino>Libraries folder*.
6. Restart the IDE

- Practical solution:

  Check the power supply connectivity to an IoT camera installed.

  1. Check the power usage of camera and use the AC-DC adaptor as per the camera power usage.
  2. Check the master module.
  3. Check the working of all the fuses in the master module.
  4. Check the polarity of the wiring as per the screw terminals in the master module.
  5. Ensure that right power channel is used for camera.
  6. Check the distance of camera from the power source.

- Practical solution:

  Install a Viconics Wireless Gateway (VWG) and related wireless controllers, ensuring clear line of sight.

  1. Mount the VWG in a location that allows clearance for wiring, servicing, and antenna removal.
  2. Press in the four tabs on both ends of the unit and lift the VWG cover off.
  3. Remove the cover to connect the new battery unit.
  4. Make sure minimum spacing distance requirements is available to freely rotate wireless antenna in all possible orientations.
  5. Connect earth-grounding wire with spade connector from the earth ground lug on the VWG.
  6. Use an earth ground spade lug (0.187") on the base of the VWG for connection to earth ground.
  7. Prepare power wiring (leave the unit powered off). Only VWG-PS-DC and VWG-PS-AC power supply with factory installed ferrite on the power cord can be used with the VWG.
  8. Connect communications wiring.
  9. Connect communications wiring to the VWG using either Net1, Net2 or the RS-485 connection based on VWG model used and configuration.
  10. For ports on any installed option board (LON, RS-485, modem) see the specific mounting and wiring guide for any additional details.
  11. Connect the backup battery to the VWG battery connector and apply power to the unit.

- Practical solution:

  Connect Raspberry Pi to another device through wired Ethernet.

  Connecting Raspberry Pi to laptop:

  1. Plug in the SD card with Raspbian OS inside a card reader.
  2. Connect the card reader to the laptop.
  3. Before powering on the Raspberry Pi turn on Internet connection sharing option from the laptop.
  4. Power up the Raspberry Pi.
  5. Plugin RJ45 cable to the laptop and connect it with Raspberry Pi.

6. Open the network setting window.
7. Click on the new network that appears on the network setting window.
8. Open the properties on this new network.
9. Open IP version 4 option and check the IP address allotted to the Pi.
10. Open the SD card connected to the Raspberry Pi from file explorer window.
11. Inside the boot folder, create a file named ssh from command prompt using command
    echo>(Directory name of SD card)>ssh
12. Remove the card reader and eject the SD card from it.
13. Plug in the SD card inside the Raspberry Pi.
14. Restart the Raspberry Pi.

UNIT 2.6: Mounting Devices at Desired Locations

Unit Objectives

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

1. Explain the steps for surface preparation while mounting devices
2. Identify the correct distance between the devices
3. Describe signal and power loss during inter-device communication
4. Evaluate the resource consumption of the set-up
5. Identify the correct set of sources for power and other utilities

Notes for Facilitation

- Tell the participants that the IoT devices should be mounted on a levelled surface. Hence, surface preparation is needed first for the mounting process.
- The next step is to mark the location and drill the surface to mount the device.
- Briefly, explain the steps of mounting a motion detector and a camera.
- In addition, tell them that a motion sensor can be mounted on the wall in the following ways:
  - Using rear cover to mount the sensor against the wall
  - Using wall mounting adaptor to mount the sensor in such a way that it faces 45° to its left or right
  - The following figure shows the two methods:

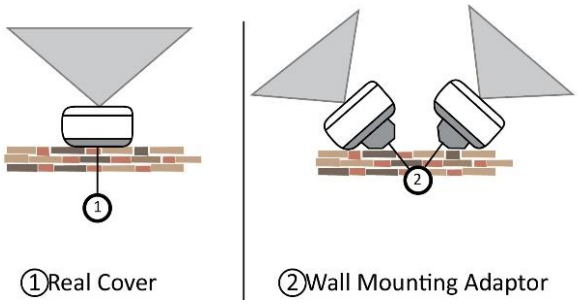

Fig 3.2.1: Methods of wall mounting of a motion sensor

- Further, tell them the steps of mounting using rear cover:
  - Press the upper sides of the rear cover and slide it down to remove the cover. The following figure shows the removing of the rear cover:

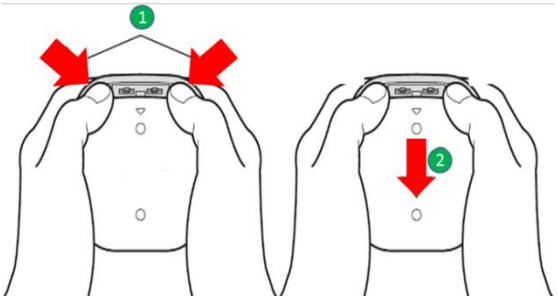

Fig 3.2.2: Removing of the rear cover

- Place the cover with “UP” mark facing upwards and fix it on the wall using screws as shown in the following figure:

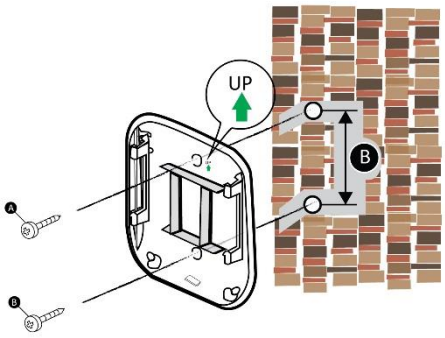

Fig 3.2.3: Fixing of the rear cover

- Attach the sensor to the rear cover by inserting its grooves on the rear cover, and pushing it down, as shown in the following figure:

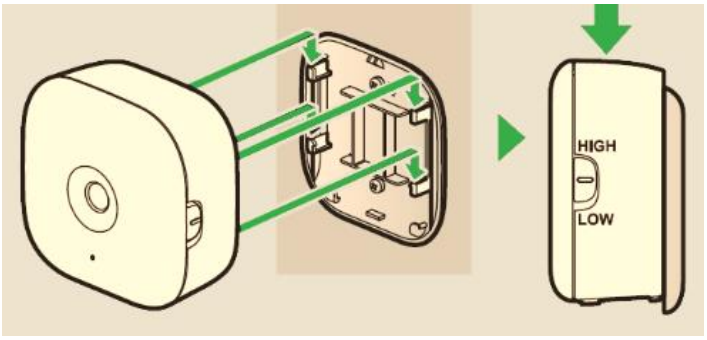

Fig 3.2.4: Attaching the sensor to the rear cover

- Also, tell them the steps of mounting using an adapter:
  - Press the upper sides of the rear cover and slide it down to remove the cover. The following figure shows the removing of the rear cover:

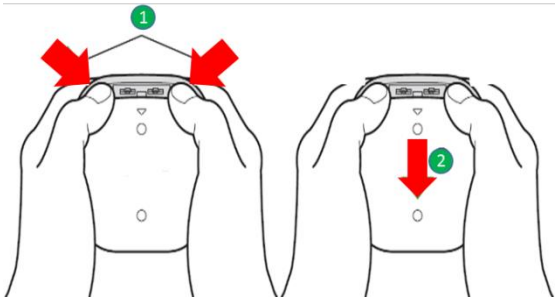

Fig 3.2.5: Removing of the rear cover

- Place the wall mounting adaptor with "UP" mark facing upwards and fix it on the wall using screws as shown in the following figure:

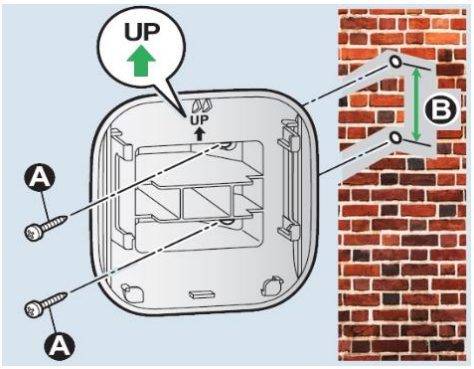

Fig 3.2.6: Attaching the wall mounting adaptor

- Attach the sensor to the adaptor by inserting its grooves on it, and pushing it down, as shown in the following figure:

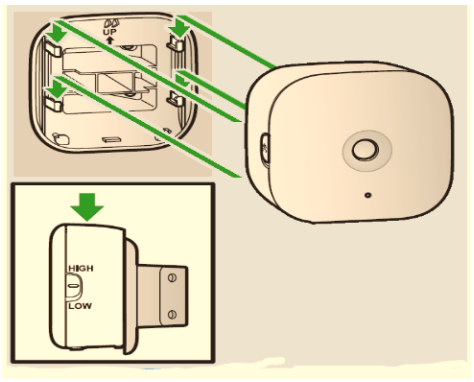

Fig 3.2.7: Attaching the sensor to the adapter

- Inform the participants that they should remember the following points to mount the sensor:
  - Mount the motion sensor on the stable location where the motion sensor can be adequately supported when mounting.
  - Do not mount motion sensor on a soft material. It may fall down, break or cause injury.
  - Do not mount the motion sensor on surfaces such as gypsum board, an autoclaved lightweight cellular concrete (ALC), a concrete block, a plywood less than 25.4 mm (1 inch) thick and so on.
- Tell them about the distance between the network devices and the nodes.
- Also, explain the line of sight with an example.
- Explain the various factors which need to be considered for establishing a network connection with the help of the following figure:

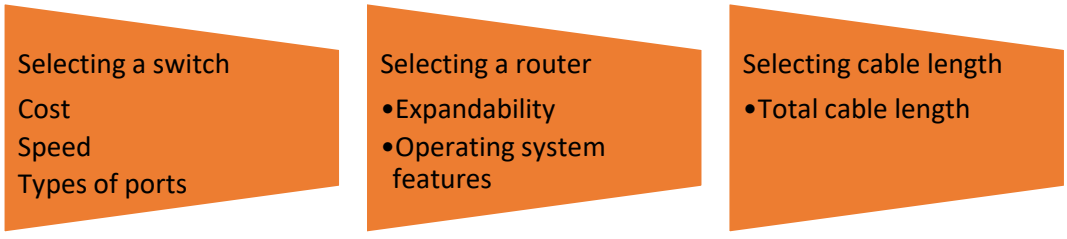

Fig 3.2.8: Factors to be considered for establishing the network connection

- Tell them that a glass surface does not affect the signal strength so much. The receiver of the signal needs to be attached to a window in line-of-sight to the camera through a glass surface.
- Explain to them about Wireless Signal Restriction: The preferred network as per the operating area of the IoT set up can be chosen on the basis as follows:
  - Personal Area Network (PAN): Few meters (within a room, home)
  - Local Area Network (LAN): Less than 1 km (intra–floor, building)
  - Campus Area Network (CAN): Between 5 to 10 kms (within a campus)
  - Metropolitan Area Network (MAN): Within 10 km (within a city)
  - Wide Area Network (WAN): The network range is greater than 10 kms (inter-city, inter-national, inter-continental).
- Further, explain to them the steps to be taken care of while connecting the cables in an IoT framework.
- Tell them about the safety rules for connecting the power cables to the device and wiring of an RGB cable.
- Tell them that while connecting the power cables to the device they must ensure the following points:
  - Take the power cord and check that the plug connections are properly done.
  - Wear the ESD strap and connect it to the ground.
  - Insert the coupler end of the device's power cord into the power supply input on the device.
  - Insert the power cord plug to the power supply outlet near the installation location.
  - Secure the power cord by using a retainer clip.
  - Ensure that the power cord is not hanging so that people do not trip.
  - Make sure the connections are tight.
  - Turn on the power supply and check the indication through the light.
- Tell them about signal and power loss that occurs during inter-device communication.
- Exercise Handling Strategy:
  - Write down the factors which needs to be considered while:
    - Selecting Switch:
      - Cost of Switch: As switch cost depends upon the number of ports, select a switch with appropriate number of ports.
      - Speed and Type of Ports: Choose a switch as per the requirement of speed and types of ports in the set-up which needs to be installed.
    - Selecting Router:
      - Expandability: While selecting a router, the number of devices to be connected in the entire network with the router should be checked. This will help in selecting the optimum router.
      - Operating System Features: Based on the type of security level, quality of service and the routing layer protocol, the router is chosen as per the best suitable version of router configuration for the network.

- Selecting Cable Length:
  - Total Cable Length: Cabling distance is a significant factor for loss of signal. So as per the suitable cabling distance, different types of cables are provided to avoid signal loss.

- Write down the points needs to be considered while choosing distance between network devices.
  - Physical Obstructions: In wireless signal set up, physical objects such as walls, buildings and other objects create hindrance in the wireless network. So the wireless device should be kept at a spot where the wireless signals cannot be obstructed.
  - Network Range and Distance between Devices: The network strength between the network devices drops by an inverse cube of the distance between the devices.

UNIT 2.7: Performing Checks and Connections

Unit Objectives

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

- Explain the connectivity between the devices
- Describe preparation of devices for transmission of data
- Explain power supply selection and grounding
- Identify post commissioning checks

Ask

- Enquire from the participants if they have any doubts from the previous sessions.
- Ask them if they can tell about Earthing.

Notes for Facilitation

- Tell the participants that they should ensure proper connectivity between the devices. Also, tell them about the steps for checking the connections.
- Tell them about the importance of grounding a device.
- Also, inform them how to select the power supply according to the power requirements and perform grounding of an electrical connection.
- Tell them about the basic steps for setting up IoT data transmission.
- Lastly, tell them about the various aspects of checking the connectivity between the IoT devices.
- Also, tell them about different types of testing for an IoT framework as shown in the following figure:

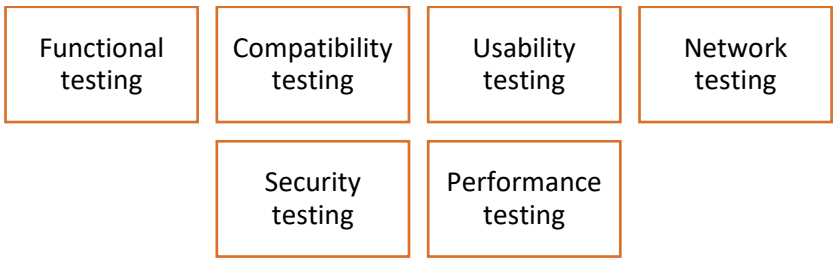

Fig 3.3.1: Different types of testing for an IoT framework

- Exercise Handling Strategy:
  - Randomly choose one of the participants to answer the following questions.
  - The purpose and importance of earthing is to:
    - Fix the potential of active conductors with respect to the earth
    - Limit the voltage in electrical system between non-current carrying parts and earth
    - Remove risk of electric shocks by implementing protection devices
    - Limit rise in potential because of medium voltage faults in network with low voltage

- Answer of the 2nd question:
  - Components validation
    - Device hardware
    - Embedded software
    - Network connectivity
  - Function validation
    - Interaction between devices
    - Basic device testing
  - Performance validation
    - Device performance
    - Data transmit frequency
  - Security and data validation
    - Validate data packets
    - Data encryption/decryption
- Answer of the 3rd question:
  - Create a checklist for tests performed in testing IoT setup.
    - Functional testing: This test is done to check whether the device is working as per the requirement of the customer, based on the inputs given.
    - Compatibility testing: In this, the version and compatibility between the devices are checked to make sure that they work well together. The protocols and versions of hardware and software of the device are checked.
    - Usability testing: This is done to check whether the customer can use the IoT devices and understand the controls. This includes usefulness, text and appeal of the controls.
    - Network testing: This test needs to be done to check whether all the network connections between the devices are working as required. There should be no log and the devices should perform in sync.
    - Security testing: This test is done to check the security of the network set up and data encryption. This performs verification and authentication of the data and verifies the same to follow security protocols.
    - Performance testing: After completing all the tests, the technician needs to perform a performance test of the setup. The working and functioning of the entire set up is checked to ensure that it is working as per the desired outcome and following all the protocols.

- Practical solution:

  Test the speed of 3 Wire Speed Sensors using a multimeter.

  1. Provide power and ground to the sensor by connecting power and ground wire to it.
  2. Set the multimeter on DC voltage
  3. Take the red probe from multimeter and hook it to signal output wire of the sensor.
  4. Connect the black probe (ground) of the multimeter to a common ground.
  5. Now check the source and open voltage from the multimeter.

- Practical solution:
  Mount a security camera system and connect it to the monitor and the DVR. Also, perform Earthing connection of the same.
  1. Inspect the area where the camera needs to be mounted.
  2. Mark a hole for the camera's cable feed through and three holes for the camera's mounting screws.
  3. Run cable to each of the camera locations.
  4. Connect the camera to system ground.
  5. Connect one end of the cable to camera and another end to DVR box.
  6. Install the camera.
  7. Connect the Ethernet cable to the camera.
  8. Set up the user interface.

UNIT 2.6: Mounting Devices at Desired Locations

Unit Objectives

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

1. Explain the steps for surface preparation while mounting devices
2. Identify the correct distance between the devices
3. Describe signal and power loss during inter-device communication
4. Evaluate the resource consumption of the set-up
5. Identify the correct set of sources for power and other utilities

Notes for Facilitation

- Tell the participants that the IoT devices should be mounted on a levelled surface. Hence, surface preparation is needed first for the mounting process.
- The next step is to mark the location and drill the surface to mount the device.
- Briefly, explain the steps of mounting a motion detector and a camera.
- In addition, tell them that a motion sensor can be mounted on the wall in the following ways:
  - Using rear cover to mount the sensor against the wall
  - Using wall mounting adaptor to mount the sensor in such a way that it faces 45° to its left or right
  - The following figure shows the two methods:

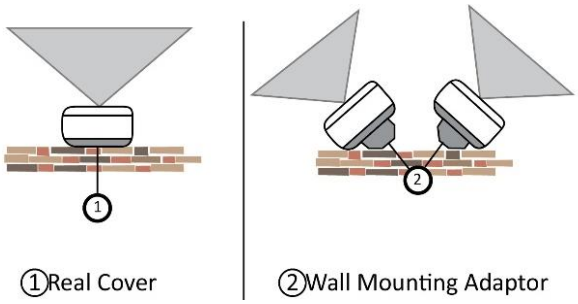

Fig 3.2.1: Methods of wall mounting of a motion sensor

- Further, tell them the steps of mounting using rear cover:
  - Press the upper sides of the rear cover and slide it down to remove the cover. The following figure shows the removing of the rear cover:

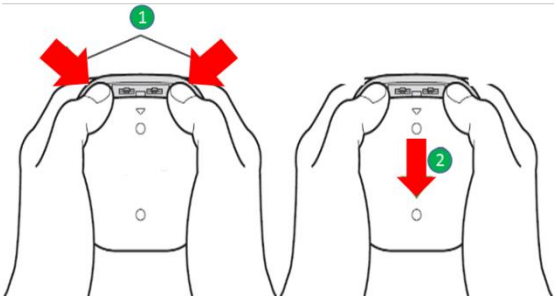

Fig 3.2.2: Removing of the rear cover

- Place the cover with “UP” mark facing upwards and fix it on the wall using screws as shown in the following figure:

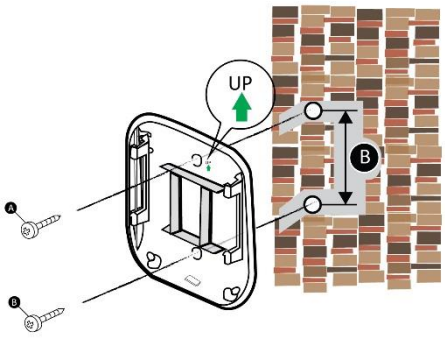

Fig 3.2.3: Fixing of the rear cover

- Attach the sensor to the rear cover by inserting its grooves on the rear cover, and pushing it down, as shown in the following figure:

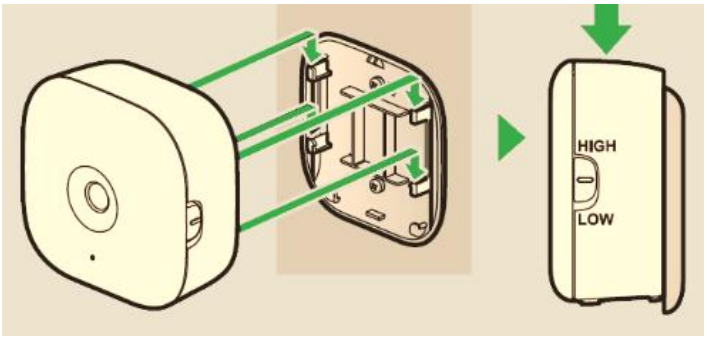

Fig 3.2.4: Attaching the sensor to the rear cover

- Also, tell them the steps of mounting using an adapter:
  - Press the upper sides of the rear cover and slide it down to remove the cover. The following figure shows the removing of the rear cover:

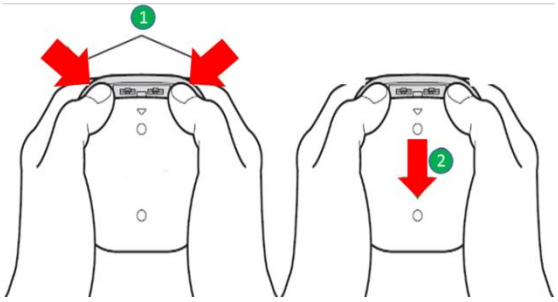

Fig 3.2.5: Removing of the rear cover

- Place the wall mounting adaptor with "UP" mark facing upwards and fix it on the wall using screws as shown in the following figure:

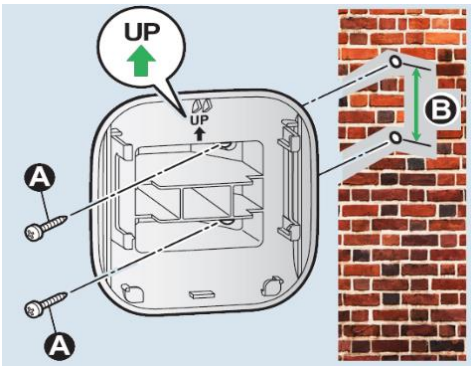

Fig 3.2.6: Attaching the wall mounting adaptor

- Attach the sensor to the adaptor by inserting its grooves on it, and pushing it down, as shown in the following figure:

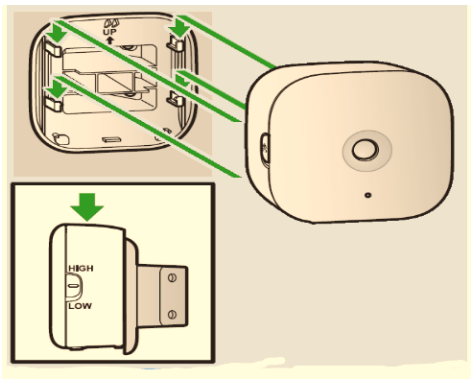

Fig 3.2.7: Attaching the sensor to the adapter

- Inform the participants that they should remember the following points to mount the sensor:
  - Mount the motion sensor on the stable location where the motion sensor can be adequately supported when mounting.
  - Do not mount motion sensor on a soft material. It may fall down, break or cause injury.
  - Do not mount the motion sensor on surfaces such as gypsum board, an autoclaved lightweight cellular concrete (ALC), a concrete block, a plywood less than 25.4 mm (1 inch) thick and so on.
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- Also, explain the line of sight with an example.
- Explain the various factors which need to be considered for establishing a network connection with the help of the following figure:

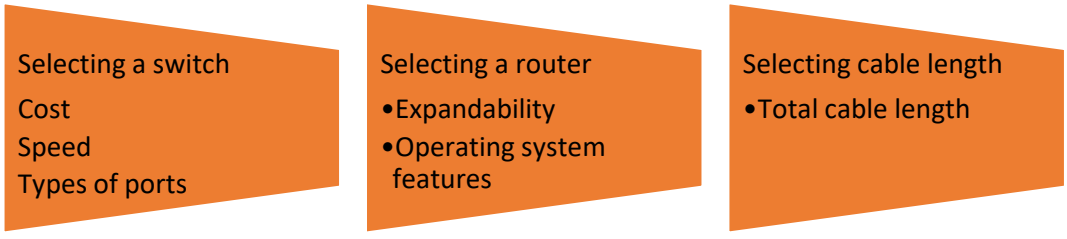

Fig 3.2.8: Factors to be considered for establishing the network connection

- Tell them that a glass surface does not affect the signal strength so much. The receiver of the signal needs to be attached to a window in line-of-sight to the camera through a glass surface.
- Explain to them about Wireless Signal Restriction: The preferred network as per the operating area of the IoT set up can be chosen on the basis as follows:
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  - Local Area Network (LAN): Less than 1 km (intra–floor, building)
  - Campus Area Network (CAN): Between 5 to 10 kms (within a campus)
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- Further, explain to them the steps to be taken care of while connecting the cables in an IoT framework.
- Tell them about the safety rules for connecting the power cables to the device and wiring of an RGB cable.
- Tell them that while connecting the power cables to the device they must ensure the following points:
  - Take the power cord and check that the plug connections are properly done.
  - Wear the ESD strap and connect it to the ground.
  - Insert the coupler end of the device's power cord into the power supply input on the device.
  - Insert the power cord plug to the power supply outlet near the installation location.
  - Secure the power cord by using a retainer clip.
  - Ensure that the power cord is not hanging so that people do not trip.
  - Make sure the connections are tight.
  - Turn on the power supply and check the indication through the light.
- Tell them about signal and power loss that occurs during inter-device communication.
- Exercise Handling Strategy:
  - Write down the factors which needs to be considered while:
    - Selecting Switch:
      - Cost of Switch: As switch cost depends upon the number of ports, select a switch with appropriate number of ports.
      - Speed and Type of Ports: Choose a switch as per the requirement of speed and types of ports in the set-up which needs to be installed.
    - Selecting Router:
      - Expandability: While selecting a router, the number of devices to be connected in the entire network with the router should be checked. This will help in selecting the optimum router.
      - Operating System Features: Based on the type of security level, quality of service and the routing layer protocol, the router is chosen as per the best suitable version of router configuration for the network.

- Selecting Cable Length:
  - Total Cable Length: Cabling distance is a significant factor for loss of signal. So as per the suitable cabling distance, different types of cables are provided to avoid signal loss.

- Write down the points needs to be considered while choosing distance between network devices.
  - Physical Obstructions: In wireless signal set up, physical objects such as walls, buildings and other objects create hindrance in the wireless network. So the wireless device should be kept at a spot where the wireless signals cannot be obstructed.
  - Network Range and Distance between Devices: The network strength between the network devices drops by an inverse cube of the distance between the devices.

UNIT 2.7: Performing Checks and Connections

Unit Objectives

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

- Explain the connectivity between the devices
- Describe preparation of devices for transmission of data
- Explain power supply selection and grounding
- Identify post commissioning checks

Ask

- Enquire from the participants if they have any doubts from the previous sessions.
- Ask them if they can tell about Earthing.

Notes for Facilitation

- Tell the participants that they should ensure proper connectivity between the devices. Also, tell them about the steps for checking the connections.
- Tell them about the importance of grounding a device.
- Also, inform them how to select the power supply according to the power requirements and perform grounding of an electrical connection.
- Tell them about the basic steps for setting up IoT data transmission.
- Lastly, tell them about the various aspects of checking the connectivity between the IoT devices.
- Also, tell them about different types of testing for an IoT framework as shown in the following figure:

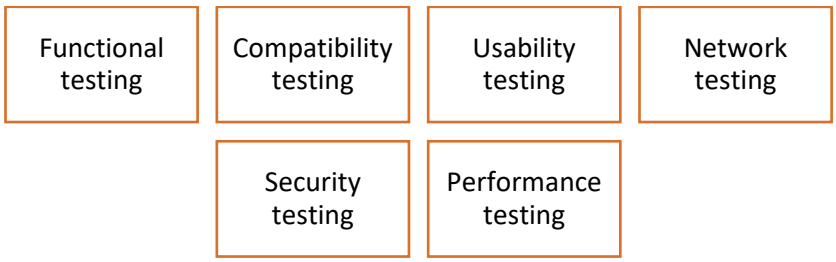


Fig 3.3.1: Different types of testing for an IoT framework

- Exercise Handling Strategy:
  - Randomly choose one of the participants to answer the following questions.
  - The purpose and importance of earthing is to:
    - Fix the potential of active conductors with respect to the earth
    - Limit the voltage in electrical system between non-current carrying parts and earth
    - Remove risk of electric shocks by implementing protection devices
    - Limit rise in potential because of medium voltage faults in network with low voltage

- Answer of the 2nd question:
  - Components validation
    - Device hardware
    - Embedded software
    - Network connectivity
  - Function validation
    - Interaction between devices
    - Basic device testing
  - Performance validation
    - Device performance
    - Data transmit frequency
  - Security and data validation
    - Validate data packets
    - Data encryption/decryption
- Answer of the 3rd question:
  - Create a checklist for tests performed in testing IoT setup.
    - Functional testing: This test is done to check whether the device is working as per the requirement of the customer, based on the inputs given.
    - Compatibility testing: In this, the version and compatibility between the devices are checked to make sure that they work well together. The protocols and versions of hardware and software of the device are checked.
    - Usability testing: This is done to check whether the customer can use the IoT devices and understand the controls. This includes usefulness, text and appeal of the controls.
    - Network testing: This test needs to be done to check whether all the network connections between the devices are working as required. There should be no log and the devices should perform in sync.
    - Security testing: This test is done to check the security of the network set up and data encryption. This performs verification and authentication of the data and verifies the same to follow security protocols.
    - Performance testing: After completing all the tests, the technician needs to perform a performance test of the setup. The working and functioning of the entire set up is checked to ensure that it is working as per the desired outcome and following all the protocols.

- Practical solution:

  Test the speed of 3 Wire Speed Sensors using a multimeter.

  1. Provide power and ground to the sensor by connecting power and ground wire to it.
  2. Set the multimeter on DC voltage
  3. Take the red probe from multimeter and hook it to signal output wire of the sensor.
  4. Connect the black probe (ground) of the multimeter to a common ground.
  5. Now check the source and open voltage from the multimeter.

- Practical solution:
  Mount a security camera system and connect it to the monitor and the DVR. Also, perform Earthing connection of the same.
  1. Inspect the area where the camera needs to be mounted.
  2. Mark a hole for the camera's cable feed through and three holes for the camera's mounting screws.
  3. Run cable to each of the camera locations.
  4. Connect the camera to system ground.
  5. Connect one end of the cable to camera and another end to DVR box.
  6. Install the camera.
  7. Connect the Ethernet cable to the camera.
  8. Set up the user interface.

UNIT 2.8: Connecting Microcontroller Boards for Data Transfer

Unit Objectives

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

- Identify the connectivity points in Arduino and Raspberry pi
- List the connectivity options available for microcontroller

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions and ask them if they have any doubts.

Ask

- Ask the participants if they can tell the differences between a microcontroller and a microprocessor.
- Ask them if they can remember the connectivity ports of an Arduino board.

Explain

- Explain the connectivity ports on the Arduino and Raspberry Pi boards.
- Explain different connectivity options for the microcontroller boards.

Notes for Facilitation

- Start the session by asking the participants the difference between microprocessors and microcontrollers.
- Tell them that a microprocessor is a standalone central processing unit which functions when external memory, clock interface, input/output devices and other peripherals are connected. That is why a microprocessor always has a lot of pins. The following image shows a micro-processor placed on a PCB:

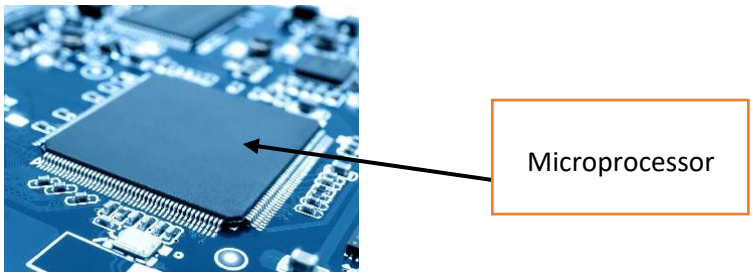


Fig. 4.1.1: Micro-processor

- Also, tell them that a microcontroller is a computer installed on a single chip. It runs specific, single program applications which perform a task which is defined by certain parameters. All the components like the RAM, CPU, input/output interfaces, memory clock and other peripherals are on-board as shown in the following image:

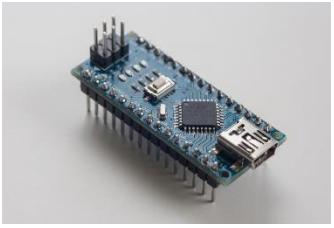


Fig. 4.1.2: Micro-controller

- Show them the following table which lists the differences between a microprocessor and a microcontroller:

Component	Microprocessor	Microcontroller
Chip	Is the heart of the computer system	Is the heart of an embedded system
Comprises	Contains CPU, general purpose registers, stack pointers, program counters, clock timing and interrupt circuits	Contains the circuitry of microprocessor and has built-in ROM, RAM, I/O devices, timers and counters
Data memory	Moves considerable instructions per second between memory and CPU	Only required to move one or two instructions between memory and CPU
Circuit	Large	Small
Overall cost	The cost of entire computer is high	Keeps the cost of entire system low
Bit instructions	Only has one or two bit handling instructions	Has to handle many bit instructions
Number of registers	Less number of registers - making the operations just memory based	Comparatively more number of registers - therefore programs are easier to write
Storage	Works on Von Neumann architecture. The program and data reside in the same memory module	Based on the Harvard architecture - the program memory and data memory are located separately
Time	Memory access time is more for I/O devices	Comparatively less access time for built-in memory and I/O devices
Hardware	Requires other hardware components	Doesn’t require many hardware components

- Tell them the differences regarding the following:
  - Chip
  - Comprises
  - Data memory
  - Circuit
  - Overall cost
  - Bit instructions
  - Number of registers
  - Storage
  - Time
  - Hardware
- Tell them the different connectivity ports, a microcontroller may have, with the help of the following figure:

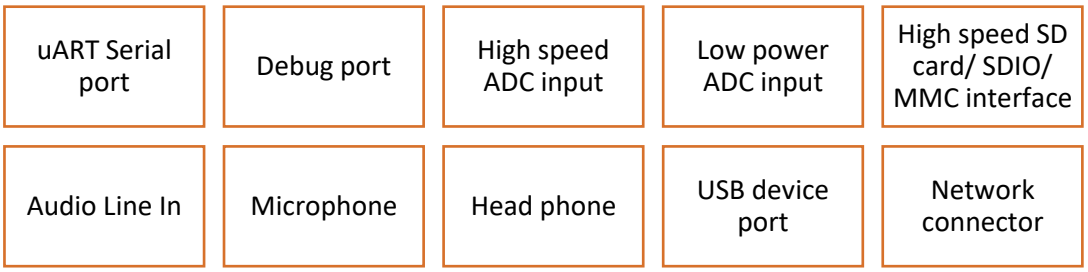


Fig 4.1.3: Different connectivity ports of a microcontroller

- Tell them that a technician needs to do the following actions:
  - Figure out the required transmitter (Wi-Fi, Bluetooth, NFC, or GSM Cellular) for wireless Arduino.
  - See if the adapter is compatible and also check its range.
- Explain the pin configuration and different ports in an Arduino board, one by one.
- Also, tell them about the pin configuration of a Raspberry Pi board.
- Explain that due to its popularity, Linux OS have a version optimized for the Raspberry Pi only.
- Tell them that out of the many versions of Raspberry Pi, version, B+ has improved form and functionality.
- Tell them that a Raspberry Pi board has the following features:
  - Squarely placed mounting holes
  - GPIO headers
  - USB Ethernet controller
  - USB ports to PC
  - Ethernet output port
  - Audio and composite output jack
  - Camera connector
  - HDMI out port
  - USB power port
  - Switching regulator
  - Display connector
  - Micro SD card slot.

- Inform them about different connectivity options for a microcontroller unit.
- Briefly explain the following:
  - Embedded Wi-Fi
  - Bluetooth
  - Low Power Wide Area Network
- Explain to them that wireless MCU Modules are low power, appropriately integrated, high performance MCUs. Embedded - ME series modules enable the end user to code applications directly on the device without the need for external MCU. The fully integrated ultra-low-power microcontroller acts as an application processor and a built-in wireless subsystem. These self-dependent modules with integrated wireless stack mean a seamless wireless connectivity.
- Tell them that the earlier modules of Raspberry Pi do not have an integrated Bluetooth module. Since almost every mobile device supports Bluetooth communication as standard, it is so easy to exchange files between the device and Raspberry Pi module.
- Further, tell them the applications of embedded wireless, such as the following:
  - Radio frequency (RF) remote
  - Sub-GHz
  - Radio-frequency identification (RFID)
- In addition, tell that Zigbee is good for supporting connections among multiple devices, which has helped it become ensconced in in-home automation systems. It has also become popular in remote controls. Zigbee has traditionally been the preference when support for faster data rates is desired.
- Also, tell that Z-Wave operates in different frequency bands in different countries, but in all instances, it avoids the unlicensed and consequently crowded 2.4 GHz band. Z-Wave tends to get chosen when farther connectivity reach is one of the design criteria.
- Inform them, how power consumption of a microcontroller is optimised. Tell them the following steps:
  - Optimise the Pull up Resistor
  - Back up the Powering Devices
  - Decrease the Needed Voltage
  - Alter the Clock Frequency
  - Choose the Right Oscillators
- Tell them about IP-enabled and non-IP-enabled devices.
- Also, tell them how to connect the IP-enabled and non-IP-enabled devices to the network.
- Exercise Handling Strategy:
  - Ask them to write the labels in their notebook.
  - Randomly ask them one by one to tell the answers.
  - The answers are:

1. Power USB	2. Barrel Jack	3. Voltage Regulator	4. Crystal Oscillator
5. Arduino Reset	6. 3.3V Pin	7. 5V	8. GND
9. Vin	10. Analog Pin	11. Main Microcontroller	12. ICSP Pin

13. Power LED Indicator
14. TX and RX LEDs
15. Digital I/O
16. AREF
17. Arduino Reset

- Ask one by one about the communication technologies such as Embedded Wi-Fi, Bluetooth, Low Power Wide Area Network and Embedded Wireless and let them discuss about them.
  - Embedded Wi-Fi: These Wi-Fi modules are plug and play devices like the embedded WLAN stack, TCP/IP (Network) stack and small-sized security supplicants. It is a self-contained solution actuated by simple 8/16/32 bit, low-cost, low-power MCU for Wi-Fi modules.
  - Bluetooth: These self-contained modules are low-power and used mainly for wearables or IoT devices which need Bluetooth Low Energy IP Stack or radio frequency (RF) experience.
  - Low Power Wide Area Network: This makes low power consuming long range high network capacity possible for more than 10 miles. For low power WAN's gateways and cloud systems need to be in place.
  - Embedded Wireless:
    - **RF Remotes**
      Unlicensed Sub-GHz radio frequency bands - Industrial, Scientific and Medical (ISM) are used for short-range, low-data-rate, and low-power wireless applications.
    - **Sub-GHz**
      License-free ISM frequency bands running at 2.4 GHz, 868 to 928 MHz, 433 MHz, and 315 MHz are used mainly for RF devices.
- Divide the number of participants in 2 groups, then ask one of them to tell about IP-enabled devices and ask the other one to tell about the non IP-enabled devices.

  Non-IP enables Devices connection:

  1. The control settings page of the ZigBee device gives an access to control panel which allows to control the devices.
  2. The control panel should be accessed for addition of a new device.
  3. Devices that are available for the required connections should be checked.
  4. It should be ensured that the other device can be discovered and is ready for connection.
  5. When the screen displays the other device, it should be selected for connection.
  6. The indication that the device is paired confirms that the connection has been established.
  7. Sometimes, password is required for pairing. If this is so, enter identical passwords on both of the devices.

IP Enabled Devices

1. The control panel should be accessed from one device.
2. The network and the sharing option should be opened.
3. The LAN, WAN connection across which the device has to be connected should be selected.
4. Then, properties window should be opened and IPv4 option should be selected.
5. "Use the following IP address" should be selected.
6. The IP address 192.168.127.XXX should be entered; XXX can have any value less than 254.
7. The subnet mask should be SET to default 255.255.255.0.
8. The settings should then be saved by selecting OK.
9. It should be ensured that the other device is discoverable and linked to the LAN or WAN.
10. It should be ensured that the IP settings of the first device is set close to that of the other device.

Unit Objectives

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

- List the types of cables and connectors
- Explain how to connect a device to the microcontroller board

Resources

- Available objects such as a duster, pen, notebook and so on
- Different connectors

Notes for Facilitation

- Tell the participants that different types of cables are required for communication. Hence, different types of connectors are also needed.
- Tell them about different types of connectors, such as:
  - CAT 5E Ethernet RJ 45 Connector
  - CAT 6 Ethernet RJ 45 Connector
  - CAT 6A Ethernet RJ 45 Connector
  - Telephone Network Connector
  - Coaxial Connector
  - Wire Connector and Terminal
  - RCA (Male and Female)
  - BNC (Male and Female)
  - F-Type
  - D-Type
  - RJ-45
  - Type C
- Explain that in the early days computers had serial and parallel ports which made it really easy to connect them to micro-controllers and FPGAs. But now, USB has its own data transfer protocols, and it is a bit difficult to implement different connections with parallel ports.
- Tell them that Cat-5 cable is widely used for 100Base-T and 1000Base-T networks. It allows data at 100 Mbps.
- In addition, tell them that Cat 5 cable is not recommended for new installations since it has become obsolete.
- Further, tell them that Cat-5e cable is recognised by the Electronic Industries Association and Telecommunications Industries Association (EIA/TIA). It offers higher frequency specification than Cat-5 cable and also allows data rate up to 125 Mbps.
- Inform them that Cat 6 cables are tightly wound and they often have a braided shielding or an outer foil.
- Further, tell them that Cat-6 cables can support speeds up to 10 Gbps, within 55 metres.

- Tell that Cat-6a are capable of supporting twice the maximum bandwidth and maintaining higher transmission speeds over longer cable lengths.
- Explain to them about the use of portable cord, AV cable, VGA cable, USB cable and HDMI cable.
- Exercise Handling Strategy:
  - Ask five participants to tell the name and the use of the cables, one by one.
  - The answers are as follows:

Name	Feature
Portable cord	The cord is used to supply power to the PCB's with microcontroller boards.
AV	These cables are used for audio and video signal transmission.
VGA	It is used to transfer picture signals from the microcontroller boards to the output devices such as screen, monitor.
USB Cable	These cables are used for low voltage DC power supply and connecting peripherals like microcontroller boards and sensors.
HDMI Cable	HDMI is used to connect any audio/video source, such as a set-top box, DVD player, or A/V receiver to an audio and/or video monitor, like digital television (DTV), with a single cable. HDMI has support for standard, enhanced, or high-definition videos. Multi-channel digital audio support is also there.

UNIT 2.9: Installing Suitable Framework

Unit Objectives

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

- Execute the steps of connecting Arduino board to the PC

Notes for Facilitation

- Tell the participants how to connect a microcontroller board to different electronic parts chips and devices.
- Tell them that Arduino board has limits on how much current can be sourced or sunk by its I/O pins.
- Also, tell that while interfacing the board with a hardware, it is to be ensured that the current limits are not exceeded. In general, for Arduinos based on the AVR microcontrollers, do not exceed 20 mA per pin.
- Further, tell them that they should not connect LEDs to Arduino outputs directly. They should always use a series resistor for it.
- Tell them how to download and install Arduino software in a device with the help of the steps shown in the following figure:

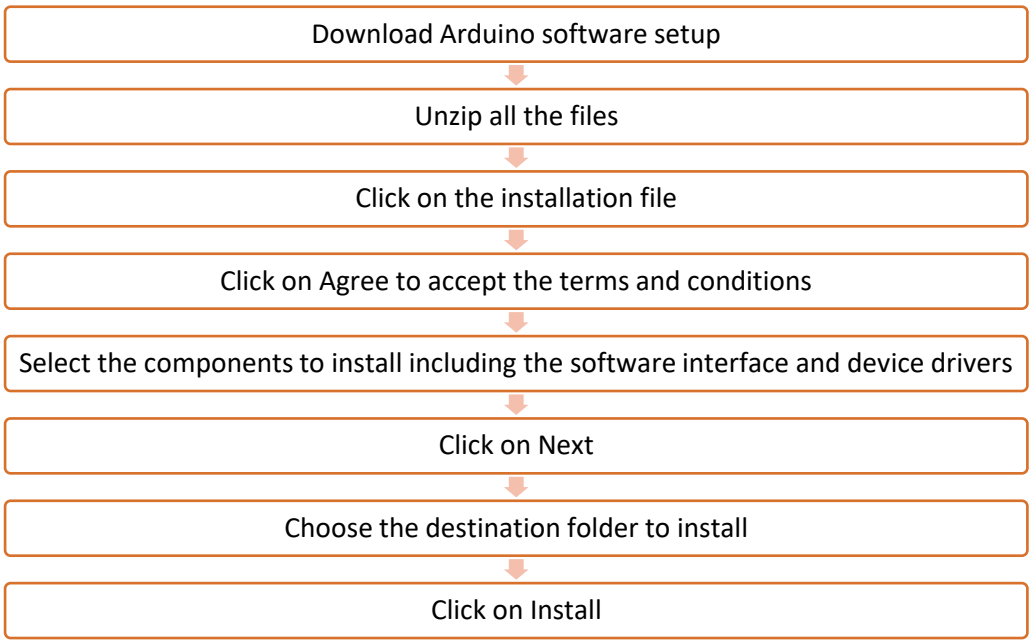


Fig 4.3.1: Steps for installing the Arduino software

- Inform them that the installation process also asks whether the device drivers for the hardware need to be installed.

- The following screenshot shows installation of device drivers:

Fig 4.3.2: Installation of device drivers

- Tell them that they need to connect the D cable to the Arduino board and the USB side of the cable to the electronic device. The following image shows how to connect cable to the Arduino board:

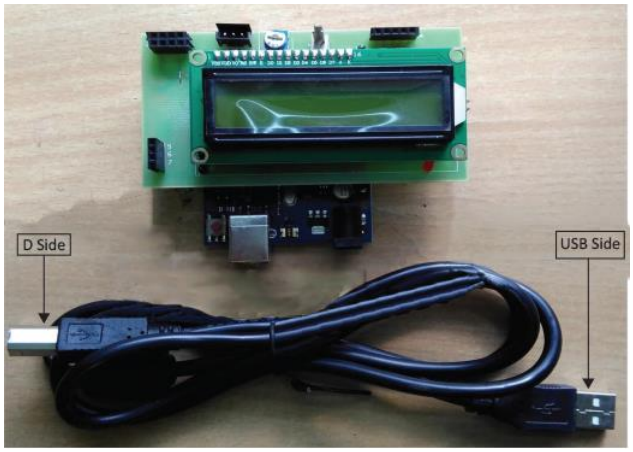


Fig 4.3.3: Connect cable to the Arduino board

- Tell that they have to double click on the Arduino IDE icon to open the software interface.
- Also, inform them that they need to select the types of an Arduino board from the list of boards. The list of boards is available in the Tools menu.
- Inform them that, they should know the port number of the board which is connected to the device, as the port number is selected.
- In addition, tell them the steps of finding the port numbers:
  - Open the “Device Manager” by right clicking on My Computer > Manage > Device Manager
  - Check “Ports (COM & LPT)”
  - Find “Arduino Uno(COM#)” with a port/COM number

The following screenshot shows finding of a port number of Arduino boards:

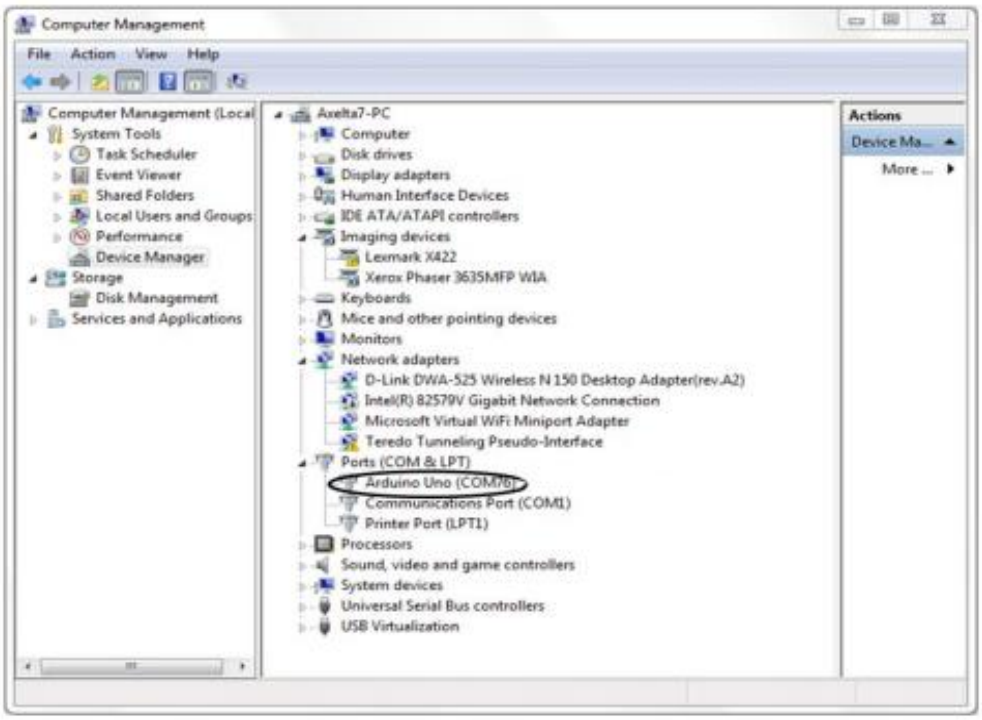
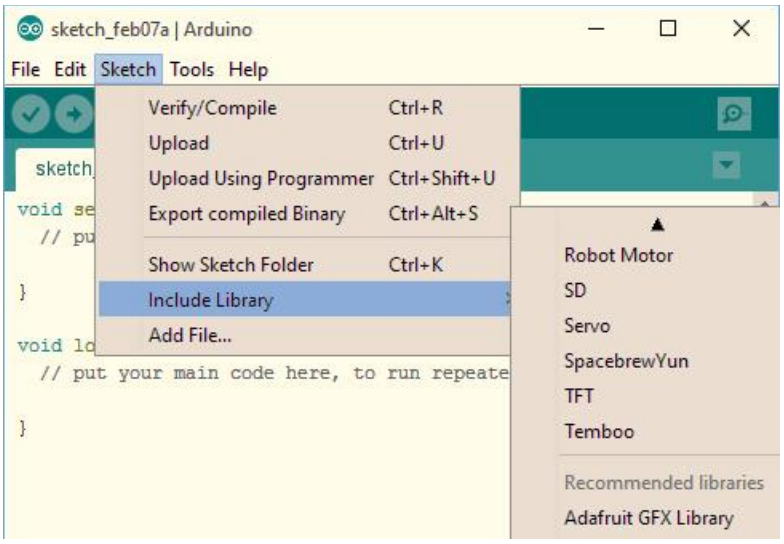


Fig 4.3.4: Finding of a port number of Arduino boards

- Tell them that they need to select a program from the Example and upload it to the Arduino board and check whether it is working perfectly.
- In addition, tell them the steps to import a library to the Arduino board:
  - Download the library file, for example DHT11.zip, where DHT11 is a temperature and humidity sensor.
  - In sketch, go to Include Library and then click on Add Library as shown in the following screenshot.
  - Browse to the folder DHT11 and select the folder and click open.

The following screenshots show the steps to include a library to the Arduino board:



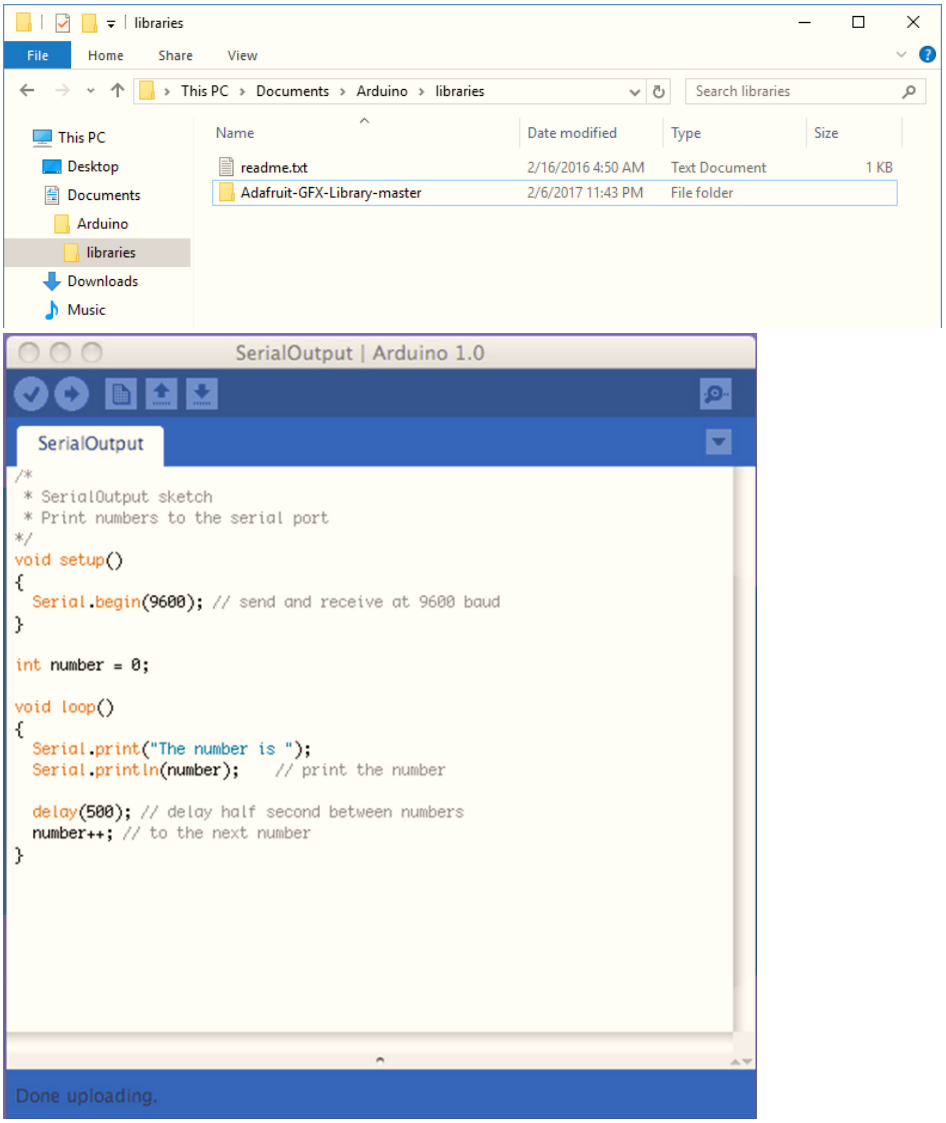


Fig 4.3.5: Steps to include a library to the Arduino board

- Further, tell that if they want to check whether the library is imported properly, they need to:
  - Go to Sketch > Include Library
  - Select DHT11 from the list of libraries
  - Check whether #include <DHT11.h>is added to the sketch.

  The following screenshots shows that a library has been imported to the board:

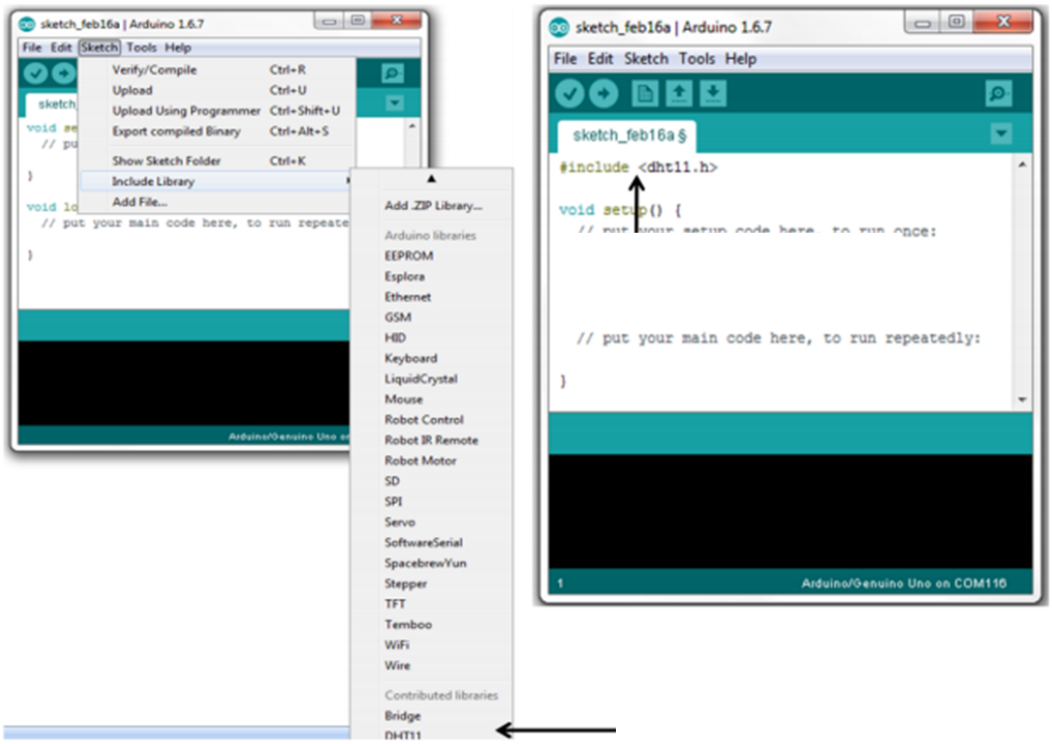


Fig 4.3.6: A library imported to the board

- Further, explain to them how to connect a device to a raspberry Pi microcontroller board.
- Exercise Handling Strategy:
  - Ask one participant randomly to identify the cables.
  - The cables are:
    - USB cable: For keyboard, mouse and power supply.
    - Ethernet cable: For internet connectivity.
    - HDMI cable: For high definition video output.

UNIT 2.10: Transferring Software Code to On-board Microprocessor & Compiling code to On Board Microprocessor

Unit Objectives

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

- Identify the nodes and gateways
- Explain the basic coding structure of microcontroller
- Identify the options to transfer codes
- Explain the challenges in transferring codes

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions and ask the participants if they have any doubts.

Explain

- Explain the basic Arduino programming.
- Explain different challenges in transferring codes.

Notes for Facilitation

- Start the session by asking the participants what they remember about nodes and gateways.
- Briefly explain a sensor node.
- Also, tell that, sensor node has a power unit, communication unit, processing unit and a sensing unit. The sensing unit of the node is the sensor.
- Show the following image of a sensor node:

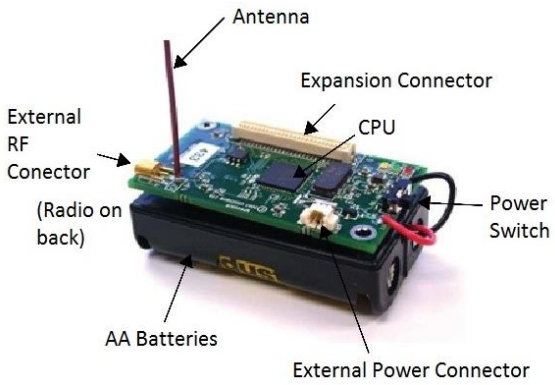


Fig 4.4.1: A sensor node

- Tell them about various communication links.

- Explain about, transparent mode: Data input to the Data IN (DIN) pin is transmitted over-the-air to the receiving radios without any modification. That's why XBee can be used in place of an RS–232 cable. In this mode the packets can be allocated to one target (point-to-point) or to multiple targets (star).
- Also, explain in brief about Power over Ethernet (PoE). Tell them that PoE allows a single cable for providing both data and electric power connection to devices such as IP cameras, VoIP phones and wireless access points. The following figure shows the concept of PoE:

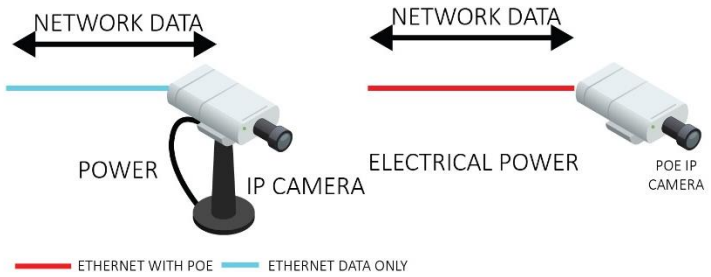


Fig 4.4.2: Concept of PoE

- Explain an IoT network and its working with an example of an IoT framework including the following:
  - PIR Motion sensor connected to a device with Arduino Uno board
  - Raspberry Pi board (Gateway)
  - Internal temperature sensor
  - LED as actuator connected to Arduino Uno
  - IoT cloud framework.
- Tell them that after the external application in Java (independent of Raspberry Pi and Arduino Uno) processes, the readings are taken by the IoT cloud platform. Any suitable IoT platform can be used for this function such as Windows Azure, AWS which are paid or Temboo, Carriot, Nearbus which are free in market. Whenever there is a movement detection, a command will be relayed to the Arduino through the Watson IoT Platform and Raspberry Pi Gateway to initiate blinking of the LED.
- Tell them about the basic structure of a program code. Tell that a program includes:
  - Statements or commands
  - Comments
  - Constants and variables
  - Labels
  - Symbols
- Also, tell them a few examples of commands of Arduino programming and their meaning.
- Also, explain to them how to load the code to a microcontroller board.
- Inform them that a code can be transferred via the following:
  - Serial cable interface
  - SD card
  - Wireless mode such as Bluetooth, ZigBee, WiFi

- Tell them that the latest controllers have bootloader memory for self-programming, that is, they do not need external programmer hardware. The only thing needed is API for shifting program to the target controller. The API can also be incorporated in the compiler, which allows direct burning.
- Explain various challenges in transferring the code, such as:
  - Power supply error
  - Choosing appropriate serial port
  - Installation of drivers
  - Pull ups
  - Microcontroller undetected by programming application.
- Exercise Handling Strategy:
  - Randomly ask the participants one by one to tell the answers.
  - The answers are:

pinMode(n,INPUT)	Set pin n to act as an input. One-time command at top of program.
pinMode(n,OUTPUT)	Set pin n to act as an output
digitalWrite(n,HIGH)	Set pin n to 5V
digitalWrite(n,LOW)	Set pin n to 0V
delay(x)	Pause program for x millisec, x = 0 to 65,535
tone(n,f,d)	Play tone of frequency f Hz for dmillisec on speaker attached to pin
for()	Loop. Example: for (i=0;i<3;i++){} Do the instructions enclosed by {} three times
if (expr) {}	Conditional branch. If expr true, do instructions enclosed by {}
while (expr) {}	While expr is true, repeat instructions in {} indefinitely

  - The steps that helps to load a software code from the nodes to the microcontroller board are:
    - With a serial cable interface, attach the programmer kit to the computer.
    - Then, put the microcontroller in the hardware's socket and push the lock button to ensure proper connection to the board.
    - Open the software on the computer. Then navigate to the menu bar and open File- functions-open-save-setting options.
    - Select 'Open' from the drop-down menu and select 'Load file'.
    - Then click 'Load' button to upload hex file into the microcontroller.

Unit Objectives

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

- Explain how to compile a code
- List the types of compilers available

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions and ask the participants if they have any doubts.

Notes for Facilitation

- Introduce the participants to compilation of a code.
- Tell them that a compiler transforms a high-level code, known as source code into a machine code. The source code is understandable by humans.
- Also, tell them that a compiler ensures that the program is correct syntactically and there is no typing error.
- Explain to them the steps to compile a microcontroller code.
- Tell them that, when a fingerprint sensor is connected to the Raspberry Pi board, the board needs to be booted up first, using a configuration tool.
- After that, they need to run the program code for the fingerprint sensor.
- Also, tell that, they need to check whether the fingerprints are being recorded or not.
- Tell them about some of the common compilers:
  - MPLAB XC8 C pic microcontroller Compiler
  - MPLAB XC16 C pic microcontroller Compiler
  - MPLAB XC 32 C pic microcontroller Compiler
  - PIC CSS pic microcontroller Compiler.
- Exercise Handling Strategy:
  - Ask the participants to name some common compilers.
    - MPLAB XC8 C pic microcontroller Compiler: The MPLAB XC8 C Compiler is the best compiler of top series compiler and it only supports the 8 bit pic microcontrollers such as PIC 10, PIC 12 and PIC 18. It is also known as ANSI C compiler.
    - MPLAB XC16 C pic microcontroller Compiler: MPLAB XC16 C Compiler is version of MPLAB XC compiler but this version only supports the 16-bit pic microcontroller such as, PIC 24F, PIC 24H, PIC 24E, DSPIC 30F, DSPIC 33F and DSPIC 33E.

- MPLAB XC 32 C pic microcontroller Compiler: The MPLAB XC32 C Compiler is also the version of MPLAB XC compiler but it is only used for support or to program the 32-bit microcontroller such as PIC32 MZ, PIC32 MX and PIC32 MM.

UNIT 2.11: Understanding Error Codes and Debug Software

Unit Objectives

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

- Identify the ways of debugging a microcontroller code
- Explain the steps of setting the software in debug mode
- Interpret the error codes

Resources to be Used

- Available objects such as a duster, pen, notebook and so on

Do

- Revise the learning of the previous sessions and ask them if they have any doubts.

Ask

- Ask the participants if they know what debugging is.

Explain

- Explain the ways of debugging a microcontroller.
- Explain some error codes.

Notes for Facilitation

- Start the session by asking the participants about debugging.
- Tell them that debugging means identifying and removing the errors from a code segment.
- Inform them that a microcontroller code can be debugged in various ways, using the following:
  - In Circuit Emulator
  - ICD (PIC microcontroller)
  - Simulation
  - Serial RS232 Interface
  - Liquid Crystal Display (LCD)
  - Pin Debugging
  - Logic Analyser.
- Also, tell them how to set the microcontroller software in debugging mode.
- Tell them the following steps:
  - Go to Build Specification Properties window

- Set the properties and check if the Debugging option is on
- Select the debug mode from Serial port, TCP port and USB options.

- After setting the debugging mode, they should run the application.
- Tell them some examples of common errors in the code.
- Tell them that some of the most common errors are listed in the following table:

Code and Message	Interpretation
E2483: Array dimension 'specifier' could not be determined	This error occurs when an array dimension is dependent upon a template parameter. But an error occurs while it is being parsed and the template argument being substituted does not yield a legal constant expression.
E2509: Value out of range	The error here is because of numeric overflow in one of the expressions. Make sure all numbers fit in 32 bits.
E2100: Invalid template declarator list	It is illegal for a declarator list to follow a template class declaration.
E2249: = expected	In compiler, an error was reported but there was none. This is usually a syntax error or typo.
E2481: Unexpected string constant	The error occurs at times when the compiler is not expecting a string constant in the source input.
E2429: Not a valid partial specialization of 'specifier'	This is an internal compiler error.
F1003: Error directive: 'message'	This message is issued when an #error directive is processed in the source file. 'message' is the text of the #error directive.
F1004: Internal compiler error	An error occurrs in the internal logic of the compiler.

- Also, explain to them some common examples of compilation error messages and their interpretations.
- Show them a code segment and tell them about the errors in the code.
- Exercise Handling Strategy:
  - Ask the participants to write the answers in the notebook.
  - Give a time limit of 20 minutes.
  - Tell the answers as follows:

Code and Message	Interpretation
E2483: Array dimension 'specifier' could not be determined	This error occurs when an array dimension is dependent upon a template parameter. But an error occurs while it is being parsed and the template argument being substituted does not yield a legal constant expression.
E2509: Value out of range	The error here is because of numeric overflow in one of the expressions. Make sure all numbers fit in 32 bits.
E2100: Invalid template declarator list	It is illegal for a declarator list to follow a template class declaration.
E2249: = expected	In compiler, an error was reported but there was none. This is usually a syntax error or typo.

- Tell them the ways for debugging a microcontroller code:
  - In Circuit Emulator
  - ICD (PIC microcontroller)
  - Simulation
  - Serial RS232 Interface
  - Liquid Crystal Display (LCD)
  - Pin Debugging
  - Logic Analyser

UNIT 2.12: Functioning of Microcontroller and Attached Devices

Unit Objectives

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

- Explain the steps to check the microcontroller functions
- Describe how to use the Emulator to check the proper functioning of the devices
- List the communication hurdles

Resources to be Used

- Available objects such as a duster, pen, notebook and sonon

Do

- Revise the learning of the previous sessions and ask the participants if they have any doubts.

Notes for Facilitation

- Start the session by telling the participants that they should understand the framework well. It will help them to identify the locations, where they need to install the nodes and gateways.
- Say that, they should check all the connections properly, so that there is no disruption in the functioning of the devices due to any loose connections.
- Tell them that they need to perform some of the following tests to check the functioning of the microcontroller board:
  - Set the baud rate and reset the controller
  - Perform GPIO test
  - Run an LCD display test
  - Run a real-time clock test
  - Perform Analog-to-digital converter (ADC) test
  - Perform a keypad test
- Also, tell them to check whether the microcontroller board is connected to the network.
- Tell them the steps to test the device's connectivity to the network.
- Further, tell them that they can manually check Wi-Fi module connectivity to the microcontroller board using the following steps:
  - Pick the WiFi Module from the Kit.
  - Connect the Arduino to the computer and the WiFi Modem to Arduino Uno Shield.
  - Connect the power adaptor and check for power indication on the WiFi module.

The following image shows an Arduino Uno board:

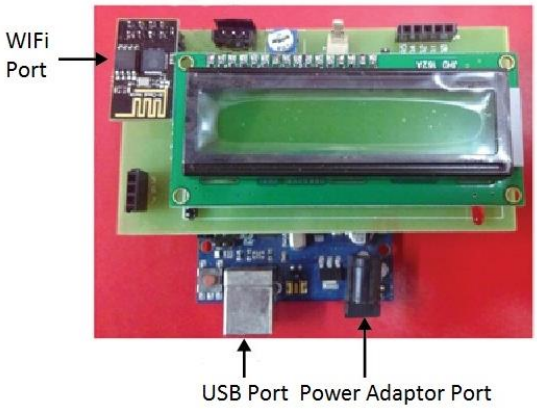


Fig 4.7.1: Arduino Uno board

- Download a demo code for the Wi-Fi module, say, WIFI Demo.txt file and copy the demo code to Arduino IDE.
- Change the "SSID" and "PASSWORD" from default to the ID and Password of the WiFi network being used.
- Upload the code in to Board from File > Upload.

- Check whether it is showing that the Wi-Fi module is connected to the Arduino board.
- Also, tell them that, if the board is not connected to the network, check whether the user ID and password are correct. The following screenshot shows setting the user ID and password:

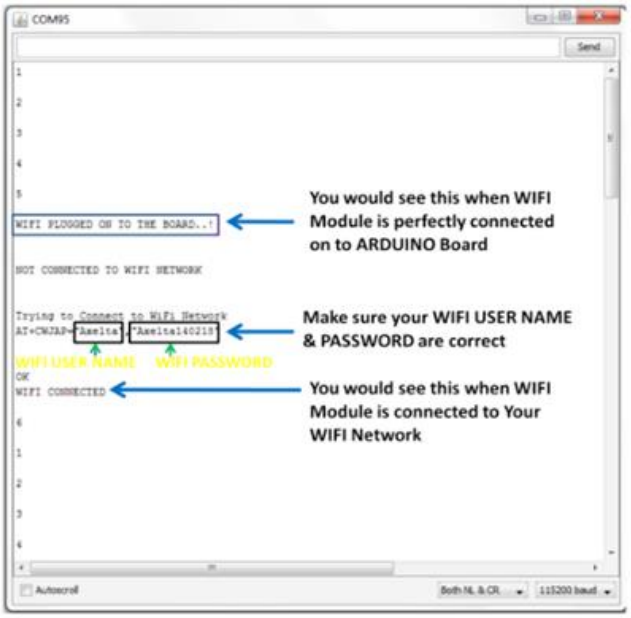


Fig 4.7.2: Setting the Wi-Fi user ID and password

- Further, tell them that, after code uploading is done:
  - Go to Sketch>Upload and save the code
  - Go to Tools > Serial Monitor
  - Change the settings such as BaudRate and format of the statements in serial monitor window

The following screenshot shows the serial monitor window:

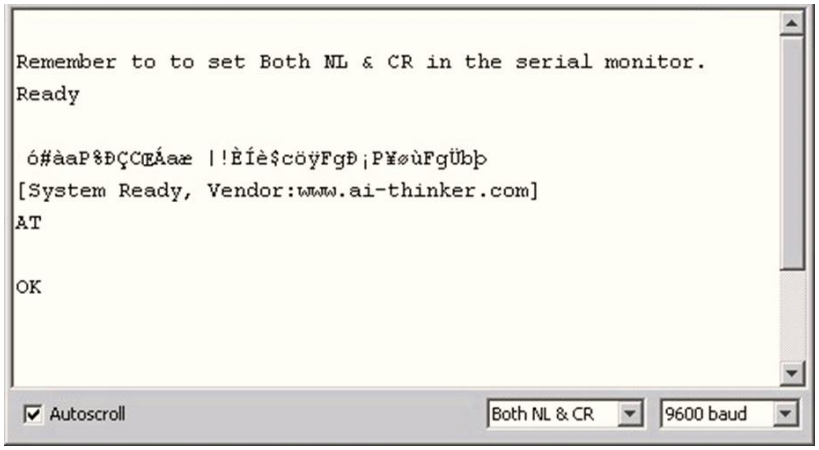


Fig 4.7.3: Serial monitor window

- Tell them that it will show a message “Board Working Fine” if the WIFI Module is working properly. Otherwise, it will give Garbage value errors. Also, tell them to contact the technical team to resolve any error. The following screenshot shows the monitor window with the Wi-Fi status:

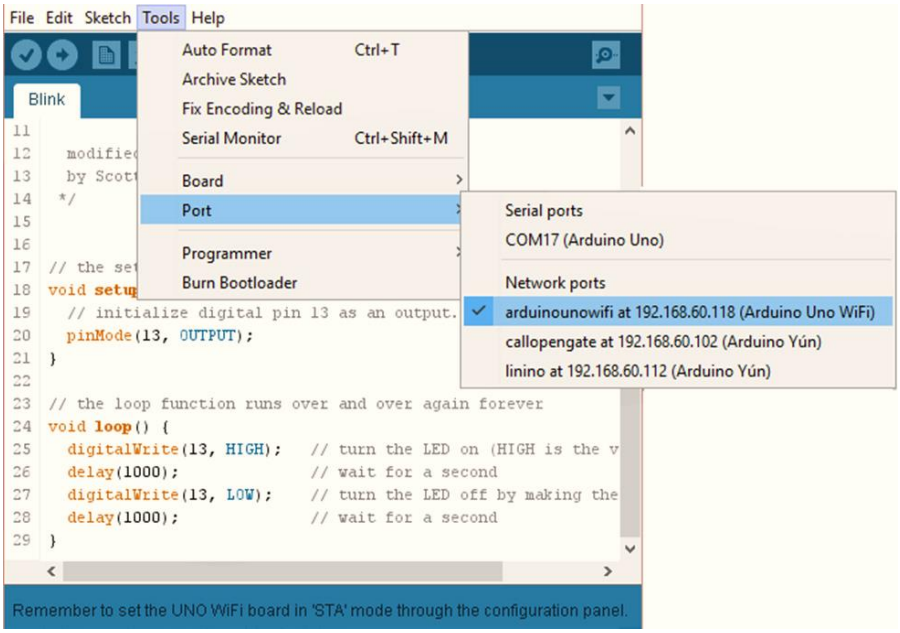


Fig 4.7.4: Serial monitor window with the Wi-Fi status

- Explain that there are three essential functions all emulators contain:
  1. The emulator control logic and emulation memory
  2. The actual emulation device
  3. The pinout adaptor
- Explain to them how to check the functioning of the microcontroller board using an emulator.

- Also, tell them that they should make sure that there are no communication hurdles and the connections are properly made.
- Exercise Handling Strategy:
  - Divide the number of participants into 2 groups.
  - Ask each group to answer the questions separately.
  - The answers are:
    - The following interactions can be enabled:
      - Change application settings, based on the current light conditions
      - Change the screen orientation (from portrait to landscape) as the device is flipped
      - Change alert mode in case of an incoming call; example: flip the device screen towards the table top to silence the device
      - Movement or gesture detection; example: a security camera with motion detection
      - Change the orientation of a map based on the device compass orientation.
- Exercise Handling Strategy:
  Write down the steps to check the functioning of a Raspberry Pi microcontroller.
  - Connect the pins of the microcontroller.
  - Connect the controller board to the devices.
  - Connect the board to the monitoring system.
  - Upload the code to the microcontroller.
  - Check whether the display is working.
  - Check whether the display is showing the output properly.
- Practical solution:
  Install and run a program on a Raspberry Pi board.
  1. Write the operating system image file onto the SD card.
  2. Select the image file extracted from the Raspbian ZIP file.
  3. Select the correct storage drive by choosing the drive letter in the dropdown menu below the device.
  4. Once the image is finished writing to the SD card, eject the drive.
  5. Insert it into the Raspberry Pi and power it on.
- Practical solution:
  Install and run a program on an Arduino board.
  1. Download the Arduino software from its official site.
  2. Click on the downloaded installer file and install it.
  3. Connect the Arduino to the USB port.
  4. Run the Arduino software.
  5. Set the port to Arduino Uno.
  6. Set the COM port.
  7. Upload any sketch.

- Practical solution:
  Install an Arduino Uno software on a windows OS and configure for a fingerprint sensor.
  1. Download the Arduino software from its official site.
  2. Click on the downloaded installer file and install it.
  3. Connect the Arduino to the USB port.
  4. Run the Arduino software.
  5. Set the port to Arduino Uno.
  6. Now, hook up all the four wires of the fingerprint sensor to the breadboard.
  7. Connect power and ground.
  8. Hook up wires to digital pin 2 and 3 of Arduino board.
  9. Download the library for the fingerprint sensor.
  10. Once the library is loaded up go to Arduino software, click on the enrol option from the downloaded library option.
- Practical solution:
  Debug a Raspberry Pi board microcontroller.
  Step 1: Establish connection between board and the computer system and then, access the serial terminal, set the baud rate at 9600 and reset the controller. Select fields for testing from the text menu.

  Step 2: GPIO Test: Connect the LEDs, Buzzer and Relays to port pins and check if LEDs are blinking, buzzer is giving a beep sound, and Relay is chattering.
  - Press 1 to test GPIO pins
  - Press k key to run the code after connecting LEDs to the ports
  - Check if all LEDs are blinking or not

  Step 3: LCD 8-bit Test: Connect the LCD pins.
  - Test LCD 8-bit mode by pressing '2' key
  - Establish connection as said before, followed by pressing 'k' to run the code

  Step 4: Real-Time Clock (RTC) Test: Connect the RTC pins to P0 (SCL-P0.6, SDA-P0.7).
  - Press key 5 to run LCD 8-bit mode test
  - Establish connections as stated before followed by pressing 'k' key to run the code
  - After pressing 'k' key, an increase in RTC time and date is observed.

  Step 5: Analog-to-digital converter (ADC) Test: The board houses temperature sensor, Pot and LDR. Values these sensors read and collect are sent on UART. Set all connection like before and press 'k' key to run the code.

  Step 6: Keypad Test: Follow same procedure to set the connections and press 'k' key using the Hex keypad to run the code and check the output.

- Practical solution:
  Perform cabling connection of a Raspberry Pi microcontroller board.
  1. Take an add-on board like the Gertboard which has an Arduino compatible IC on it.
  2. Plug a standard Arduino into the USB port of the Raspberry Pi.
  3. Use a USB to Serial adapter with Arduino.
  4. Use the Serial Pins on the Raspberry Pi to connect to Arduino.

UNIT 2.13: Initializing Nodes and Gateways

Unit Objectives

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

- Identify the prerequisites for initialization of nodes and gateways
- Explain the configuration of edge appliances
- Identify the steps of node and gateway initialization
- Describe how to check connectivity
- Explain the execution scenarios of software

Resources

- IoT camera setup
- Related software
- Internet connection

Ask

- Ask the participants about nodes and gateways for an IoT installation setup.
- Ask them whether they know about the different modes of network connection.

Explain

- Explain to the participants the basic steps involved in installing an IoT camera set up, such as the following:
  - Basic hardware setup
  - Cable and power connection
  - Internet connection between the devices
  - Initialization of the devices

Notes for Facilitation

- Start the session by asking the participants questions from previous lessons.
- Tell them about the steps and pre-installation activities.
- Tell them that they should identify the location of installation and check for the power points and network connectivity.
- Inform them that they must unpack the devices very carefully, and check if there is any missing or damaged item. If so, they should immediately report to the supervisor.
- Tell that, they should read the instructions for mounting the camera, since it depends on the type of the camera. The type of camera may be:
  - Box
  - Dome
  - PTZ.

- Further, say that, it is required to know the power requirements for the devices. The power requirements can be known from the power adapter specification label and the instruction manual.
- Tell them to check whether there is a network setup already installed or not. If there is none, tell them to install the network connection.
- Say that, they need to check whether the camera is connected to the network. For this, they need to:
  - Install the utility software, received with the package
  - Run the software
  - Find the camera along with its IP address and host name.
- Also, explain them the steps to configure the camera settings as shown in the following figure:

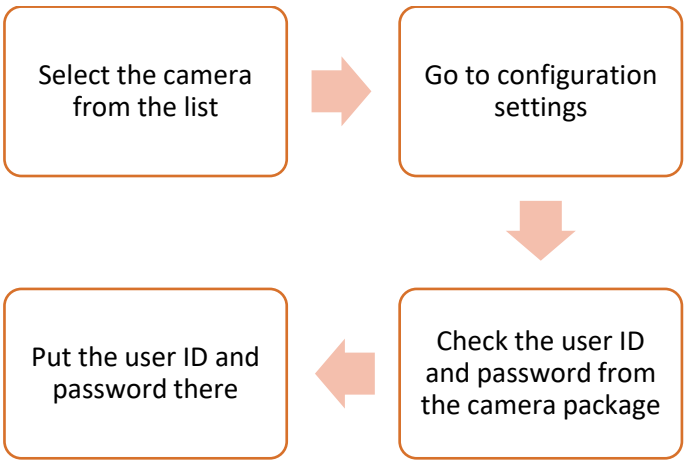


Fig 5.1.1: Configuring the camera

- Further, tell them to set the network connection mode.
- Tell them the steps for PPPoE settings with the help of the following figure:

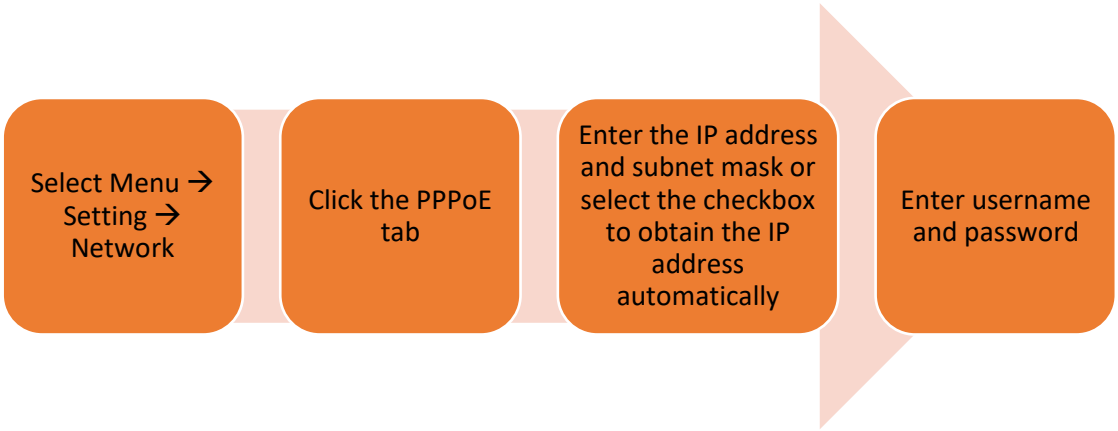


Fig 5.1.2: Steps for PPPoE settings

- Also, tell them if the user wants the Digital Video Recorder (DVR) to receive the IP address and network settings automatically from a Dynamic Host Configuration Protocol (DHCP) server, the DHCP checkbox should be selected.
- Also, explain the steps to install and configure the router.
- Tell them that they need to initialize all the devices to connect them to the network and enable them to be operated remotely.

- Explain the steps to install and configure the settings to connect network video recorder (NVR) to the network and also, to connect it to the cameras.
- In addition, tell them that, if it is required to connect the setup to an alarm system, the steps in the following figure need to be followed:

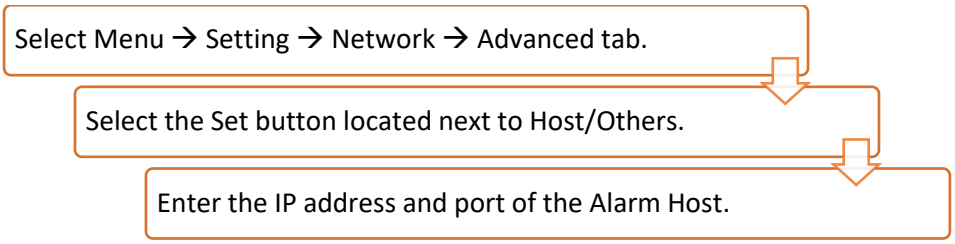


Fig. 5.1.3: Steps for setting up a remote alarm host

- Tell them to check the list of devices connected to the network to verify that all the nodes are connected and there are no such devices listed, which were not supposed to be.
- Briefly, explain the steps to initialize the gateway device.
- Also, inform them about the steps to secure the gateway and network, so that, no external body can access it.
- Also, tell them how to configure the gateway device so that the nodes can be accessed remotely.
- Tell them that they need to perform the following checks after the initialisation:
  - Test the network connectivity
  - Check the connection of the devices to the gateway
  - Connect a physical device to the gateway and test the connectivity
- Inform them about the parameters they need to know for the installation and configuration process.
- Tell them that the set up includes various types of IoT devices other than a camera and different manufacturers require different types of parameters to be filled in the configuration wizard of the IoT device. The following table shows the parameters:

Primary Interface	Hostname
	IP address
	Netmask
	Default gateway (the WAN gateway)
	DNS IP address
	Domain name for the device
	Administrator password
	SMTP server IP address
	Primary interface speed
In-Path Deployments	In-path interface IP address
	In-path netmask
	In-path gateway
	In-path: LAN interface speed and duplex
	In-path: WAN interface speed and duplex

- Show them different execution scenarios of related software.
- Exercise Handling Strategy:
  - Modes of network selection in setting up an IoT camera device:
    - **DHCP:** This option allows to connect to the network without providing any IP. The camera will automatically request the IP from the router.
    - **Manual:** In this option an IP address need to be provided in the TCP/IP section. Make sure that the IP is not used by some other network.
    - **PPPoE:** The camera can be directly connected with the modem using PPPoE protocol when the Internet service is using the PPPoE internet protocol. For this, the service provider need to be contacted to get the required details. The router uses the same PPPoE protocol setting; only the username and password is required.
- Exercise Handling Strategy:
  - Steps in gateway initialization:
    - Connect the power adapter to the back panel of the router.
    - Insert the Ethernet cable to the router and the computer system.
    - Configure the Internet connection and set up password.
    - Check the setup details as shows in the following screenshot:
    - Open Internet browser and type the default gateway address at the address bar.
    - Login to the account and the router details' window will open.
- Exercise Handling Strategy:
  - To test the network connectivity the steps given below are to be followed:
    - Open command prompt and type "ipconfig" and press enter. It shows the connection details and ensures that there is no problem in network connection.
    - Type "ping <gateway address>" to check there is no loss of packets and the router is working well.
  - To check the connection of the devices to the gateway, the steps given below are to be followed:
    - Launch the IoT device software installed on the laptop or desktop and open the default webserver page.
    - Check the status of each device and sensor to "OK". This means the devices are connected to the gateway or router.
  - To connect a physical device to the gateway and to test the connectivity, the steps given below are followed:
    - To do so in Microsoft azure suite, click on the devices to check the device parameters.
    - Click on "Add New"
    - Define the device ID
    - Configure the device ID and IoT hub name
    - Set the command for the device
    - Check whether the device is functioning according to the command

UNIT 2.14: Launching the Software on Nodes and Gateways

Unit Objectives

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

- Identify the prerequisites for software installation
- Explain the challenges with launching software

Resources

- IoT camera setup
- Related software
- Internet connection

Ask

- Ask the participants if they can tell about the pre-requisites of launching a software interface on a device.

Explain

- Explain the participants about the prerequisites of launching a software for the IoT framework.
- Explain to them that a software interface is required to control all the devices from a single device.
- Also, tell them that the software interface helps the operator to operate the devices easily and remotely.
- Tell them about various challenges faced in using the software interface:
  - Hardware-Software Compatibility
  - Device Interaction
  - Network Availability
- Exercise Handling Strategy:
  - Ask one participant randomly to tell the answers.
  - The prerequisites are: Cable connection, network connectivity, devices installed and related software.

UNIT 2.15: Confirming Communcation & Establishing Connectivity

Unit Objectives

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

- Explain the data transfer indicators
- Compare data transfer on various networks
- Explain different data transfer failure scenarios

Resources

- IoT camera setup
- Related software
- Internet connection

Ask

- Ask the participants if they can tell the importance of indicators on the devices.
- Ask them if they remember various network communication technologies.

Explain

- Explain to the participants how data transfer status can be understood from the indicators.
- Explain the comparison scenarios of data transfer via various networks.
- Explain to them the software used to test the data transfer.

Notes for Facilitation

- Start the session by asking the participants the importance of indicators on the devices.
- Tell them about the common LED indications for:
  - WiFi
  - Ethernet
  - Online
  - Upstream
  - Downstream
  - Power
- Explain to them the comparison between the data transfer via Bluetooth and other communication methods regarding the following:
  - Frequency Bands
  - Channel Bandwidth
  - Data Rate

- Packet Length
- Power Consumption

- Also, tell them about the comparison between the data transfer over various networks regarding:
  - IEEE Specification
  - Frequency Band
  - Network Type
  - Power Consumption (mA)
  - Nominal Range (m)
  - Max. Signal Rate.

- Tell them that the mechanism and techniques of data transfer depend on the type of network. The different types of network are as follows:
  - Wi-Fi
  - Near Field Communication (NFC)
  - Z-Wave
  - Bluetooth LE
  - ZigBee

- Explain that the bluetooth, WI-Fi, ZigBee and cellular technologies are some popular standards. The wireless technologies support some remote data transfer, sensing and control on devices.
- Also, explain ZigBee is used in transmitting data between electronic devices within a short-distance. The transmission rate is not high. The applications that require low data rate as well as low power and are hard to replace or require charging of battery frequently, use ZigBee technology.
- Tell the participants that bluetooth LE has been designed for ultra- low-power applications. It can reuse classic Bluetooth circuitry components. The raw data rate of Bluetooth LE is 1 Mb/s. It has a range of up to few tens of meters. The following table lists the different Bluetooth technologies:

	Bluetooth 4.2 LE	**802.15.4**	**802.11**
Frequency Bands	2.4 GHz	900 MHz and 2.4 GHz	2.4 and 5 GHz
Channel Bandwidth	2 MHz	2 and 5 MHz	20.40.and 80 MHz
Data Rate	1 Mbps	Up to 250 Kbps	Up to 867 Mbps (2 antennas. 80 MHz); 72.2 Mbps for 1 antenna. 20 MHz channel
Packet Length	10-265 bytes	127 bytes	Up to 1.048.575 bytes
Power Consumption	< 10 mW	< 10 mW	> 100 mW

- Inform them about how to check the network status.
- Tell them that the network speed can also be checked by running a typical speed test on various websites. Besides, there are utility programs named "ping" for local networks. Versions of these programs are pre-installed in the desktop computers and laptops, and these are on the local network.
- Further, tell them some examples for testing the network speed and statistics:
  - LAN Speed Test (Lite)
  - LANBench
  - NetStress.
- **Explain NetStress as:**
  It is a simple network benchmarking tool that requires to be run on both the computers. It can find the receiver IP address automatically. It measures Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) throughput. The following screenshot shows a NetStress window:

Fig. 5.3.1: NetStress window

- Tell them that digital storage oscilloscope is used to check various events with time stamps, glitches in power supply and signal integrity check.
- Also, tell them software defined radio is used to emulate receiver and transmitter for a large range of wireless gateways.

- Explain different data transfer failure scenarios to them, such as:
  - Transferring data from a computer to cloud takes longer than expected time.
  - Device is not in range of network.
  - Faulty network hardware causes performance issues. It causes mismatch in network speeds.
  - Network hubs can cause auto-negotiation mismatches, network packet collisions and packet drops.
  - Outdated Firmware can affect network performance
  - Data transfer over 2.4 and 5 GHz Wi-Fi bands is much slower than wired Ethernet.
  - 3rd party applications contribute to network traffic by scanning and downloading content.
  - Backup functions consume CPU, memory and disk access resources and decrease data transfer rates.
- Exercise Handling Strategy:
  - Draw the table on the board and ask the participants to come to the board one by one and write the answers.

	ZigBee	Bluetooth LE	Z-Wave	NFC	Wi-Fi
IEEE Specification	802.15.4	802.15.1	ITU -T	ISO 13157	802.11 a/b/g
Frequency Band	868/915 MHz; 2.4 GHz	2.4 – 2.5 GHz	908.42 MHz	13.56 MHz	2.4 GHz; 5 GHz
Network Type	WPAN	WPAN	WPAN	P2P	WPAN
Power Consumption (mA)	40	12.5	2.5	50	116
Nominal Range (m)	10	50	30	.05	100
Max. Signal Rate	250 kbps	305 kbps	40-100 kbps	424 kbps	54 Mbps

- Ask any 5 participants to tell the answers one by one.

Issue	Cause / Solution
Faulty network hardware cause performance issues. It causes mismatch in network speeds.	• USB 3.0 or higher port along with a high-quality USB cable should be used. • Faulty and outdated networking devices must be used.
Network hubs can cause auto-negotiation mismatches, network packet collisions and packet drops.	Network hubs should be replaced with Gigabit switches.
Outdated firmware can affect network performance.	Network equipment firmware must be updated, and outdated hardware should be replaced.
Data transfer over 2.4 and 5 GHz Wi-Fi bands is much slower than wired Ethernet.	• Direct connection using Ethernet cable is better than the wireless one. • If an Ethernet connection is not possible, connect using the 5 GHz band.
3rd party applications contribute to network traffic by scanning and downloading content.	Ensure 3rd party applications are not indexing or virus scanning.

Unit Objectives

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

- List the steps to connect to a network remotely
- Identify the steps to connect to short range networks

Resources

- IoT camera setup
- Related software
- Internet connection

Explain

- Explain to the participants how to access a device from an external network.
- Explain how to connect a device to different networks.

Notes for Facilitation

- Start the session by telling the participants that a user may need to access the nodes when he/she is out of home. Hence, external connectivity is required, to access the devices from different networks.
- Explain how to access a router or any device remotely, with the help of the steps shown in the following figure:

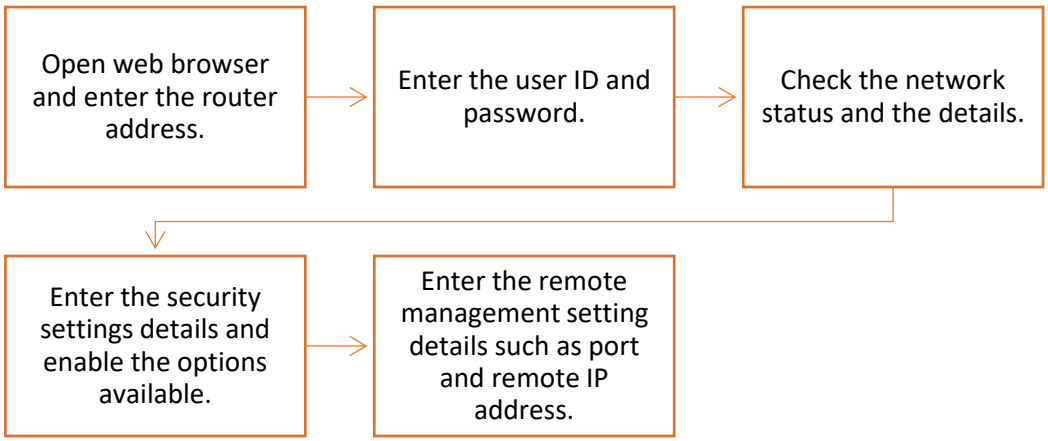


Fig. 5.4.1: Steps to access a router or any device remotely

- Explain the steps to connect a Raspberry Pi to another system via Bluetooth, with the help of the following figure:

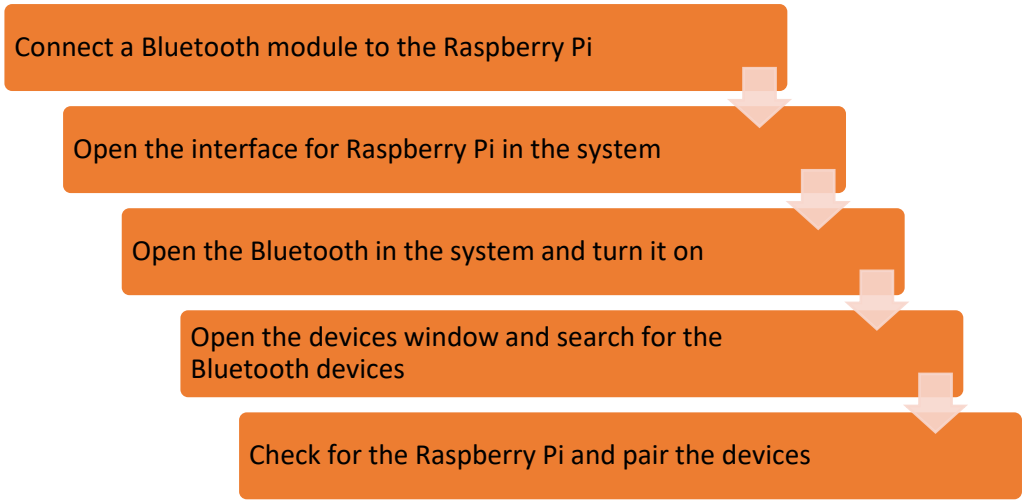


Fig. 5.4.2: Steps to connect a Raspberry Pi to another system via Bluetooth

- Explain the steps to connect an Arduino board to another system via ZigBee, with the help of the following figure:

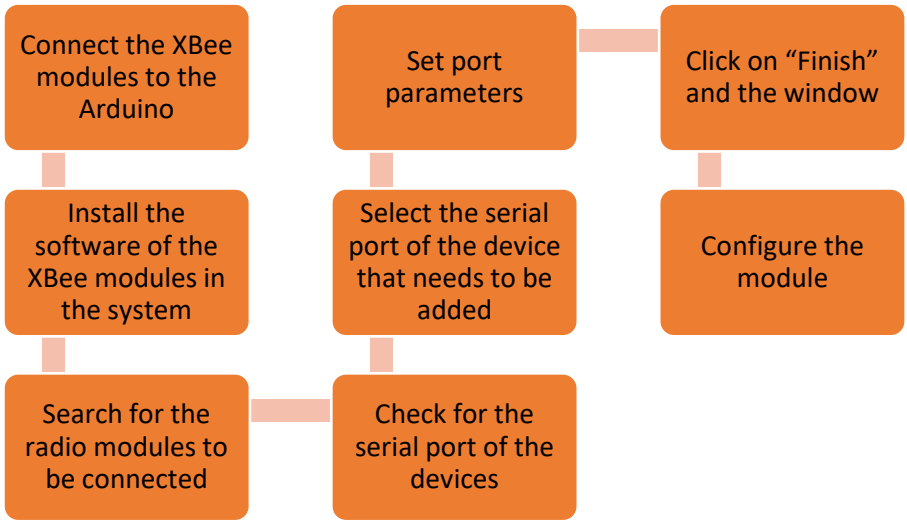


Fig. 5.4.3: Steps to connect an Arduino board to another system via ZigBee

- Exercise Handling Strategy:
  - Ask any two participants to mention the steps for connecting a Bluetooth using Raspberry Pi framework:

    Step 1: Connect the XBee modules to the Arduino.

    Step 2: Install the software of the XBee modules in the system.

    Step 3: Search for the radio modules in the options

    Step 4: Select the serial port of the device that needs to be added

    Step 5: Click on "Finish"

    Step 6: Configure the module

UNIT 2.16: Controlling Edge Appliances and Hubs

Unit Objectives

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

- Explain the configuration of a router
- Describe controlling of devices by connecting hub
- Explain the bypassing of a hub

Resources

- Router
- Related software
- Internet connection
- Laptop, tablet or computer

Ask

- Ask the participants if they can configure a router.

Explain

- Explain the steps to configure a router.
- Explain a hub.

Notes for Facilitation

- Start the session by asking the participants questions from previous lessons.
- Explain the steps to configure router settings.
- Tell them how to control the devices by connecting them to a hub. Show them how a hub looks like, with the help of the following image:

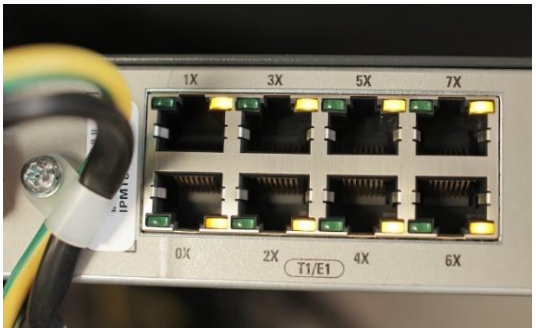


Fig. 5.5.1: A network hub

- Tell them that a technician needs to perform a regular check on the information, alerts, storage, and notifications send from the edge devices.
- A technician needs to keep a tab on the working of each edge device and gateway connected in a system network.

- Also, tell them that a hub is a hardware device that helps in data communication. It sends data packets to all devices on a network. It is used to connect segments of a LAN.
- Tell them how to bypass a hub.
- Also, tell them how to activate bridge mode to bypass a hub.
- Exercise Handling Strategy:
    - Ask any 2 participants to answer the questions.
    - Ask others, if the anwers were correct.
        - The steps for configuring Bridge mode:
            - Connect to the router by entering its IP address in the browser's address bar. In most cases it'll be https://192.168.1.1
            - Login using the default username and password – generally, username will be "admin" and password will be "admin" or "password." The default username and password would be mentioned in the router's manual, or may be printed on the router itself.
            - Next, click on Network and disable DHCP. Save.
            - Reconnect and remove the username and password. Save again.
        - The steps for configuring a router:
            - Access the router configuration page using a web browser on the computer.
            - Type in the username and password to arrive at the configuration settings page.
            - After gaining access on the router's management page, click on Network > WAN and change WAN connection type to PPPoE.
            - Change the settings as required.

Unit Objectives

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

- Explain the types of data transfer
- Identify various data transfer modes
- Explain how to control the data transfer

Resources

- Router
- Related software
- Internet connection
- Laptop, tablet or computer

Ask

- Ask the participants what they know about data transfer.

Explain

- Explain the steps to configure a router.
- Explain a hub.

Notes for Facilitation

- Tell the participants about different types of data transfer:
  - Interrupt Transfer
  - Bulk Transfer
  - Isochronous Transfer
  - Control Transfer
- Tell that Interrupt Transfer is intended for devices that send and receive small amounts of data infrequently or in an asynchronous time frame. This transfer type can be used for low-, full- and high-speed devices.
- Interrupt transfer type guarantees a maximum service period and that delivery will be re-attempted in the next period if there is an error on the bus. The interrupt transfer is unidirectional and periodical.
- Explain that bulk transfer is typically used for devices that transfer large amounts of non-time sensitive data, and that can use any available bandwidth, such as printers and scanners. This transfer type can be used by full-speed and high-speed devices, but not by low-speed devices.

- Bulk transfer allows access to the bus on an "as-available" basis, guarantees the data transfer but not the latency and provides an error check mechanism with retries attempts. If part of the USB bandwidth is not being used for other transfers, the system will use it for bulk transfer.
- Tell them that isochronous transfer is generally used for multimedia streams and telephony. This transfer type can be used by full-speed and high-speed devices, but not by low-speed devices.
- Also, tell that isochronous transfer is unidirectional. Bi-directional isochronous transfer requires two isochronous pipes, one in each direction.
- Since timeliness is more important than correctness in this type of transfer, no retries are made in case of error in the data transfer. However, the data receiver can determine that an error occurred on the bus.
- Tell them that control transfer is used for supporting configuration, command and status operations between the software on the host and the device. This transfer type is used for low-, full- and high-speed devices.
- In addition, tell that control transfer allows data flow in both directions.
- Explain to them about various data transfer modes:
  - Simplex
  - Half duplex
  - Duplex.
- Lastly, tell them how to control data transfer by changing the settings of the router.
- Exercise Handling Strategy:
  - Ask one participant to tell the type of data transfer.
  - Ask others to tell the features.
  - The types of transfers are:
    - Interrupt Transfer
    - Bulk Transfer
    - Isochronous Transfer
    - Control Transfer.

Practical solution:

Perform a Zigbee gateway set up for a smart home set up.

1. Connect the zigbee with Internet using the Ethernet cable.
2. Connect the power supply cable to the zigbee.
3. Connect the mobile phone to the same Wi-Fi.
4. An application will appear on the phone.
5. Open the application and pair up the gateway.
6. Now the home system can be operated using the application.

Practical solution:

Perform a Raspberry Pi board Bluetooth network configuration.

1. Power on the Raspberry Pi.
2. Go into "search or connect mode”
3. Connect the Bluetooth of the phone to the Raspberry Pi.

4. An app on the device will ask for WiFi name and WiFi password
5. The app generates the wpa_supplicant.conf and writes the new wpa_supplicant.conf to the /etc/wpa_supplicant/ via Bluetooth

Practical solution:

Perform a Raspberry Pi serial console connection over Bluetooth.

On Android phone:

1. Open Settings
2. Select Bluetooth
3. This will make the phone “discoverable”

On Raspberry Pi:

1. Click Bluetooth ▸ Turn On Bluetooth
2. Click Bluetooth ▸ Make Discoverable
3. Click Bluetooth ▸ Add Device
4. Phone will appear in the list, select it and click Pair
5. Enter a PIN code

On Android phone again:

1. Enter the same PIN code when prompted
2. Touch “OK”.

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3. Level 1 Troubleshooting of IOT

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Key Learning Outcomes

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

- Identify the types of IOT testing
- Explain connectivity of IoT devices
- Explain the IoT test approaches
- List the IoT test challenges and IoT testing tools
- Describe testing pin configuration
- Explain the different ways of connecting the IoT gateway to the nodes
- List the tools to verify networking connectivity
- Explain the role of event viewer and hardware in verifying network connectivity
- Explain the role of local connectivity
- List the steps to check on-board memory storage card for storing node data in Raspberry Pi
- Explain the two ways to store data locally for the Arduino boards.
- List the parameters to check working of on-board Wi-Fi or a 3G, 4G connectivity module
- Explain the role of range, bandwidth, Intermittent connectivity and security
- List the steps to run Wireshark
- Explain the checking of on-board power supply
- Demonstrate checking of power supply at different hardware configurations
- List the parameters affecting the performance matrix of node and gateway connections
- Explain the role of Maximum transmission unit (MTU), data loss, delay and reliability
- Identify the basic troubleshooting steps to check the data transfer between the gateway and the server
- Identify the Secure Internal Communication (SIC) ports
- Explain the checking of SIC and gateway connectivity
- Identify the steps for loading software and testing the communication between devices
- Explain starting a node, checking active links and establishing a session
- Describe securing of devices using the MQTT protocol
- Explain device authentication based on user id/password
- Explain device authentication based on one-time password (OTP)

UNIT 3.1: Testing Connectivity between Devices

Unit Objectives

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

- Identify the types of IOT testing
- Explain connectivity of IoT devices
- Explain the IoT test approaches
- List the IoT test challenges and IoT testing tools
- Describe testing pin configuration

Ask

- Ask the participants if they know about IoT testing.

Say

- Tell the participants that they should know about the testing of devices and connection that should be done after the installation activities.

Notes for Facilitation

- Make the session interactive by involving the participants in a discussion and introduce the topics to them.
- Tell them that the various testing related to IoT are as follows:
    - Usability testing
    - Compatibility testing
    - Protocol and device interoperability testing
    - Security and privacy testing
    - Upgrade testing
    - Performance and real-time testing
    - End user application testing
    - Connectivity Testing
- Tell them that the devices should be configured in such a way that they can notify warning and error messages.
- Tell them that they should select the protocol correctly, as per the requirements. Also, they need to check the compatibility of the devices and communication technologies with the protocol being used.
- Explain to the participants about the security of IoT devices and also, tell them that they should configure the gateway devices and make them secure.
- They need to upgrade the software, if it is required.
- In addition, tell them that they should check the device connectivity, both offline and online.

- Tell them to check whether the indicators' lights are on and also, show the various execution scenarios. For example, if a motion detector and an alarm are installed, show the user that the motion is detected in the system, it is showing error messages and also it is raising alarms.
- Tell them about the followiong testing challenges:
  - Network availability
  - Device compatibility
  - Power problem
- Also, tell them about testing tools, such as:
  - Wireshark and Tcpdump software
  - JTAG (Joint Test Action Group) Dongle, Digital Storage Oscilloscope and Software Defined Radio
- Explain to them how to test the pin configuration of a microcontroller board.
- Exercise handling Strategy:
  - Ask them to write the types of testing in IoT. The solution is as follows:
    a. Usability testing
    b. Compatibility testing
    c. Protocol and device interoperability testing
    d. Security and privacy testing
    e. Upgrade testing
    f. Performance and real-time testing
    g. End user application testing
    h. Connectivity Testing
  - Ask them to write some basic points to remember for end user/pilot testing in IoT. The solution is as follows:
    a. As far as the IoT is concerned, pilot testing is a must.
    b. Testing only in a lab makes sure that the product/system works appropriately. But, this may backfire badly when exposed to real-time conditions/steps/scenarios.
    c. During pilot testing, the system is exposed to a limited number of users in the real field. They use the application and give feedbacks on the system.
    d. These comments come in handy to make rectifications so that the application becomes robust enough for production deployment.

UNIT 3.2: Checking Connectivity between Devices

Unit Objectives

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

- Explain the different ways of connecting the IoT gateway to the nodes
- List the tools to verify networking connectivity
- Explain the role of event viewer and hardware in verifying network connectivity
- Explain the role of local connectivity

Ask

- Ask the participants if they know about the different ways the nodes and the gateway can be connected.

Notes for Facilitation

- Make the session interactive by involving the participants in a discussion and introduce the topics to them.
- Tell them that nodes can be connected via a gateway device or directly.
- Tell them that they should check the network connectivity between the devices. The functioning of network may be checked using various tools, such as Event Viewer.
- The Event Viewer is a tool in Windows OS which displays detailed information about important events on the system. The events may be:
  - An application may not start as expected
  - An application has automatically downloaded updates
- Tell them that the Event Viewer is useful for troubleshooting application errors.
- In addition, tell them that Windows event log records the alerts and notifications in a computer.
- Say that, to use Event Viewer tool, they need to do the following:
  - Check the event log.
  - Check the system log folder and analyse the type of error warning lists
  - Visit the event properties page for each error warning
  - Use the nethelpmsg command to get the description of the error.
- Also, tell them to check the connectivity of hardware devices as follows:
  - Check the cables for their functionality.
  - Check the server operation guide to check hardware functionality.
  - Check the network adaptors and drivers' functionality through the control panel.
  - Select the device from the device box and check the property.
  - Troubleshoot a device, if it is not working properly.
- Tell them that for configuring the network they will require the following information:
  - IP address
  - Gateway address

- Protocol
- Subnet mask

- Tell them to use ping command to check the network connectivity. Also, show practically the use of ping command.
- Exercise handling Strategy:
  - Ask the participants to write the steps to configure IP details. The solution is as follows:
    1. Open the command prompt, type ipconfig and press ENTER
    2. In the output look for:
       a. IP address
       b. Default gateway
       c. DBCP server
    3. Use ping tool to get the network connectivity between default gateway and DHCP server.
  - Ask the participants to write the steps to test TCP/IP connectivity by using ping command bare. The solution is as follows:
    1. Open the command prompt, type the following to ping the loopback address: 127.0.0.1
       If it fails, then verify that the computer was restricted after TCP/IP was installed and configured.
    2. Ping the IP address of the computer.
       If the ping command fails, then restart the computer to check whether the computer is with TCP/IP installed and configured.
    3. Ping the IP address of default gateway.
       If the ping command fails, verify the default gateway IP and check if the router is operational.
    4. Ping the IP address of remote host.
       If the ping fails, check the correctness of remote host IP address; see that it is operational and the router between host and remote computer is operational.
    5. Ping the IP address of the DNS server.
       If the command fails then verify the DNS server IP address correctness; also check that the DNS server is operational and the router between the computer and the DNS server is operational.

UNIT 3.3: Checking On-board Memory Storage Card

Unit Objectives

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

- List steps to check on-board memory storage card for storing node data in Raspberry Pi
- Explain the two ways to store data locally for the Arduino boards.

Resources

- Raspberry pi and Arduino board
- Related software
- SD card
- Laptop, tablet or computer

Notes for Facilitation

- Tell the participants that some microcontroller boards come with built-in secure digital (SD) drive and can work as storage devices.
- Also, tell them that Raspberry Pi has built-in storage, but Arduino board does not have. It requires an SD card shield to attach a local memory storage to it.
- Tell the steps to check the memory storage of the microcontroller boards.

UNIT 3.4: Testing Working of Connectivity Modules

Unit Objectives

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

- List the parameters to check working of on-board Wi-Fi or a 3G, 4G connectivity module
- Explain the role of range, bandwidth, Intermittent connectivity and security
- List the steps to run Wireshark

Ask

- Ask the participants if they know about the parameters that should be known while checking the on-board Wi-Fi or Bluetooth module.

Notes for Facilitation

- Start the session by involving the participants in a discussion and asking questions from previous modules.
- Tell them that they need to know the range, bandwidth, intermittent connectivity and security details while working with the connectivity module.
- Tell them to check the indicators to get an idea about the signal strength and transmission.
- Say that, to test whether there is any loss of packets, the steps shown in the following figure should be performed:

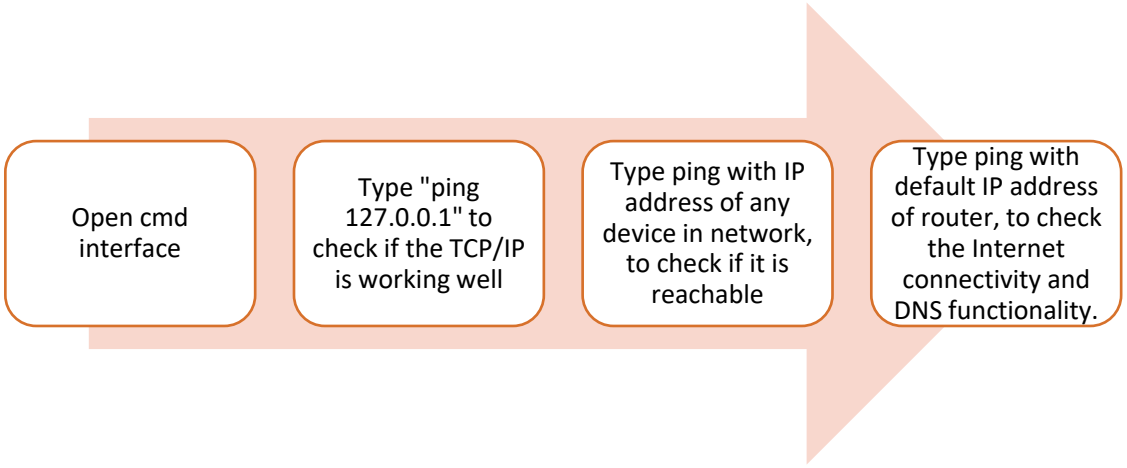

Fig. 6.4.1: Steps to test whether there is any loss of packets

- Tell them the steps to check the bandwidth.
- Explain to them why it is important to check the intermittent connectivity. Tell them that it helps them to identify whether the fault is in wired or wireless connection.
- Also, tell the how to troubleshoot network issues using the Wireshark tool.
- Check that all the devices are listed in the network and are shown on the control device's interface.

- Exercise handling Strategy:
  - Ask the participants to write the steps involved in testing the packet loss in network. The solution is as follows:

    1. For windows, click start button and enter “cmd’ in search field section. Then, press ENTER.
    2. Type the ping followed by an IP address and then press ENTER. The following are some common ping commands:
       Ping 127.0.0.1: This is a “loopback ping” in which if the loopback step fails, then the TCP driver might be corrupted, the network adaptor might not be working or IP has been interfered by another service.
       Ping: This will ping IP address of a local computer of a remote server or any client that receives the IP address to verify that it is reachable. Example, ping 192.168.1.1 which is default IP address of NETGEAR router.
       Ping: This command will test the Internet connectivity and DNS functionality. Example, ping google.com.

  - Ask the participants to write the factors to be considered for testing the bandwidth of an Iot network. The solution is as follows:

    1. The volume of data that each device is generating
    2. The number of devices that are deployed in a network
    3. The way the data is being sent; as a constant stream or in intermittent bursts, as the bandwidth that is available will need to cope with the peak periods

UNIT 3.5: Checking the On-board Power Supply

Unit Objectives

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

- Explain the checking of on-board power supply
- Demonstrate checking of power supply at different hardware configurations

Notes for Facilitation

- Tell the participants to check the power requirements of the devices, nodes and gateways.
- Then, tell them the power requirements of a Raspberry Pi, with the help of the following figure:

Maximum power used by Raspberry Pi	○1 Amp
Power used by the GPIO pins	○50mA
Power used by an individual GPIO pin	○16mA
Power used by an HDMI port	○50mA
Power required by the camera module	○250mA
Power required by keyboards and mice	○100mA or over 1000mA

Fig. 6.5.1: Power requirements of a Raspberry Pi

- Tell them how to check the power supply of a microcontroller board using a multimeter.
- Tell them to check the power supply at different hardware configurations:
  - Normal Mode + WLAN + LAN
  - Normal Mode + WLAN
  - Normal Mode + LAN + USB Keyboard + Mouse
  - Normal Mode + LAN
  - Normal / Idle Mode
  - Power Down Mode
- Exercise Handling Strategy:
  - Ask the participants to write the different types of hardware considerations for IoT hardware power testing. The solution is as follows:
    a. Normal Mode + WLAN + LAN
    b. Normal Mode + WLAN
    c. Normal Mode + LAN + USB Keyboard + Mouse
    d. Normal Mode + LAN
    e. Normal / Idle Mode
    f. Power Down Mode

UNIT 3.6: Checking Communication Link Performance Matrix

Unit Objectives

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

- List the parameters affecting the performance matrix of node and gateway connections
- Explain the role of Maximum Transmission Unit (MTU), data loss, delay and reliability

Ask

- Ask the participants if they can tell the parameters affecting the performance of node and gateway connections.

Notes for Facilitation

- Start the session by asking questions to the participants regarding the previous sessions.
- Tell them that the parameters affecting the performance of a node and a gateway connection are:
  - Maximum transmission unit
  - Data loss
  - Delay
  - Reliability
- Explain the steps to check the transmission units through a network. Tell that from the output, they can get know the maximum unit that can be transmitted to a node over a network.
- Also, tell them the steps to know the amount of data loss and network latency.
- Explain to them how to test the delay in the network, using:
  - Ping
  - Traceroute
- Tell them that reliability of a network should be considered while working with IoT devices.
- Also, inform them that reliability is concerned with the ability of a network to carry out a desired operation such as "communication".
- Tell them that a network's reliability is measured on the following factors:
  - Downtime: The time it takes to recover.
  - Failure Frequency: The frequency when it fails to work the way it is intended.

- Exercise Handling Strategy:
  - Ask the participants to write down the steps to check the data loss in the network. The solution is as follows:
    a. Begin the packet loss test. Open Windows menu to locate the command processor.
    b. Identify the IP address of the gateway.
    c. Now, ping the IP of the gateway.
    d. To test the packet loss, ping a website from the network.
    e. It will provide the network latency reported as round-trip time (RTT) in milliseconds (ms).

UNIT 3.7: Checking Data Transfer from Gateway to Server

Unit Objectives

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

- Identify the basic troubleshooting steps to check the data transfer between the gateway and the server
- Identify the Secure Internal Communication (SIC) ports
- Explain the checking of SIC and gateway connectivity

Notes for Facilitation

- Tell the participants that the IoT devices should be connected to the gateway and then to the server for the analytical process.
- Inform them that to connect the device to a cloud server, an account of the cloud platform is required. For example, Carriots is a freely accessible cloud platform.
- Before sending data to the cloud, the Carriots platform needs to be configured as per requirements, to manage the data. Carriots uses a hierarchical structure to group and manage devices. Therefore, create this structure before using the device.
- Tell them that the possible steps to configure the cloud server account as per requirements are as follows:
    - Create a project under which all the sensor data would be stored. The following screenshot shows creating a project:

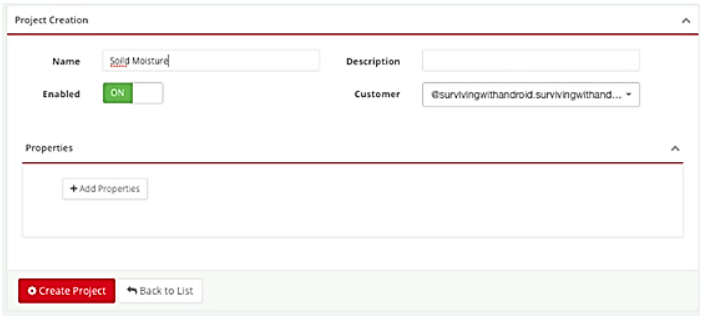

Fig. 6.7.1: Creating a project

    - Fill the details of the devices which are in service, and then create a group for the devices:

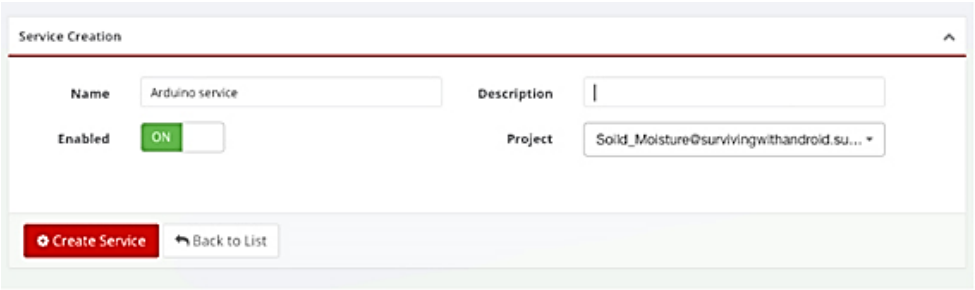

Fig. 6.7.2: Filling the details

- Configure the devices which are used to send the data. The following screenshot shows configuring the devices:

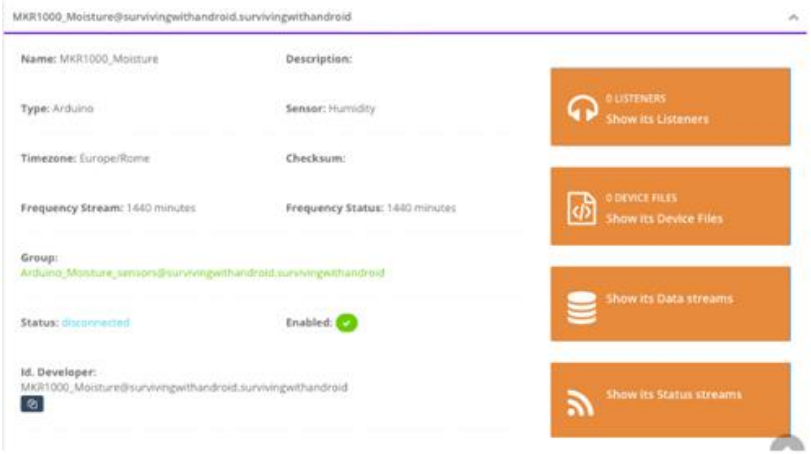

Fig. 6.7.3: Configuring the devices

- Tell them that, for the Carriots IoT system, it uses Carriots listener as a monitoring and alerting system.
- In addition, tell that alistener is a process that analyses the incoming values and applies a specific rule. When the rule is verified, then it invokes a script.
- Tell them about configuring triggers for the sensor devices and enabling messaging service by configuring all the required parameters such as the destination device identification and the message body as shown in the following figure:

Fig. 6.7.4: Enable messaging service

- Tell them about the basic troubleshooting steps for the data transfer between the gateway and the server.
- Also, tell them to check whether both the server and the gateways are using the secure internal communication (SIC) activation keys.
- Exercise Handling Strategy:
  - Ask the participants to write the types of SIC ports that need to be checked while testing the network connectivity. The solution is as follows:
    a. Port 18209: This port is used for communication between the VPN-1/Firewall-1 Module and the certificate authority (status, issue, revoke).
    b. Port 18210: This port is used to pull certificate from the CA.
    c. Port 18211: This port is used by the cpd daemon on the module to receive the certificate (when clicked on the initialize in the policy editor).

UNIT 3.8: Checking the Communication between Devices

Unit Objectives

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

- Identify the steps for loading the software and testing the communication between the devices
- Explain starting a node, checking active links and establishing a session

Notes for Facilitation

- Start the session by discussing about nodes and gateways.
- Tell them the basic steps to test the functioning of node and gateway software with the help of the following figure:

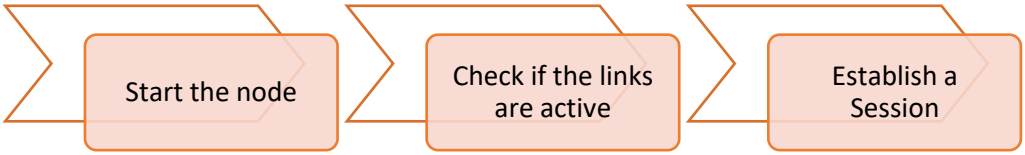

Fig. 6.8.1: Test the functioning of node and gateway software

- Exercise Handling Strategy:
  - Ask the participants to write down the steps taken to check the links in an IoT network. The solution is as follows:
    a. Locate the host resource icon which is on the left side of the SNA node operation window. Select the "+" icon to expand the list of resources.
    b. Click the connections (for CPI-C and APPC configurations, click peer connections).
    c. Click on the details icon on the toolbar to get the details about the displayed links.

UNIT 3.9: Setting Connectivity Credentials

Unit Objectives

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

- Describe securing of devices using the MQTT protocol
- Explain device authentication based on user id/password
- Explain device authentication based on one-time password (OTP)

Ask

- Ask the participants if they know about the different ways the nodes and gateway can be connected.

Notes for Facilitation

- Make the session interactive by involving the participants in a discussion about securing the devices.
- Tell them that in case of IoT, security of the devices is of utmost importance.
- Inform them that the devices connected to a network can be secured by the ways as shown in the following figure:

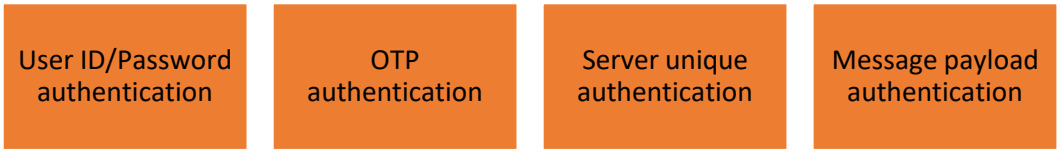

Fig. 6.9.1: Securing the devices

- Explain the process of authentication one by one.
- Explain the OTP authentication process with the help of the following figure:

Fig. 6.9.2: OTP authentication process

- Exercise Handling Strategy:
  - Ask the participants to mention the methods of authentication of any IoT set up. The solution is:
    a. Authenticating with a User Name and Password
    b. Authenticating with OTP Authentication
- Practical Solution:
  - Check the on-board memory storage card for storing node data in Raspberry Pi.
    1. Open a new command line/terminal session
    2. Run the following command and press enter: Df
    3. This will display the total disk usage for the SD card in columns.
    4. To make it more readable, add the -h flag, which will add G and M units for gigabytes and megabytes: df -h
  - Run and capture data loss by using Wireshark in a network.
    1. Download and install the Wireshark
    2. Open the Wireshark on the system
    3. Click the gear icon on the top of the window
    4. Make sure that the monitor mode is enabled for en0 interface
    5. Click on the close icon and restart the Wireshark
    6. Start capture on en0, a beacon, control and management frame interspersed with data frames.
  - Perform test delay in a network.
    1. Enter the commands for testing network and Internet latency directly at the command line.
    2. Run a Ping loopback test. The Ping loopback test will test the computer's connection to verify that there are no local hardware problems causing the network or Internet latency issue.
    3. Type "Ping 127.0.0.1 -n 20". This IP address is the same for nearly all built in network connections. The "-n 20" extension will send 20 packets of data before terminating the test.
    4. View the statistics. The time it took for the packet of data to travel locally should be less than 5minutes and there should be zero packet loss.
    5. Run Ping to a remote server. Now that it has been verified that the local port is working, Ping remote servers to test the latency.
    6. Normal latency varies according to the type of connection from 5 - 40ms for cable modem, 10 - 70ms for DSL, 100 to 220ms for dial-up to 200 - 600 for cellular. The distance to the remote server also adds to latency.
    7. Type "Ping" followed by the IP address or site URL to be pinged and hit Enter.
    8. View the report. As the test pings the remote address, it will report back the results; the final number after the "time = "is the time it took, in milliseconds, for the packet to travel to the remote site and back to the computer.

9. Run the traceroute test. The traceroute test will show the path that data travels from the computer to the remote server and any delay in that path. This can be helpful in determining the source of network or Internet delays.
10. Type “tracert” followed by the IP address or site URL to route and hit Enter.
11. View the results. As the test traces the path, it will display each address along the way and the time it took for a data packet to travel to it, and it will acknowledge receipt for each “hop” along the path. The more “hops” or other devices the data packet needs to route through, the more delay will be experienced.

UNIT 3.10: Project on Humidity and Temperature Sensing Device

Unit Objectives

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

- Demonstrate the setting up of IoT hardware for obtaining humidity and temperature information from a sensor which would be analysed on cloud platform through wireless Internet.

Ask

- Ask them if they have the knowledge to build an IoT project.
- Ask them if they know some of the requirement for completing the project.
- Ask them if they know how the project can be useful in real life scenarios.

Notes for Facilitation

- Help the participants in understanding the objective of the project.
- Tell them the real-life application of the project.
- Discuss the feasibility and life of the project.
- Tell the participants to perform the practical with the help of the provided material
- Provide the required material for completing the product.
- Ask the participants to follow the safety rules and regulations while completing the project.
- Tell them to record the project in detail and create a report.

UNIT 3.11: Project on Air Pollution Sensing Device

Unit Objectives

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

- Demonstrate the setting up of the hardware for IoT enabled air pollution meter which monitors air quality on a smartphone using a third-party app.

Ask

- Ask the participants if they have the knowledge to build an IoT project.
- Ask them if they know some of the requirement for completing the project.
- Ask them if they know how the project can be useful in real life scenarios.

Notes for Facilitation

- Tell them that third party tools like Blynk app can be used for this project.
- Tell them to follow all the safety rules and regulations while performing the project.
- Tell the participants to use the tools and equipment carefully.
- Tell the participants to note down the steps and procedure followed while completing the project in a formatted form.
- Explain to them about the importance of securing the devices by providing username and password.
- Tell them to demonstrate the project after completion.

UNIT 3.12: Organizational Processes and Standards

Unit Objectives

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

- Define organizational processes
- Identify the elements and steps of an organizational process
- Explain the importance of organizational processes
- Identify the hierarchy in an organization

Ask

- Enquire if anybody knows about organizational process.
- Ask the participants to tell some work ethics.
- Ask if anyone knows about the documentation process.
- Ask the participants to share their expectations from this course.

Notes for Facilitation

- Tell the participants that any situation involving two or more persons working collectively requires organising. The act of organising involves integrating, balancing and coordinating the activities of people working together for seeking common goals.
- Also, tell that the organizing process, thus, establishes working relationship among employees by assigning tasks and giving them enough rights to perform those tasks.
- Explain to them about the concept of organising by telling that it refers to the process of identifying and grouping the activities to be performed and dividing them among the individuals. It involves creating the relationship of authority and responsibility among them for the accomplishment of organisational objectives.
- Tell the participants about the characteristics of organising which are listed as follows:
  1. **Organising is a basic function and a sub-process of management** - Organising constitutes an essential element in the main process of management. It is done in relation to all other functions of management. The organising function follows the function of planning and the other functions of management follow organising. Thus, organising is a sub-process of management.
  2. **Organising is a continuous process -** An organisation is a continuing entity. The need for organising function is felt whenever new activities or functions are introduced, or existing functions and activities are re-shuffled in the organisation.
  3. **Organising is a function of all managers -** The management function of organising is practised by all the managers in the organisation. The nature and the importance of the organising function, however, may vary with different managers. The middle-level managers are significantly involved in organising their departmental activities as a large number of members are involved in the performance of the activities.
  4. **Organising involves coordination -** To create a balance and structure in the organisation, the activities of members need to be well-coordinated.

5. **Goal-oriented** - Organising is designed on the basis of objectives and it aims at achieving them smoothly.
6. **Group effort -** Organising deals with group efforts that are made for attaining common goals.
7. **Establishes authority-responsibility relationship -** Organising establishes authority-responsibility relationship among the organisational members.

- Tell the participants that there are four basic elements of organisational structure which are listed in the following figure:

Functional Structure

- Under a functional organization structure, people who do similar tasks are grouped together, based on specialty. So, all the accountants are placed in the finance department and so on for the marketing, operations, senior management and human resources departments.

Divisional Structure

- In a divisional structure, the company groups workers into teams based on the products or projects that meet the needs of a certain type of customer. For example, a bakery with a catering operation might structure the workforce based on key clientele, such as a wedding department and a wholesale-retail department.

Matrix Structure

- A matrix structure combines elements of the functional and divisional models; so it's more complex. It groups people into functional departments of specialization, then further separates them into divisional projects and products.

Flat Structure

- A flat organizational structure attempts to disrupt the traditional top-down management system of most companies. Management is decentralized so there is no everyday "boss." Each employee is the boss of themselves, eliminating bureaucracy and red tape and improving direct communication.

Fig 8.1.1 Elements of organisational structure

- Explain to the participants about the importance of organizing process. Tell that it creates a network of roles and relationships and provides a framework within which each employee performs the activities that have been assigned to him/her. The role becomes more meaningful and he/she contributes effectively for achieving pre-determined objectives. Therefore, organising is regarded as a mechanism or means to achieve planned objectives.

- Further, tell them about the factors affecting the organizational structure which are listed in the following figure:

Strategy	Organisational structure to be used for an enterprise is the direct result of objectives to be achieved which are derived from strategy. Organizational structure of a manufacturing concern with assured market will be different from that of another concern operating under highly competitive situation.
Nature of activities	Organizational structure of a trading concern is different from that of an educational institution for the simple reason that activities of the two organizations are different.
Size and life cycle	Larger the organisation, the more will it tend to have work specialisation, horizontal and vertical differentiation, and rules and regulations. Organisational structure would be different at birth, youth, midlife and maturity stages.
Culture	Culture refers to a system of shared beliefs and values. A strong organisational culture means rules and regulations can be substituted by the culture. Stronger the culture, more the structure can be predictable, orderly and consistent with no written documentation.
Technology	Organisational structure of an enterprise using sophisticated capital-intensive mass-production technology will be different from the enterprise using labour- intensive small-scale production technology.
Environment	Organisational structure of an enterprise operating in the midst of a highly dynamic environment organic will be different from the enterprise operating in a stable environment mechanistic. Organisations operating in stable environment can gainfully employ a highly formalised structure.
People	People-structure relationship is important. A good organisational structure provides people with the supportive structures to attain organisational and individual objectives.

Fig 8.1.2 Factors affecting organisational structure

- Explain about the difference between formal and informal organisational structure as given in the following table:

Formal Organisation	Informal Organisation
•A formal organisation is a consciously planned and a deliberately designed entity. It is based on superior-subordinate relationships which are created by assignment of work and delegation of authority.	•When people work together in a formal relationship of superior and subordinate, they come in contact with each other. This interaction provides them with an opportunity to know each other and develop personal and social relations.

Fig 8.1.3 Formal and informal organisation

- Further, explain to them about the difference between organisation as a structure and organisation as a process. For example, in organisation as a structure, it is majorly concerned with the job. The design is mainly interested in job descriptions, functions and territories. The processes are not fully clear. Even though people have different jobs, they perform their jobs with limited responsibility and performance. These organizations are mainly vertical organizations divided into departments which have their own responsibilities and tasks. Whereas an organization as a process is mainly concentrated on how the job is done. It can be said that an organization is dealing with the design of processes in the terms of time, space, funds, materials and human resources, focusing on the outcome of the work.
- Exercise Handling Strategy:
  - To facilitate the exercise, ask the participants to form groups of 5 people and give them designation of manager, trainee, team lead, technician and CEO. Ask them to stand in an increasing order based on the position that they belong to. The correct order is:

    Trainee – Technician – Team lead – Manager – CEO.

  - For the next exercise, ask them to arrange themselves according to the steps in an organisational process. The correct order is:
    - Analyze the target
    - Create a strategy
    - Categorize the work
    - Assign and give authorization
    - Co-ordinate and have perfect relationships

UNIT 3.13: Project Handling Concepts and Applications

Unit Objectives

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

- Explain different project handling concepts
- List the steps of an IoT project implementation process

Explain

- Explain to the participants that an IoT technician should be able to work in harmony with the colleagues or members in a team. In case of any conflict, the matter should be resolved by communicating with them. If the need for an intervention by a senior is felt, then the matter should be reported to the supervisor.
- Tell them that while doing work and any interaction related to work, the interest of the organization should be the focus.
- Tell that all the members may work together or may work on individual projects to fulfil the organizational goals.
- Inform them that it is important to understand the role and responsibility of each one of the team members and the task being performed by that person.
- Explain that teamwork is defined as coming together of people to achieve common goals. The goals here are the organizational goasl. The daily tasks which are assigned are a part of the organizational goals. Team work means that each member in the team is contributing their bit to the overall tasks.
- Tell that in a team, all the members are important and might be dependent on each other for work. Sometimes, the members do the work individually. However, the collective result is a team effort, similar to what will be seen in a game of cricket, or during the construction of a building or building an aircraft. It is also important to understand that the work may depend on the completion of the tasks. Therefore, for smooth progress of work, the tasks should be completed on time.
- Tell the participants that every organization has its own defined work processes to manage IT operations at its facility. For an IoT technician, it is important to learn these work processes and follow them.
- Explain the work processes briefly. Tell them that generally, most of the work processes are automated by IT support software systems while others need to be performed manually or physically. An IoT technician should be aware of the common IT work processes of the organization he/she works in, to work efficiently.
- Tell the participants to consider a situation where a customer complains that a computer lost network connectivity. There can be numerous explanations for the problem such as:
    - Defect in physical component such as a cable break or a faulty router
    - A faulty configuration on the computer or a network device
    - Loss of network connectivity to one network resource such as email, which led the customer to assume that all network connectivity was lost

- A successful IoT technician uses critical thinking skills to isolate the real cause of the issue by formulating questions, gathering information, and determining what is relevant.
- Tell the participants that when on a visit to a customer site, to ensure good service, the customer's requirement should be understood, and a solution should be suggested.

Notes for Facilitation

- Explain to them about Service Level Agreement (SLA) by saying that a it is a formal contract between the service provider and the customer, defining services, responsibilities, scope and duties of both the parties.
- Then, tell them about the importance of an SLA.
- Explain to the participants that there is a formal process of addressing IT related issues and problems when they appear. This process is called as escalation process.
- Explain to them about functional and hierarchical escalation with the help of the following points:
    - Functional and hierarchical type of escalations can regularly be found inside the IT service managed condition when incident and problem management orders are executed.
    - With functional escalations, the incident/problem is routed to a more experienced level that can deliver the next level of support.
    - Hierarchical escalations act more as a correspondence and intend to caution both the staff and the administration, in a proactive way, of potential SLAbreaches.
- In addition, tell them about the activities involved in an escalation management process such as initiating the escalation, logging the escalation and developing an escalation management action.
- Lastly, tell them about the importance of record keeping.
- Tell them that record keeping is very beneficial, especially in case of conflicts and contradictions in the work committed and the work done. It provides several benefits.
- Inform them that there is a written escalation process available at all IT departments and all the staff members are trained to its use. Under this process:
    - Priority levels are assigned to various issues
    - Delegated responsibilities are assigned to some particular personnel
- A particular time is allocated to some personnel to resolve the issue before escalation.

Ask

- Ask the participants if they know about the personality traits and skills required for the job of an IoT technician.

Say

- Tell the participants that they should know the right way to handle the customers, understand their needs and provide the right service to them as per the company's standards and policies.

Explain

- Explain to the participants about the importance of communication with the customer to know their requirement.
- A technician should be able to understand the correct requirement in order to give the right kind of service. The complaints or work requirements will flow in from the customer care centre or from the supervisor.
- After a complaint has been lodged, the technician should have clarity about the work, the customer location and the details of the product's problem before going to visit the customer. There can be a situation when a technician might be able to understand the real problem only after physical examination, but it always helps to understand the problem briefly before a visit to the customer. This might save an extra visit which could happen because of incomplete information.
- Explain to the participants about the importance of personal grooming.
- Tell the participants that they represent the company in front of the customer and therefore, they should take care of personal grooming.
- Explain to the participants about the importance of personal hygiene, such as when they visit the customer their clothes should be neat and tidy, their hair should be trimmed and they must not smell of sweat as this creates an unhealthy impression in front of the customer.
- Explain to the participants about the importance of following workplace etiquette. It is the accepted social behaviour while working along with others in a team.
- It includes the norms as shown in the following figure:

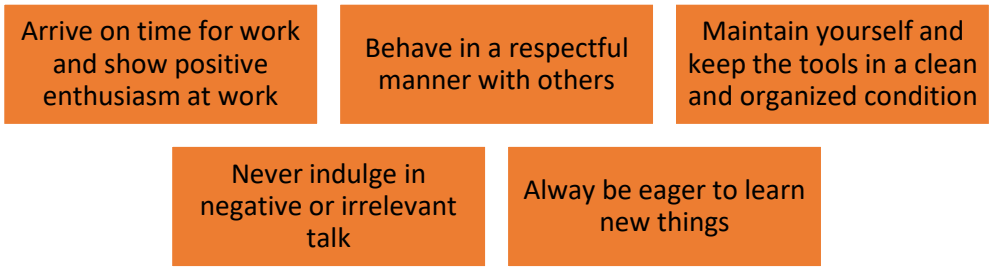

Fig.8.2.1: Workplace etiquette norms

Notes for Facilitation

- Exercise Handling Strategy
  - To facilitate the exercise, ask the participants to answer true or false for the following statements:
    1. Project management reduces the cost of project - True
    2. It is very important to create a strategy to start a project - True
    3. Project management is not beneficial for the employees – False

UNIT 3.14: Records Maintenance

Unit Objectives

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

- Identify business records
- Explain the methods of record maintenance
- Explain the importance of record maintenance

Say

- Start the session by telling the participants that support services are services that address problems with a service or product sold to a customer.
- Tell them that a technician is responsible for attending to problems to resolve or perform maintenance functions by visiting the client or remote locations.
- Tell them that an invoice is a copy from a manufacturer given to the customer after purchase of goods and services.

Notes for Facilitation

- Explain to the participants, the roles and responsibilities of a technician with the help of the following points:
  - Attends to problems to resolve them
  - Performs maintenance functions by visiting clients or remote locations
  - Assesses and installs or fixes the equipment or machinery.
  - Provides support and service in different fields such as IT.
- Tell them that a technician provides hardware and related software service and maintenance. The maintenance may include installation or repair of hardware equipment or associated software by monitoring, troubleshooting and replacing faulty modules.
- Explain to them the importance of doing regular preventive maintenance of the equipment.

- Explain that a regular maintenance plan ensures the benefits as shown in the following figure:

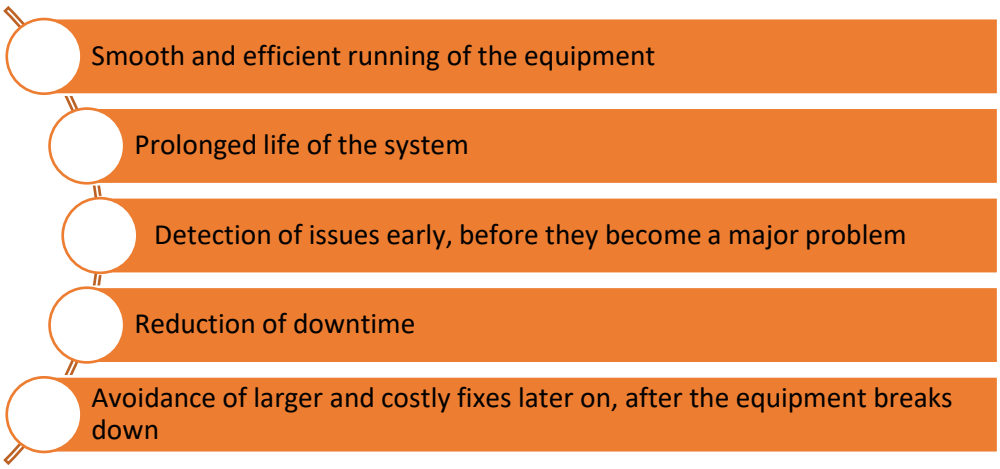

Fig.8.4.1: Regular maintenance plan

- Explain that the following steps should be followed to keep a computer system efficient:
  - Use Microsoft Fix It
  - Reduce items that run on start-up
  - Remove programs no longer in use
  - Clean the system drive
  - Clean the browser
  - Scan for and remove malware
  - Scan and remove viruses and spyware
  - Make adjustments for better performance
  - Defrag system drive
  - Add more ram memory
  - Upgrade to an SSD drive
- Explain the importance of performing software maintenance.
- Explain that software maintenance consists of the following four techniques:
  - Corrective maintenance
  - Adaptive maintenance
  - Perfective maintenance
  - Preventive maintenance
- Explain the importance of doing regular software updates.
- Explain that malware, short for malicious software, is especially designed to gain access or damage a computer without the knowledge of the owner.
- Explain the importance of performing Windows maintenance.
- Explain that Windows automatic maintenance schedules the maintenance, only when the system is on and idle.
- Explain that the first step of hardware maintenance is cleaning a computer and its components. Cleaning the physical components is essential as it:
  - Keeps everything in good working order

- Allows proper air flow
- Prevents spreading of germs

- Tell the participants about the importance of having a proper toolkit before starting cleaning and maintenance work.
- Explain to them that the hardware tools can be classified into four categories:
  - Electrostatic tools
  - Hand tools
  - Cleaning tools
  - Diagnostic tools
- Tell the participants about the importance of maintaining invoice and also tell the customer about the same.
- In addition, tell them it is necessary to maintain schedules and reports for future purpose and to keep track of all activities.
- Exercise Handling Strategy:
  - To facilitate the exercise, ask the participants to form groups and give them exercise papers which contain the fill in the blanks statements and ask them to fill them. Statements that can be used are:
    1. Common method to store the data are electronic and manual methods.
    2. IoT integrates hardware, software, infrastructure and network.

UNIT 3.15: Record Performance/Test Results

Unit Objectives

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

- Explain the significance of recording performance
- Analyse a technician's role in recording performance
- Identify methods used in recording performance

Notes for Facilitation

- Explain to the participants about SLA by saying that it is a formal contract between the service provider and the customer, defining services, responsibilities, scope and duties of both the parties.
- Then, tell them about the importance of an SLA.
- Explain to the participants that there is a formal process of addressing IT related issues and problems when they appear. This process is called as escalation process.
- Explain to them about functional and hierarchical escalation with the help of the following points:
    - Functional and hierarchical type of escalations can regularly be found inside the IT service managed condition when incident and problem management orders are executed.
    - With functional escalations, the incident/problem is routed to a more experienced part that can deliver the next level of support.
    - With functional escalations, the occurrence/issue is directed to a more experienced part that can provide further level of support.
    - Hierarchical escalations act more as a correspondence and intend to caution both the care staff and the administration, in a proactive way, of potential SLA (Service Level Agreements) breaches.
- In addition, tell them the activities involved in the escalation management process such as initiating the escalation, logging the escalation and developing an escalation management action.
- Lastly, tell them about the importance of record keeping.
- Tell them that record keeping is very beneficial, especially in case of conflicts and contradictions in the work committed and the work done. Record keeping provides several benefits.
- Inform them that there is a written escalation process available at all IT departments and all the staff members are trained to its use. Under this process:
    - Priority levels are assigned to various issues
    - Delegated responsibilities are assigned to some particular personnel
    - A particular time is allocated to some personnel to resolve the issue before escalation

- Explain issue escalation using the following figure:

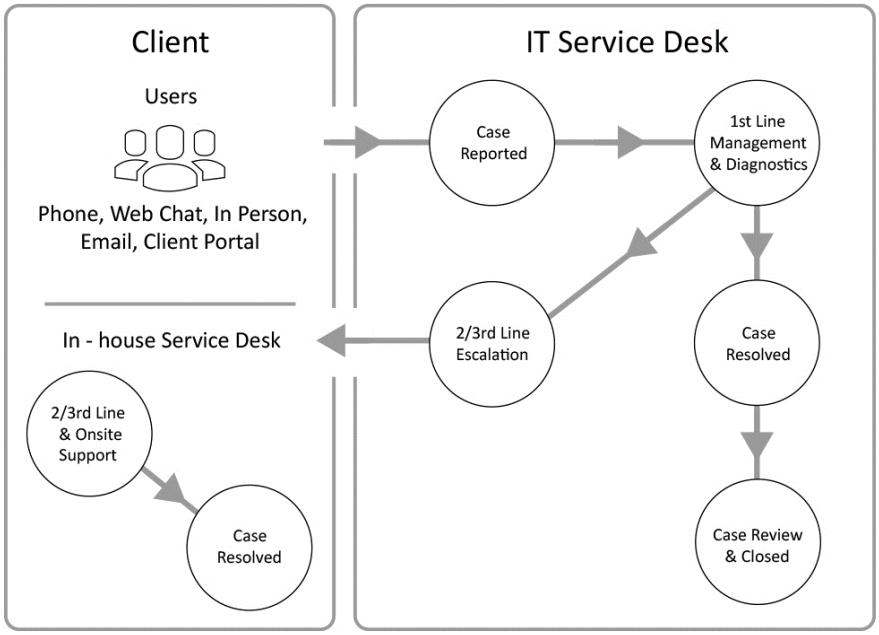

Fig.8.5.1: Issue escalation

- Exercise Handling Strategy
  - To facilitate the exercise, ask the participants to form groups and give them exercise papers which contain the fill in the blanks statements and ask them to fill them. The fill in the blank statements are as follows:
    1. Each organization needs to have proper _____with client and technician to minimize error.
    2. After service, technician should _____ check at client's place.
    3. Give one example of things that every technician should have: _____
    4. _____is one of the technician roles
    5. _____ tool is used for issue resolving by analysing previous history.
  - Answer for the above questions are:

1. Each organization needs to have proper communication with client and technician to minimize error.
2. After service, technician should schedule a maintenance and performance check at client's place.
3. Give one example of things that every technician should have:
   - Install efficient and high-quality devices.
   - Schedule a visit to client site to check the performance of the device(s).
   - Make use of automation tools.
   - Place alarm system which can signal during error.
4. Visiting customer's place for performance check is one of the technician's role.
5. Real time data tool is used for issue resolving by analysing previous history.

UNIT 3.16: Maintain Records and Process Documents

Unit Objectives

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

- Explain the importance of documentation
- Explain global format system used for documentation
- List the steps of document processing
- List the qualities required to do documentation

Notes for Facilitation

- Explain to the participants about the factors that they need to consider while doing documentation which are listed as follows:
  - What records need to be kept?
  - How are they to be stored – such as hard copy or electronic?
  - Where are the documents to be stored?
  - How long should the records to be retained? (what is an appropriate time; think about the shelf-life of the product and possibly how the product may be misused)
  - Who is responsible for the records?
  - Who needs frequent access to the records?
- Tell them that the documentation of critical incidents, whether positive or negative, is also recommended so that the managers have a record of employee performance spanning a period of time.
- Further, explain to them that documentation is used in other ways in organizations. These can include procedures, work instructions and computer software instructions, to name a few; but for purposes of the Human Resources function, these are the common uses of documentation. And, these are instructions about how to document appropriately.
- Explain to them about the list that needs to be documented when working in an organisation. The list is as follows:
  - Memos and letters sent to employees
  - A written summary of the date, time, place and people involved in an incident
  - Any work documents involved
  - Notes from meetings
  - Witness statements
  - Investigation interviews
  - Performance evaluations
  - Disciplinary actions of any kind, including termination

- Explain about the advantages of documentation which are listed in the following figure:

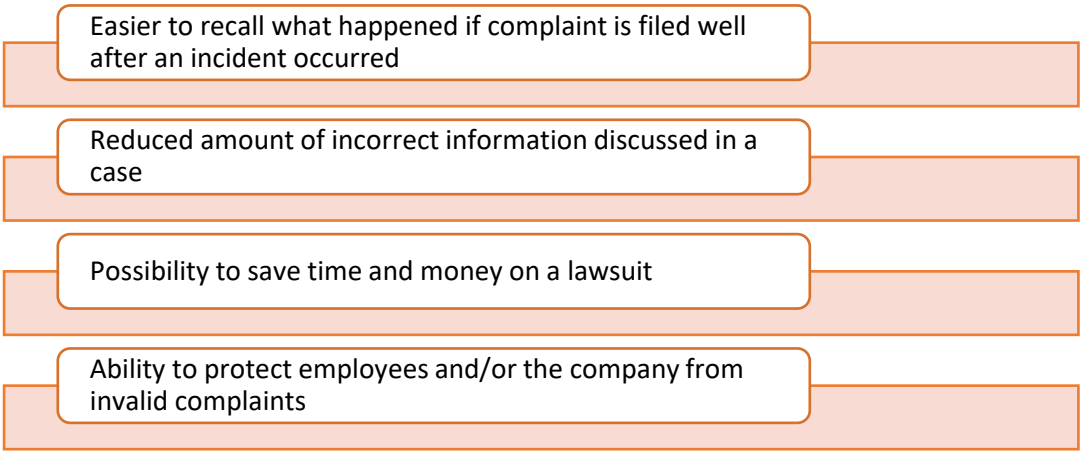

Fig 8.6.1 Advantages of documentation

- Exercise Handling Strategy:
  - To facilitate the exercise, ask the participants to group themselves for the discussion on the following topics:
    1. What are the tools used in document processing? The answer may be:
       - Laptop or desktop
       - Scanner
       - Software tools
    2. Give an example of things that a technician needs to document. The answer may be
       - The client's name
       - Project plan and strategy
       - Tools and product information
       - Duration of the project
       - Start date
       - Technician information
       - Work process information
       - Test and feedback information
       - Error report
       - Customer service and query information.
    3. Give 2 qualifications of a person who is involved in record maintenance. The answer may be:
       - Should be able to understand all the tools and sources related to maintenance
       - Should be in a position to take decisions appropriate for maintaining and processing records
       - Should be aware of legal and privacy statements
       - Should track all day-to-day activities
       - Should be able to protect them and be aware of the possible threats
       - Should be able to furnish required records
       - Should be able to classify important and unimportant information

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Corporation
Transforming the skill landscape

Telecom
Sector
Skill
Council

4. Plan work effectively Organize Resources and Implement safety Practices

Unit 4.1 – Work Place Health and Safety

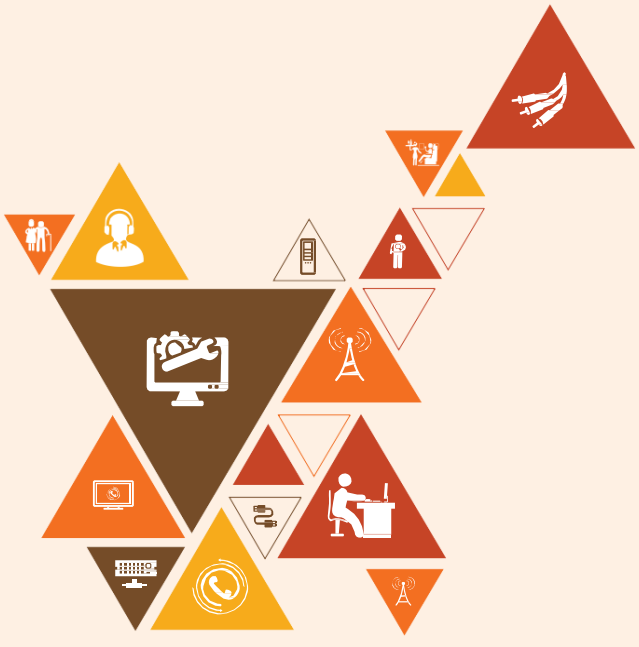
Unit 4.2 – Different types of Health Hazards

Unit 4.3 - Importance of safe working Places

Unit 4.4 - Reporting Safety Hazards

Unit 4.5 - Waste Management

unit 4.6 - Organization's focus on Greening of Jobs



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Key Learning Outcomes

At the end of this module, you will be able to:

1. Explain about workplace health and safety
2. understand different types of health hazards
3. Demonstrate various first-aid techniques
4. Understand the importance of safety at workplace
5. understand basic hygiene practices and hand washing techniques
6. Explain the need for Social Distancing
7. Understand the hazard reporting methods at workplace
8. Explain e-waste and process of disposing them
9. Explain the greening of jobs

UNIT 4.1: Workplace Health and Safety

Unit Objectives

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

1. Understand about workplace health and safety
2. Explain tips to design a safe workplace
3. Explain precautions to be taken at a workplace

Resources to be Used

- Participant handbook, white board marker pen, notebook, whiteboard, flipchart, laptop, overhead projector, laser pointer, etc.

Notes

- In this unit, we will discuss about workplace health & safety.

Say

Good morning and welcome back to this training program on Telecom E-Waste Handler.
In this session, we will discuss about workplace health & safety practices.

Ask

Ask the trainees the following questions:

- What do you understand by workplace safety?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson.

Say

In this session, we will discuss the following points:

- Safety: Tips to design a safe workplace
- Non-Negotiable employee safety habits

Let us participate in an extempore activity to understand this unit better.

Activity

- This activity will be based on individual performance.
- Provide each trainee with a printout/Xerox copy of the safety hazard report
- Now ask each of them to fill up the report individually
- After completing, collect all the forms and evaluate them
- End the session by providing constructive feedback

Activity	Duration (in mins)	Resources Used
Role-play – Safety Hazard Report	40 minutes	Participant handbook, whiteboard, notebook, laptop, pen, pencil, marker, printout/Xerox copy of safety hazard report, etc.

Do

- Ensure that the report contains all possible hazards in the workplace, safety measures, and ways to counter the hazards if they occur
- Guide the trainees throughout the activity
- Ask the trainees if they have any questions
- Encourage other trainees in the class to answer it and encourage peer learning in the class
- Explain the consequences of not following the safety guidelines at the workplace

UNIT 4.2: Different types of Health Hazards

Unit Objectives

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

1. Understand the health hazards
2. Demonstrate First Aid Techniques

Resources to be Used

- Participant handbook, pen, notebook, whiteboard, markers, flipchart, laptop, overhead projector, laser pointer, equipment and tools, safety signs and symbols, safety equipment

Notes

- In this unit, we will discuss about different types of health hazards and first aid techniques

Say

- Good morning and welcome back to this training program on Telecom E-Waste Handler. In this session, we will discuss about different types of health hazards.

.

Ask

Ask the trainees the following questions:

- What is a health hazard?
- Can you name any health hazards that may occur at the workplace?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson.

Notes for Facilitation

Illness, injuries, and pain are part of human life. This can happen anyway. Every individual is prone to illness and injuries at anytime and anywhere.
In case of any of these, some kind of immediate medical attention or treatment is needed to reduce the discomfort, pain, and deterioration of the condition

Explain the first aid techniques for injuries due to various causes. For burns, electric shock, fracture due to accidental fall etc.
Explain the concept of CRP and give a demonstration using a video how to administer CRP for a patient suffering a heart attack.
Through a demonstration explain the use of various safety gadgets used in the workplace.

Say

In this session, we will discuss the following points:

- First aid
- First aid techniques
  - For burns
  - For broken bones and fractures
  - For heart attack/stroke
  - For head injury
- Using breathing apparatus
- Briefing and guidance for firefighters
- Evacuation process
- Special evacuation requirements for specially-abled persons
- Importance of fire safety drills

Let us participate in an activity to understand this unit better.

Activity

- This session will be in the form of a "Show and Explain " activity.
- In this activity, bring a few PPE (relevant to the job role) to the class and demonstrates each of them - safety helmet, safety goggles, gloves, ear muff, respirator, harness, safety boots, etc.
- Now ask the trainees to identify the PPE and state their usage
- After the session, you will select a few volunteers and make them wear PPEs.
- The focus of this activity is to select and use appropriate personal protective equipment compatible with the work and compliant with relevant occupational health and safety guidelines.

Activity	Duration (in mins)	Resources Used
Practical activity - PPE	40 minutes	Participant handbook, laptop, overhead projector, internet connection, various protective equipment like safety helmet, safety goggles, gloves, ear muff, respirator, harness, safety boots, etc.

Do

- Ensure that all trainees participate in the activity
- Share your inputs and insight to encourage the trainees and add to what they talk about

Summarize

- Ask the participants what they have learnt so far.
- Ask if they have any questions related to what they have talked about so far.
- Close the discussion by summarizing the different health hazards and video demo of how to wear the PPE kits and first aid techniques.

UNIT 4.3: Importance of safe working practices

Unit Objectives

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

1. Explain Basic Hygiene Practices
2. Understand the importance of Social Distancing
3. Demonstrate the safe working practices

Resources to be Used

- Participant handbook, pen, notebook, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, etc.

Notes

- In this unit, we will discuss about the importance of safe working practices.

Say

Good morning and welcome back to this training program on Telecom E-Waste Handler.
In this session, we will discuss about the importance of safe working practices

Ask

Ask the trainees the following questions:

- List a few personal hygiene tips that you regularly follow.
- How social distancing helps to reduce the spread of Covid 19?
- What are the various covid protocols people followed during the pandemic?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson.

Elaborate

In this session, we will discuss the following points:

- Basic hygiene practices
    - Personal hygiene
    - Personal hygiene practices at home
- Importance of social distancing
    - Social distancing and isolation
    - Self-quarantine
    - Disposing off the PPE kits
- Safe workplace practices
    - Supplies and Accessories in the first aid box
    - CPR

Say

- Let us participate in a practical activity to understand this unit better.

Notes for Facilitation

- Familiarize the trainees with the first aid box and the supplies inside it.
- Explain the importance of first aid and why is it good to know how to administer CRP for a patient who has suffered a heart attack.
- Answer all the questions/doubts raised by the trainees in the class
- Encourage other trainees to answer queries/questions and boost peer learning in the class

Practical

- Gather all the trainees in the laboratory and divide them into groups of two
- Ask each group to demonstrate the correct process for performing CRP
- Ensure the students follow all the steps of CPR in the correct sequence
- This activity can also be performed on a dummy, if available

Activity	Duration (in mins)	Resources Used
Practical activity - CPR	60 minutes	Participant handbook, whiteboard, notebook, laptop, pen, marker, dummy (if available), etc.

Do

- Prepare in advance and use appropriate energisers
- Encourage the students to explore how the training session can help them improve their work
- Keep the ambience constructive and positive
- Ensure each contribution is given fair consideration

Answers for exercises in PHB

1. Burnt area should be kept under Lukewarm for a minimum of 10 minutes
2. Emergency exits should be easily accessible in case of fire
3. Antiseptic Cream or Solution must be applied to the wound to reduce the risk of infection
4. The RICE which is Rest, Ice, Compression and Elevation therapy must be applied to control and reduce swelling
5. CPR is Cardio Pulmonary Resuscitation

UNIT 4.4: Reporting Safety Hazards

Unit Objectives

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

1. Discuss the process of reporting in case of emergency (safety hazards)
2. Understand methods of reporting hazards

Resources to be Used

Participant handbook, pen, notebook, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, etc.

Say

Good morning and welcome to this training program on Telecom Technician-IOT Devices/ Systems In this session, we will discuss about reporting safety hazards.

Ask

Ask the trainees the following questions:

- What is a safety hazard?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson.

Elaborate

In this session, we will discuss the following points:

- Methods of reporting safety hazards
- Describing hazard matrix
- Hazard report form

Say

Let us participate in an activity to understand this unit better.

Notes for Facilitation

- Explain the trainees about reporting the safety hazards to the people concerned.
- Explain the 6C's of communication protocols followed in the organizations.
    - Communicate First
    - Communicate Rightly
    - Communicate Credibly
    - Communicate Empathetically
    - Communicate to instigate appropriate action
    - Communicate to promote respect
- Explain about the Hazard report form
- Ask the trainees if they have any questions
- Encourage other trainees to take part in the activity and encourage peer learning in the class
- Discuss the exercises at the end of the chapter in the Participant Handbook and encourage them to answers.

Activity

- Divide the class into small groups
- Conduct a quiz and ask questions related to the unit
- Display all questions on the projector screen
- Display the correct answer after all groups have got their chances of answering a given question

Activity	Duration (in mins)	Resources Used
Quiz – Interpreting Signs	40 minutes	Laptop, internet connection, overhead projector, white screen, whiteboard, markers, laser pointer

Do

- Ask a student to maintain the scores on the whiteboard
- Jot down the crucial points on the whiteboard as the students speak
- Share your inputs and insight to encourage the students and add to what they talk about
- Ensure that all students participate in the class
- Ask a student to summarise what was discussed in the session
- Demonstrate enthusiasm for the subject matter, course and participant's work

UNIT 4.5: Waste Management

Unit Objectives

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

1. explain what is e-waste?
2. Understand the concept of waste management
3. Explain the process of recycling e-waste

Resources to be Used

- Participant handbook, pen, notebook, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, etc.

Say

Good morning and welcome back to this training program on Telecom Customer Care Executive (Repair Centre).
In this session, we will discuss about waste management.

Ask

Ask the trainees the following questions:

- What do you understand by waste management?
- What are the sources of medical waste?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson.

Elaborate

In this session, we will discuss the following points:

- Introduction to e-waste
  - What is e-waste?
- Electronic goods/gadgets are classified under three major heads
- E-waste management process
- Recyclable and non-recyclable waste
- Colour codes of waste collecting bins
- Waste disposal methods
- Sources of waste
- Source of Pollution
- Types of Pollution – Air, Water, Soil, Noise, Light

Say

Let us participate in an extempore activity to understand this unit better.

Activity

- This activity will be based on individual performance.
- In this activity, you will give two topics to the trainees
- The first topic in this session will be air pollution.
- The second topic on which the trainees will prepare their extempore will be on waste disposal method.
- You will randomly pick up trainees and separate them into two groups.
- Ensure that the trainees are equal in number.
- Allot the trainees 2 minutes to prepare the topic you will give them.
- After the time is up, you will call out any trainee and ask them to speak on the topic for 5 minutes.
- The trainee, with a simple explanation but rich content, will be appreciated with accolades.

Activity	Duration (in mins)	Resources Used
Extempore	40 minutes	Participant Handbook, Whiteboard, Notebook, Pen, Pencil, Marker, etc.

Do

- Do a de-briefing of the activity
- Conduct a doubt clarification session if needed.
- Encourage the quiet and shy trainees to open up and speak

Notes for Facilitation

- Encourage other participants to answer it and encourage peer learning in the class
- Answer all the doubts in case any of the participants

UNIT 4.6: Organization's focus on Greening of Jobs

Unit Objectives

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

1. Understand the concept of ESG
2. Explain the different factors of ESG

Resources to be Used

- Participant handbook, pen, notebook, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, etc.

Say

Good morning and welcome back to this training program on Telecom Customer Care Executive (Repair Centre).
In this session, we will discuss about greening of Jobs

Ask

Ask the trainees the following questions:

- What is ESG?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson.

Elaborate

In this session, we will discuss the following points:

- What is ESG?
  - ESG stands for Environmental, Social, and Governance.
  - Environmental, social, and governance (ESG) investing refers to a set of standards for a company's behaviour used by socially conscious investors to screen potential investments.
  - Investors are increasingly applying these non-financial factors as part of their analysis process to identify material risks and growth opportunities.
- Factors of ESG
  - Environmental
  - Social
  - Governance

Say

Let us participate in a group discussion to explore the unit a little more.

Activity

- Conduct a group discussion in the class on the factors of ESG
- Ask the participants what they have learnt from this exercise
- Ask if they have any questions related to what they have talked about so far
- Close the discussion by summarising the importance of the ESG in recent times

Activity	Duration (in mins)	Resources Used
Group Discussion	45 minutes	Participant Handbook, Whiteboard, Notebook, laptop, Pen, Pencil, Marker, microphone and speakers etc.

Do

- Do a de-briefing of the activity
- Conduct a doubt clarification session if needed.
- Encourage the quiet and shy trainees to open up and speak
- Ensure a friendly and cordial atmosphere during the group discussion
- Give chance to each and everybody to give their opinion
- Guide the students in identifying key points

Notes for Facilitation

- Encourage other participants to answer it and encourage peer learning in the class
- Answer all the doubts in case any of the participants
- Discuss the proper combination technique in group discussion
- Make sure everybody understood the concept of greening of Jobs

Ask

- If they can, why can't you?
- Discuss concepts related to 'Creativity and Innovation' with the participants as given in the Participant Handbook.

Say

- Recall the stories on motivation.
- What is the inner drive that motivates people to succeed?
- Let's learn more about such creative and innovative entrepreneurs with the help of an activity.

Team Activity

- This is a group activity.
- Think of any one famous entrepreneur and write a few lines about him or her.

Activity De-brief

- Why did you choose this particular entrepreneur?
- What is his/her brand name?
- What creativity does he/she possess?
- What was innovative about their ideas?

Do

- Conduct a doubt clarification session if needed.
- Encourage the non-participating trainees to open up and speak

Summarize

- Summarize the unit by asking participants if they know of some people who are highly creative and innovative in their approach.
- Ask them to share some experiences about these people with the class.

Notes for Facilitation

- Source for stories on innovations:

http://www.rediff.com/getahead/report/achievers-top-31-amazing-innovations-from-young-Indians/20151208.htm

Answer for exercises in PHB

1. ESG stand for Environmental, Social, Governance
2. Governance factors include tax strategy, structure of the company, relationship with the stakeholders
3. The three causes of air pollution emissions from the car, factories emitting chemical dust, and pollen
4. Mining waste includes chemical gases
5. Landfill is a Waste that can't be recycled or reused
6. Green and blue coloured bins are used for disposing the waste
7. The plastics cans are trashed in Blue colored bin.
8. discarded electrical and electronic components are considered as e-Waste
9. glass part of e-waste is recycled and used again
10. E-waste is made up of hazardous substances like lead, mercury and Cadmium

Skill India
कौशल भारत - कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

5. Interact effectively with team members and customers

Telecom
Sector
Skill
Council

Unit 5.1 – Discuss how to communicate effectively and develop interpersonal skills

Unit 5.2 – Explain the importance of developing sensitivity towards Differently abled people

TEL/N9102

Key Learning Outcomes

At the end of this module, you will be able to:

1. Understand what communication is and the importance of communication in the workplace
2. Understand effective communication and how to communicate effectively for success
3. Discuss types of communication - verbal and non-verbal
4. Communicate at workplace
5. Communicate effectively with superiors
6. Communicate effectively with colleagues and customers using different modes viz face-to-face, telephonic and email communication
7. Understand the hurdles to effective communication
8. Conduct professionally at the workplace
9. Respect differences in gender and ability
10. Communicate effectively with a person with disabilities
11. Show respect for disabled people

UNIT 5.1: Interaction with supervisor, peers and customers

Unit Objectives

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

4. Understand the importance of communication
5. Understand types of communication

Resources to be Used

- Participant handbook, pen, notebook, whiteboard, flipchart, markers, laptop, overhead projector, laser pointer, equipment and tools

Notes

- In this unit, we will discuss how to communicate effectively with supervisor, peers and customers

Say

Good morning and welcome to this training program on Telecom Technician-IOT Devices/ Systems In this session, we will discuss about effective communication with supervisor, peers and customers

Ask

Ask the trainees the following questions:

- What is communication?
- What is non-verbal communication?
- What are the barriers to effective communication?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson

Elaborate

In this session, we will discuss the following points:

- What is communication?
- Why is communication important?
- Effective communication
    - Effective communication for success
    - Significance of clear and effective communication
- Types of communication
    - Verbal communication
    - Non-Verbal communication
        - Signs and symbols
        - Gestures and expressions
- Communication at workplace
    - Communication with supervisors
    - Communication with colleagues & customers
    - Face-to-face communication
    - Telephonic communication
    - Email communication
- Importance of timely completion of tasks
- Standard operating procedure
- Escalation matrix
    - Escalation mechanism
    - Escalation through CRM
- Escalation Issues at work
    - What does it mean to escalate an issue at work?
    - When should you escalate an issue at work?
- Hurdles for effective communication
- Professional conduct
- Respect gender differences
- Communication with a disabled person
    - Communicating with people with a hearing impairment
    - Respect People with disability
    - Safety at the workplace for people with disability
        - Responsibilities of an employer towards disabled people
- Workplace adaptations for people with disability
    - Workplace adaptations

Say

In this session, we will discuss the following points:

Let us participate in the activity to understand all about effective communication

Activity

Scenario 1:

- This is an activity involving two. One volunteer as boss and the other as team member
- Provide the trainees with a scenario mentioned below
- You are the boss for a team of 15 members. You want to convey your displeasure regarding the performance of one of your team member. How would you convey this to him/her
- State what measures you will take to convey this matter to them.

Scenario 2:

- This is an activity involving two. One volunteer as boss and the other as team member
- Provide the trainees with a scenario mentioned below
- You are the boss for a team of 15 members. You want to appreciate one of your team mate's performance. He closed a big business deal of Rs.1 cr. How would you do?
- State what measures you will take to appreciate to them.

Activity	Duration (in mins)	Resources Used
Mock activity	60 minutes	Participant handbook, whiteboard, laptop, notebook, pen, pencil, marker, etc.

Do

- Ensure that all trainees participate in the class.
- Encourage the non-participating trainees to open up and speak.
- Do a de-briefing for this activity. You tell them, scolding is always done in private, one to one, whereas appreciation is always done in open in front of others, for them to feel happy about it and at the same time others get motivated to give their best performance.

Notes for Facilitation

- Ask them to answer the questions given in the participant manual.
- Ensure that all the participants answer every question.
- Answer all the doubts raised by the trainees in the class
- Discuss the proper communication technique in all the class activity

UNIT 5.2: Explain the importance of developing sensitivity towards differently abled people

Unit Objectives

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

3. Communicate Effectively with person with disabilities
4. Respect people with disability, at workplace

Resources to be Used

- Participant handbook, pen, notebook, whiteboard, markers, flipchart, laptop, overhead projector, laser pointer, equipment and tools

Notes

- In this unit, we will discuss about how to communicate effectively with people who has disabilties

Say

- Good morning and welcome back to this training program on Telecom Customer Care Executive (Repair Centre).
- In this session, we will discuss about how to communicate with people who are differently abled

.

Ask

Ask the trainees the following questions:

- What is an effective communication?
- Have they ever got an opportunity to help/assist a disabled person?

Write down the trainees' answers on the whiteboard/flipchart.
Draw appropriate cues from the answers and start teaching the lesson

.

Notes for Facilitation

A **disability** is any condition that makes it more difficult for a person to do certain tasks or interact with the people around them (socially or materially). These conditions, or defects, may be cognitive, developmental, intellectual, mental, physical, sensory, or a combination of multiple conditions

As a co-worker, one should be empathetic with them and talk to them politely and with respect. Every work place has guidelines for handling these kinds of people. And all employees need to adhere to those guidelines.

Say

In this session, we will discuss the following points:

- What is a disability
- General tips for communication with disabled people
- Respect people with disability
- Work place safety for people with disability
- Work place adaptation by people with disability

Do

- Ensure that all trainees have understood the purpose of this module
- Encourage them to participate in the discussion

Summarize

- Ask the participants what they have learnt so far.
- Ask if they have any questions related to what they have talked about so far.
- Explain them how to interact with differently abled people, respect them and assist and support them to complete their work if need be.
- Learnt about effectively communicating with people who are differently abled.

Ask

- If they can, why can't you?
- Discuss concepts related to 'Creativity and Innovation' with the participants as given in the Participant Handbook.

Say

- Recall the stories on motivation.
- What is the inner drive that motivates people to succeed?
- Let's learn more about such creative and innovative entrepreneurs with the help of an activity.

Team Activity

- This is a group activity.
- Think of any one famous entrepreneur and write a few lines about him or her.

Activity De-brief

- Why did you choose this particular entrepreneur?
- What is his/her brand name?
- What creativity does he/she possess?
- What was innovative about their ideas?

Do

- Conduct a doubt clarification session if needed.
- Encourage the non-participating trainees to open up and speak

Summarize

- Summarize the unit by asking participants if they know of some people who are highly creative and innovative in their approach.
- Ask them to share some experiences about these people with the class.

Notes for Facilitation

- Source for stories on innovations:

http://www.rediff.com/getahead/report/achievers-top-31-amazing-innovations-from-young-Indians/20151208.htm

Answers for exercises in PHB

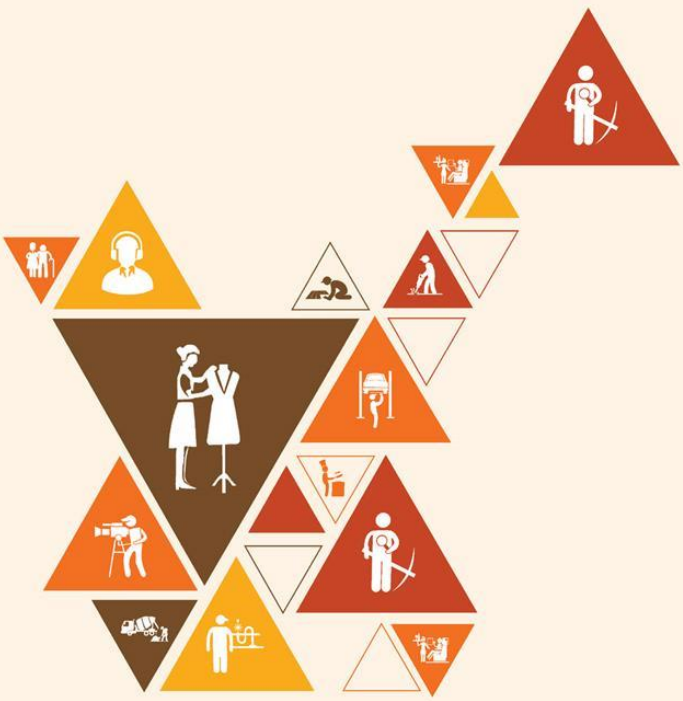
1. What are the three points you will focus on when you talk to people face to face?
   i. Adjust the tone of voice, don't be too loud
   ii. Make eye contact
   iii. Use appropriate language
   iv. Maintain adequate distance
   v. Acknowledge, nod during interaction
   vi. Use appropriate non-verbal gestures to communicate with persons with disabilities

2. Before sending the mail it's important to check the Grammar and Spelling of the content
3. When you interact through phone, provide your identity details like Name and Company
4. Add your Signature at the bottom of your mail.
5. The Customer Care Executives are responsible for handling customer queries

11. Annexures

Annexure 1 – Training Delivery Plan

Annexure 2 – Assessment Criteria



Annexure 1

Training Delivery Plan

Training Delivery Plan			
Program Name:	Certificate Course in Telecom Technician – IoT Devices/Systems		
Qualification Pack Name & Ref. ID	Telecom Technician – IoT Devices/Systems (TEL/Q6210)		
Version No.	4.0	**Version Update Date**	27-01-2022
Pre-requisites to Training	10 + 2 preferably		
Training Outcomes	After completing this programme, participants will be able to: 1. Install IoT Devices at Customer Premises/equipment: List IoT devices (nodes and gateways) and identify suitable points/locations for installing them. 2. Configure IoT devices and establish communication: Connect nodes and gateways (hardware pre-configured) to data transfer devices (PC/Laptop) for software upload to micro-controllers, on-board compilation and debugging of software. 3. Troubleshoot the IoT devices: Troubleshoot IoT nodes and gateways over different modes of communication (Bluetooth, Zigbee, Wi-Fi etc.) 4. Demonstrate health and safety measures: Work in accordance with emergency procedures, standards and guidelines for health and safety in the organization		

Sl. No.	Module Name	Session Name	Session Objectives	NOS Reference	Methodology	Training Tools/Aids	Duration (hours)
1	Role and Responsibilities of a Telecom Terminal Equipment Application Developer (Android)	Introduction to the program Introduction to the Telecom Technician IOT Devices/Systems	• Explain the overview of the Program • Explain the role and responsibilities of Telecom Technician IOT Devices/Systems • Rules for Efficient Learning in the class room • Discuss the outcome of this training program and the employment opportunities for the trainees. • Identify the various electrical and electronic components and their specifications. • Explain the scope/future and industry of the IOT device/system. • Introduce Internet of things • Applications of IoT	Bridge module	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Laptop with software like MS Office and internet, Whiteboard, Marker, Projector	6 T (4:00) P (2:00)
2		Microprocessors,Sensors, Actuators	• Explain Microprocessors and MIcrocontrollers • Explain Types and Functions of Sensors • Assembling of Mother board				6 T(4:00) P(2:00)
3		Communication Protocols, Microcontroller Boards	• Data transfer types and protocols in IoT • Discuss the components of a microcontroller board •				4 T(2:00) P(2:00)
4		Understanding Edge Devices,Nodes and Gateways,Cloud Computing	• Introduction to Edge Devices • Functions of Edge Devices • System requirement for installing Android Studio • Installation of Android Studio				14 T(10:00) P(4:00)
5	(TEL/N6234)Install and Configure IOT devices at customer premises	Preparing for installation of IOT devices	•Discuss various type of micro-processor boards (Arduino, Raspberry-pi, other customized platforms) and microcontrollers •Explain the function of various types of sensors (humidity, temperature, reed, pressure, gyrometer, accelerometer, video surveillance cameras etc) and actuators •Discuss the short range communication protocols (blue tooth, Zigbee, Wi-fi, etc) and long range •protocols including 3G/4G, 6 lowpan, lora etc and their applicability in IoT •Examine various components and pin configurations of micro-controller boards and interconnectivity provisions for input/output power supply etc •Explain the key differences between node and a gateway and their respective applications	TEL/N6234-PC1-PC5	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Laptop with software like MS Office and internet, Whiteboard, Marker, Projector, JDK software, IDE for android application development	66 T(36:00) P(42:00)
6		Running the project	• perform testing of the functionality and UI of the app using different emulators • concept of activity and activity lifecycle • fundamentals of SDK and its tools • Procedure to create AVD	TEL/N6234-PC17,KU9,KU3, KU4			22 T(12:00) P(20:00)
7		Creating a Project with Simple Userinterface	• Define height,width and background for the project using XML elements • Make it interactive by placing various controls and Menus in the project	TEL/N6234-PC7,PC12,			22 T(1200 P(18:00)

8	TEL/N6236 Perform level 1 troubleshooting of IOT devices	Basic Layout, Short Messaging Services and Networking	• implement changes in layout, add Graphic User Interface (GUI) and create necessary code for sending and receiving Short Messaging Service (SMS) • send SMS using intent and also setup SMS receiving • create different layout and incorporate email service • integrate location based services • execute various tasks such as long running tasks, repeated tasks, asynchronous tasks on a separate thread repeatedly	TEL/N6236-PC7,PC8,PC9,PC11,PC19	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Tablets of different brands Laptop with software like MS Office and internet, Whiteboard, Marker, Projecto, SQLIte	34 T:14:00) P(20:00)
9		Data Storage	• implement data persistence to prevent loss of data • Explain the various techniques of storage of data namely cloud storgae, internal storage, external storage (SD Card) and static resources • android local data storage techniques	TEL/N6236-PC1,PC3,KU3			32 T:12:00) P(20:00)
10		Working with SQLite	• Explain the Structured Query Language (SQL) commands to select, insert, update or delete data in the database • Explain the integration of the database with application • database and data persistence tools and techniques • process to create a database • concepts and application of SQL	TEL/N6236-PC4,PC5, KU3,KU4,KU5			12 T:12:00) P(20:00)
13		Networking and Publishing	• organise the application for release on application store • prepare to public the application in google play store • deploy and publish the applications on android platform • fundamentals of networking	TEL/N2302-PC9,PC11,PC12, KU8			32 T(12:00) P(20:00)
15	TEL/N9101 Organise resources and work effectively and safely	Perform work as per quality standards	•Employ appropriate ways to keep the workspace clean and tidy •Discuss how to perform individual roles and responsibilities as per the job role while taking accountability for the work •Show how to record/document tasks completed as per the requirements within specific timelines •Perform the steps to implement schedules to ensure the timely completion of tasks •Identify the cause of a problem related to your own work and validate it •Apply appropriate techniques to analyse problems accurately and communicate different possible solutions to the problem	TEL/N9101 PC1, PC2, PC3, PC4, PC5, PC6	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Whiteboard/blackboard marker /chalk, Duster, Computer or Laptop attached to LCD projector, Personal Protection Equipment: Safety glasses, Head protection, Rubber gloves, Safety footwear, Warning signs and tapes, Fire extinguisher and First aid kit	6 T(2:00) P(4:00)

16		Maintain a safe, healthy and secure working environment (Part - 1)	•Discuss how to comply with the organisation's current health, safety, security policies and procedures •Demonstrate the steps to check for water spills in and around the workspace and escalate these to the appropriate authority •Practice reporting any identified breaches in health, safety, and security policies and procedures to the designated person •Use safety materials such as goggles, gloves, earplugs, caps, ESD pins, covers, shoes, etc. •Apply required precautions to avoid damage of components due to negligence in ESD procedures or any other loss due to safety negligence •Identify hazards such as illness, accidents, fires or any other natural calamity safely, as per the organisation's emergency procedures, within the limits of the individual's authority •Explain the importance of regularly participating in fire drills or other safety-related workshops organised by the company •Discuss the significance of reporting any hazard outside the individual's authority to the relevant person in line with organisational procedures and warn others who may be affected	TEL/N9101 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11, PC12, PC13, PC14	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Whiteboard/blackboard marker /chalk, Duster, Computer or Laptop attached to LCD projector, Personal Protection Equipment: Safety glasses, Head protection, Rubber gloves, Safety footwear, Warning signs and tapes, Fire extinguisher and First aid kit	6 T(2:00) P(4:00)
17		Maintain a safe, healthy and secure working environment (Part - 2)	•Explain how to maintain appropriate posture while sitting/standing for long hours •Employ appropriate techniques to handle heavy and hazardous materials with care while maintaining an appropriate posture •Discuss the importance of sanitising workstations and equipment regularly •Discuss how to avoid contact with anyone suffering from communicable diseases and take necessary precautions •Show how to clean hands with soap and alcohol-based sanitiser regularly •List the safety precautions to be taken while travelling, e.g., maintain a 1m distance from others, sanitise hands regularly, wear masks, etc. •Role-play a situation to report hygiene and sanitation issues to the appropriate authority •Discuss how to follow recommended personal hygiene and sanitation practices, for example, washing/sanitising hands, covering the face with a bent elbow while coughing/sneezing, using PPE, etc.	TEL/N9101 PC15, PC16, PC17, PC18, PC19, PC20, PC21, PC22	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Whiteboard/blackboard marker /chalk, Duster, Computer or Laptop attached to LCD projector, Personal Protection Equipment: Safety glasses, Head protection, Rubber gloves, Safety footwear, Warning signs and tapes, Fire extinguisher and First aid kit	6 T(2:00) P(4:00)

18		Conserve material / energy / electricity	•Apply appropriate ways to optimise the usage of material, including water, in various tasks/activities/processes •Use resources such as water, electricity and others responsibly •Demonstrate the steps to carry out routine cleaning of tools, machines and equipment • Apply appropriate ways to optimise the use of electricity/energy in various tasks/activities/processes •Perform periodic checks of the functioning of the equipment/machine and rectify wherever required •Explain the significance of reporting malfunctioning and lapses in the maintenance of equipment •Use electrical equipment and appliances properly	TEL/N9101 PC23, PC24, PC25, PC26, PC27, PC28, PC29			6 T(2:00) P(4:00)
19		Use effective waste management / recycling practices	•Identify recyclable, non-recyclable and hazardous waste •Apply appropriate ways to deposit recyclable and reusable material at the identified location •Explain the process to dispose of non-recyclable and hazardous waste as per recommended processes	TEL/N9101 PC30, PC31, PC32			6 T(2:00) P(4:00)
20	TEL/N9102 Communication and interpersonal skills	Interact effectively with superiors	•Explain how to receive work requirements from superiors and customers and interpret them correctly •Role-play a situation to inform the supervisor and/or concerned person about any unforeseen disruptions or delays •Practice participating in decision-making by providing facts and figures, giving/accepting constructive suggestions •Practice rectifying errors as per feedback and ensure the errors are not repeated	TEL/N9102 PC1, PC2, PC3, PC4	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Whiteboard and Markers, Chart paper and sketch pens, LCD Projector and Laptop for presentations, Sample of escalation matrix, organisation structure	6 T(2:00) P(4:00)
21		Interact effectively with colleagues and customers (Part - 1)	•Discuss how to comply with the organisation's policies and procedures for working with team members •Apply appropriate modes of communication, such as face-to-face, telephonic and written, to communicate professionally •Show how to respond to queries and seek/provide clarifications if required	TEL/N9102 PC5, PC6, PC7			6 T(2:00) P(4:00)
22		Interact effectively with colleagues and customers (Part - 2)	•Illustrate the process to co-ordinate with the team to integrate work as per requirements •Discuss how to resolve conflicts within the team/with customers to achieve a smooth workflow •Discuss how to recognise emotions accurately in self and others to build good relationships •State how to prioritise team and organisation goals above personal goals	TEL/N9102 PC8, PC9, PC10, PC11			6 T(2:00) P(4:00)

23		Gender sensitisation	•Explain how to maintain a conducive environment for all genders in the workplace •Discuss ways to encourage appropriate behaviour and conduct with people across gender •Explain how to ensure equal participation of people across genders in discussions	TEL/N9102 PC12, PC13, PC16			6 T(2:00) P(4:00)
24		PwD sensitisation	•Identify ways to assist team members with a disability in overcoming any challenges faced at work •Practice appropriate verbal and non-verbal communication while interacting with People with Disability (PwD)	TEL/N9102 PC14, PC15			6 T(2:00) P(4:00)
25	Employability Skills	DGT/VSQ/N0102 Employability Skills		DGT/VSQ/N0101			60 hrs
Grand Total: 540 hrs Total Theory Duration: 150 hrs Total Practical Duration: 210 hrs OJT Duration: 120 DGT Employability Skills: 60							

Annexure II

Assessment Criteria

CRITERIA FOR ASSESSMENT OF TRAINEES

Assessment Criteria for "Telecom Technician - IoT Devices/Systems"	
Job Role	Telecom Technician - IoT Devices/Systems
Qualification Pack	TEL/Q6210, V. 4.0
Sector Skill Council	Telecom Sector Skill Council
Sr. No.	**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.
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 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 unsuccessful completion, the trainee may seek reassessment on the Qualification Pack.

Assessment Outcome	Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N6234: Install and configure IOT devices at customer premises	*Analyse requirements for IoT devices*	**10**	**12**	**-**	**3**
	PC1. identify various type of micro-processor boards (Arduino, Raspberry-pi, other customized platforms) and microcontrollers	2	-	-	1
	PC2. determine functioning of various types of sensors (humidity, temperature, reed, pressure, gyrometer, accelerometer, video surveillance cameras etc) and actuators	2	6	-	1
	PC3. identify short range communication protocols(blue tooth, Zigbee, Wi-fi, etc) and long range protocols including 3G/4G, 6 lowpan, lora etc and their applicability in IoT	2	-	-	-
	PC4. examine various components and pin configurations of micro-controller boards and interconnectivity provisions for input/output power supply etc	2	6	-	1
	PC5. identify the key differences between node and a gateway and their respective applications	2	-	-	-
	Install IOT devices at suitable points/locations	**8**	**16**	**-**	**2**
	PC6. generate installation points for capturing desired input parameters and gateway accounting to meet with power supply requirements	2	8	-	1
	PC7. establish communication line connectivity using appropriate nodes, gateway, ethernet and 3G/4G/Wi-fi networks and check functioning of the protocols	2	4	-	-
	PC8. locate points on surface and mount IoT devices at identified points/location	2	4	-	1
	PC9. manage necessary connections for power supply and earthing by ensuring proper grounding, no floating earth situation and understanding of SNR in case of wiring	2	-	-	-
	Configure devices to ensure effective data transfer	**14**	**14**	**-**	**3**
	PC10. interpret connectivity options available on micro controller boards for data transfer	2	-	-	-

	PC11. use appropriate cable connectors and microcontroller for connection to data transfer device (desktop/laptop)	2	-	-	-
	PC12. install suitable framework on desktop/laptop which is compatible with the micro-controller board	2	4	-	1
	PC13. transfer software code to on-board micro- processor through nodes and gateways	2	4	-	-
	PC14. compile on-board micro processor code using appropriate framework on desktop/laptop.	2	-	-	1
	PC15. identify faults/errors in codes and debug software	2	6	-	-
	PC16. manage proper functioning of micro-controller and related devices using appropriate emulators/framework features	2	-	-	1
	Test connections between nodes, gateways and backend servers	**8**	**8**	**-**	**2**
	PC17. set up nodes and gateways appropriately for execution of the uploaded software	2	8	-	1
	PC18. confirm communication/data transfer using on-screen i/o streams or appropriate led indications (as per the system test manual)	2	-	-	-
	PC19. establish effective connectivity between gateway and local Wi-fi router or 3G/4G connectivity options (pre-configured in the uploaded software on gateway micro-controller), including configuration	2	-	-	1
	PC20. check data transfer and confirm the same from the server end	2	-	-	-
	NOS Total	**40**	**50**	**-**	**10**

Assessment Criteria	Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N6236: Perform level 1 trouble-shooting of IOT devices	*Troubleshoot IOT nodes/gateway*	**17**	**32**	**-**	**4**
	PC1. setup test environment and formulate test strategy/test cases	4	6	-	-
	PC2. test connectivity between various devices/components, such as between sensors and micro-controller, using appropriate software tools/framework	3	4	-	1
	PC3. check all connections and pin/jumper settings to ensure uninterrupted on board power supply	3	6	-	1
	PC4. re-load the node software	2	6	-	1
	PC5. check on-board memory storage card (for storing node data) using appropriate micro- controller board and software/framework	3	6	-	1
	PC6. record performance/test results	2	4	-	-
	Troubleshoot communication devices	**23**	**18**	**-**	**6**
	PC7. check the working of various connection/communication modules, such as Wifi, 3G and 4G, whichever is applicable at nodes	4	-	-	1
	PC8. create appropriate connectivity IDs/password in the software code	3	6	-	1
	PC9. check communication link performance matrix between node and gateway using appropriate software tools/framework	4	6	-	1
	PC10. re-load nodes and gateway software, if required, and check communication again	4	6	-	1
	PC11. check data transfer from gateway to server	4	-	-	1
	PC12. escalate the issues/concern to the central/main tech team	4	-	-	1
	NOS Total	**40**	**50**	**-**	**10**

Assessment Criteria	Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
TEL/N9101: Organise Work and Resources as per Health and Safety Standards	*Perform work as per quality standards*	**4**	**9**	**-**	**2**
	PC1. keep workspace clean and tidy	-	1	-	-
	PC2. perform individual role and responsibilities as per the job role while taking accountability for the work	1	1	-	1
	PC3. record/document tasks completed as per the requirements within specific timelines	-	1	-	1
	PC4. implement schedules to ensure timely completion of tasks	-	2	-	-
	PC5. identify the cause of a problem related to own work and validate it	2	2	-	-
	PC6. analyse problems accurately and communicate different possible solutions to the problem	1	2	-	-
	Maintain safe, healthy and secure working environment	**16**	**27**	**-**	**4**
	PC7. comply with organisation's current health, safety, security policies and procedures	1	1	-	-
	PC8. check for water spills in and around the workspace and escalate these to the appropriate authority	1	2	-	1
	PC9. report any identified breaches in health, safety, and security policies and procedures to the designated person	1	2	-	1
	PC10. use safety materials such as goggles, gloves,ear plugs, caps, ESD pins, covers, shoes, etc.	1	2	-	1
	PC11. avoid damage of components due to negligence in ESD procedures or any other loss due to safety negligence	2	3	-	1
	PC12. identify hazards such as illness, accidents, fires or any other natural calamity safely, as per organisation's emergency procedures, within the limits of individual's authority	2	1	-	-
	PC13. participate regularly in fire drills or other safety related workshops organised by the company	1	3	-	-

	PC14. report any hazard outside the individual's authority to the relevant person in line with organisational procedures and warn others who may be affected	1	3	-	-
	PC15. maintain appropriate posture while sitting/standing for long hours	1	1	-	-
	PC16. handle heavy and hazardous materials with care, while maintaining appropriate posture	1	1	-	-
	PC17. sanitize workstation and equipment regularly	1	2	-	-
	PC18. clean hands with soap, alcohol-based sanitizer regularly	-	1	-	-
	PC19. avoid contact with anyone suffering from communicable diseases and take necessary precautions	-	1	-	-
	PC20. take safety precautions while travelling e.g. maintain 1m distance from others, sanitize hands regularly, wear masks, etc.	1	2	-	-
	PC21. report hygiene and sanitation issues to appropriate authority	1	1	-	-
	PC22. follow recommended personal hygiene and sanitation practices, for example, washing/sanitizing hands, covering face with a bent elbow while coughing/sneezing, using PPE, etc.	1	1	-	-
	Conserve material/energy/electricity	**7**	**16**	**-**	**3**
	PC23. optimize usage of material including water in various tasks/activities/processes	1	2	-	-
	PC24. use resources such as water, electricity and others responsibly	1	2	-	1
	PC25. carry out routine cleaning of tools, machine and equipment	1	2	-	-
	PC26. optimize use of electricity/energy in various tasks/activities/processes	1	3	-	1
	PC27. perform periodic checks of the functioning of the equipment/machine and rectify wherever required	1	3	-	1
	PC28. report malfunctioning and lapses in maintenance of equipment	1	2	-	-
	PC29. use electrical equipment and appliances properly	1	2	-	-

	Use effective waste management/recycling practices	**3**	**8**	**-**	**1**
	PC30. identify recyclable, non-recyclable and hazardous waste	1	2	-	1
	PC31. deposit recyclable and reusable material at identified location	1	3	-	-
	PC32. dispose non-recyclable and hazardous waste as per recommended processes	1	3	-	-
	NOS Total	**30**	**60**	**-**	**10**
TEL/N9102: Interact Effectively with Team Members and Customers	*Interact effectively with superiors*	**7**	**15**	**-**	**2**
	PC1. receive work requirements from superiors and customers and interpret them correctly	1	2	-	-
	PC2. inform the supervisor and/or concerned person about any unforeseen disruptions or delays	2	4	-	1
	PC3. participate in decision making by providing facts and figures, giving/accepting constructive suggestions	2	5	-	1
	PC4. rectify errors as per feedback and ensure the errors are not repeated	2	4	-	-
	Interact effectively with colleagues and customers	**7**	**26**	**-**	**4**
	PC5. comply with organisation's policies and procedures for working with team members	1	2	-	-
	PC6. communicate professionally using appropriate mode of communication such as face-to-face, telephonic and written	2	4	-	1
	PC7. respond to queries and seek/provide clarifications if required	2	4	-	1
	PC8. co-ordinate with team to integrate work asper requirements	-	3	-	-

	PC9. resolve conflicts within the team/with customers to achieve smooth workflow	1	5	-	1
	PC10. recognize emotions accurately in self and others to build good relationships	1	4	-	-
	PC11. prioritize team and organization goals above personal goals	-	4	-	1
	Respect differences of gender and ability	**11**	**24**	**-**	**4**
	PC12. maintain a conducive environment for all the genders at the workplace	2	5	-	1
	PC13. encourage appropriate behavior and conduct with people across gender	2	5	-	1
	PC14. assist team members with disability in over coming any challenges faced in work	3	4	-	1
	PC15. practice appropriate verbal and non- verbal communication while interacting with People with Disability (PwD)	2	4	-	1
	PC16. ensure equal participation of the people across genders in discussions	2	6	-	-
	NOS Total	**25**	**65**	**-**	**10**
DGT/VSQ/N0102: Employability Skills (60 Hours)	*Introduction to Employability Skills*	**1**	**1**	**-**	**-**
	PC1. identify employability skills required for jobs in various industries	-	-	-	-
	PC2. identify and explore learning and employability portals	-	-	-	-
	Constitutional values – Citizenship	**1**	**1**	**-**	**-**
	PC3. recognize the significance of constitutional values, including civic rights and duties, citizenship, responsibility towards society etc. andpersonal values and ethics such as honesty, integrity, caring and respecting others, etc.	-	-	-	-
	PC4. follow environmentally sustainable practices	-	-	-	-

	Becoming a Professional in the 21st Century	**2**	**4**	**-**	**-**
	PC5. recognize the significance of 21st Century Skills for employment	-	-	-	-
	PC6. practice the 21st Century Skills such as Self-Awareness, Behaviour Skills, time management, critical and adaptive thinking, problem-solving, creative thinking, social and cultural awareness, emotional awareness, learning to learn for continuous learning etc. in personal and professional life	-	-	-	-
	Basic English Skills	**2**	**3**	**-**	**-**
	PC7. use basic English for everyday conversation in different contexts, in person and over the telephone	-	-	-	-
	PC8. read and understand routine information, notes, instructions, mails, letters etc. written in English	-	-	-	-
	PC9. write short messages, notes, letters, e-mails etc. in English	-	-	-	-
	Career Development & Goal Setting	**1**	**2**	**-**	**-**
	PC10. understand the difference between job and career	-	-	-	-
	PC11. prepare a career development plan with short- and long-term goals, based on aptitude	-	-	-	-
	Communication Skills	**2**	**2**	**-**	**-**
	PC12. follow verbal and non-verbal communication etiquette and active listening techniques in various settings	-	-	-	-
	PC13. work collaboratively with others in a team	-	-	-	-
	Diversity & Inclusion	**1**	**2**	**-**	**-**
	PC14. communicate and behave appropriately with all genders and PwD	-	-	-	-
	PC15. escalate any issues related to sexual harassment at workplace according to POSH Act	-	-	-	-
	Financial and Legal Literacy	**2**	**3**	**-**	**-**
	PC16. select financial institutions, products and services as per requirement	-	-	-	-

	PC17. carry out offline and online financial transactions, safely and securely	-	-	-	-
	PC18. identify common components of salary and compute income, expenses, taxes, investments etc	-	-	-	-
	PC19. identify relevant rights and laws and use legal aids to fight against legal exploitation	-	-	-	-
	Essential Digital Skills	**3**	**4**	**-**	**-**
	PC20. operate digital devices and carry out basic internet operations securely and safely	-	-	-	-
	PC21. use e- mail and social media platforms and virtual collaboration tools to work effectively	-	-	-	-
	PC22. use basic features of word processor, spreadsheets, and presentations	-	-	-	-
	Entrepreneurship	**2**	**3**	**-**	**-**
	PC23. identify different types of Entrepreneurshipand Enterprises and assess opportunities for potential business through research	-	-	-	-
	PC24. develop a business plan and a work model,considering the 4Ps of Marketing Product, Price, Place and Promotion	-	-	-	-
	PC25. identify sources of funding, anticipate, and mitigate any financial/ legal hurdles for the potential business opportunity	-	-	-	-
	Customer Service	**1**	**2**	**-**	**-**
	PC26. identify different types of customers	-	-	-	-
	PC27. identify and respond to customer requestsand needs in a professional manner.	-	-	-	-
	PC28. follow appropriate hygiene and grooming standards	-	-	-	-
	Getting ready for apprenticeship & Jobs	**2**	**3**	**-**	**-**
	PC29. create a professional Curriculum vitae (Résumé)	-	-	-	-
	PC30. search for suitable jobs using reliable offlineand online sources such as Employment exchange, recruitment agencies, newspapers etc. and job portals, respectively	-	-	-	-
	PC31. apply to identified job openings using offline	-	-	-	-

	/online methods as per requirement				
	PC32. answer questions politely, with clarity and confidence, during recruitment and selection	-	-	-	-
	PC33. identify apprenticeship opportunities and register for it as per guidelines and requirements	-	-	-	-
	NOS Total	**20**	**30**	**-**	**-**

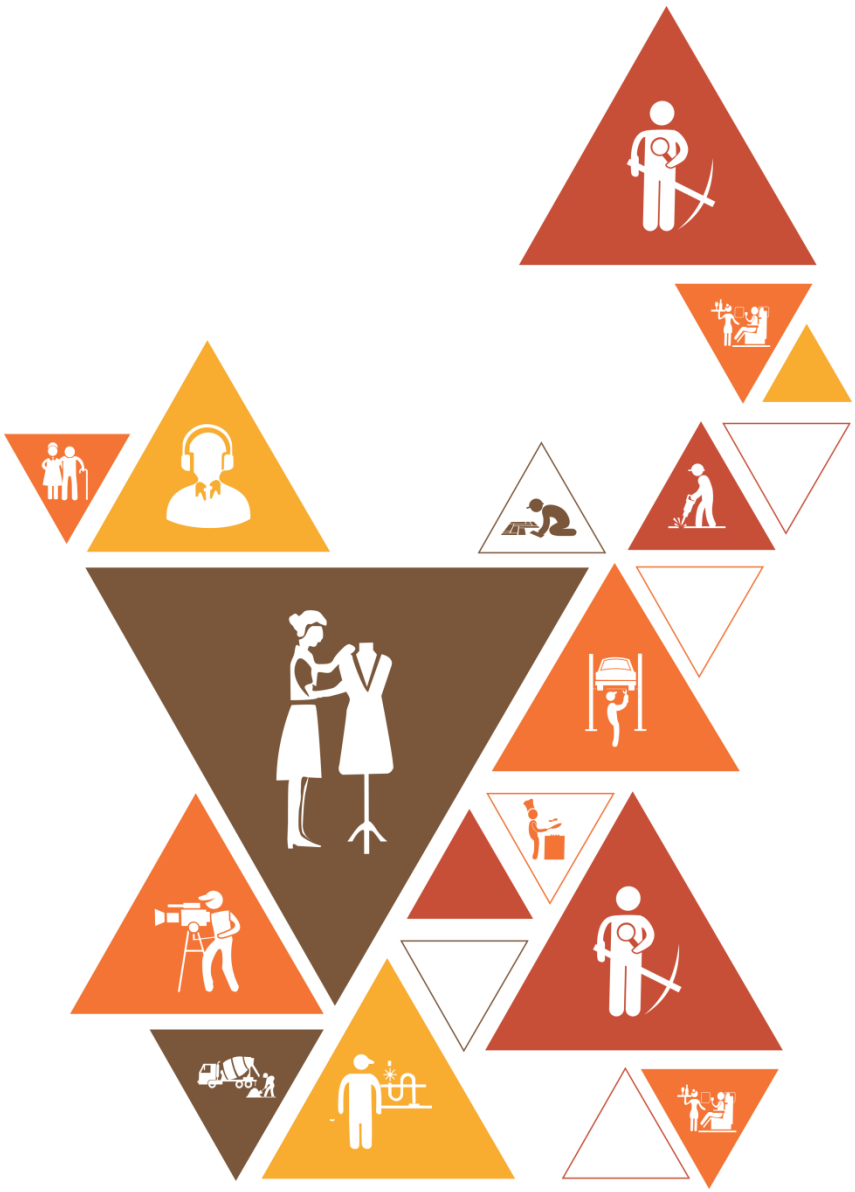
Annexure

Chapter No	Unit No	Topic Name	Page No in PHB	QR Code
1	1.1	Applications of Internet of Things	11	Click the QR code to view the video the concept of IoT
2	1.1	Applications of Internet of Things	13	Click the QR code to view the video on working of IoT
3	1.1	Applications of Internet of Things	13	Click the QR code to view the video on smart parking using IoT
4	2.11	Understanding Edge Devices	51	Click the QR code to view the video on edge devices
5	**2.3**	IoT Cloud Framework	92	Click the QR code to view the video on data management

Annexure(contd.)

Chapter No	Unit No	Topic Name	Page No in PHB	QR Code
5	4.3	Importance of safe working practices(First Aid Techniques)	329	Click/Scan this QR code to view the video for First Aid at work place
6	4.3	Importance of safe working practices	338	Click/Scan this QR code to view the video on Hand Washing techniques
7	4.3	Importance of safe working practices	345	Click/Scan this QR code to view the video on CPR Techniques
8	4.5	Waste Management	349	Click/Scan this QR code to view the video on Waste Management
9	5.1	Types of Communication	363	Click/Scan this QR code to view the video on Types of Communication
10	5.1	Types of Communication	366	Click/Scan this QR code to view the video communication with Customer and colleagues
11	5.1	Types of Communication	**368**	Click/Scan this QR code to view the video on Effective Telephone Communication

Chapter No	Topic Name	QR Code
12	Employability Skill	Click/Scan the QR code to access e-Book onEmployability Skills



Notes

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