IOT ASSIGNMENT 1 CLINZ SABU

43 S8 CSA

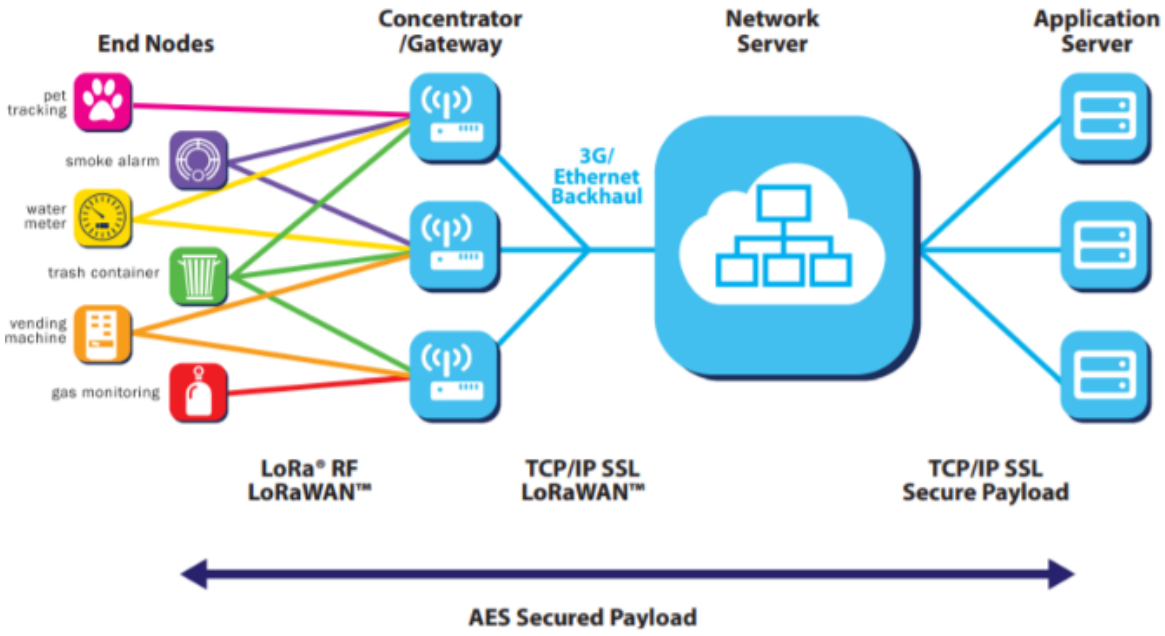
1.Demonstrate the LoRaWAN technology as an IoT communication paradigm.

The LoRaWAN protocol is a Low Power Wide Area Networking (LPWAN) communication protocol that functions on LoRa. The LoRaWAN specification is open so anyone can set up and operate a LoRa network.

LoRa is a wireless audio frequency technology that operates in a license-free radio frequency spectrum. LoRa is a physical layer protocol that uses spread spectrum modulation and supports long-range communication at the cost of a narrow bandwidth. It uses a narrow band waveform with a central frequency to send data, which makes it robust to interference

Characteristics of LoRaWAN technology

- Long range communication up to 10 miles in line of sight.
- Long battery duration of up to 10 years. For enhanced battery life, you can operate your devices in class A or class B mode, which requires increased downlink latency.
- Low cost for devices and maintenance.
- License-free radio spectrum but region-specific regulations apply.
- Low power but has a limited payload size of 51 bytes to 241 bytes depending on the data rate. The data rate can be 0,3 Kbit/s – 27 Kbit/s data rate with a 222 maximal payload size.



2. Illustrate any four wireless technologies and its architectural characteristics.

1. Wireless LAN

Wireless LAN (WLAN) technology provides internet access within a building or a limited outdoor area. First used within offices and homes, WLAN technology is now also used in stores and restaurants. The use of home networks greatly increased as the COVID-19 pandemic forced office workers, students, teachers and others to work and study from home.

2. Wireless MAN

Wireless metropolitan area networks have been installed in cities worldwide to provide access for people outside an office or home network. These networks cover a wider area than office or home networks, but the principles are the same. APs are located on the sides of buildings or on telephone poles throughout the covered area. APs are connected to the internet via a wired network and broadcast a wireless signal throughout the area. Users connect to their desired destination by connecting to the nearest AP, which forwards the connection through its internet connection.

3. Wireless PAN

Wireless personal area networks cover a very limited area -- typically a maximum of 100 meters for most applications -- using protocols like Bluetooth and Zigbee. Bluetooth enables hands-free phone calls, connects a phone to earpieces or transmits signals between smart devices. Zigbee connects stations along an IoT network. Infrared technology is limited to line of sight, such as connecting TV remotes to televisions.

4. Wireless WAN

Wireless WANs use cellular technology to provide access outside the range of a wireless LAN or metropolitan network. These networks enable users to make phone calls to others. WANs can support either speech or data transfer using the same technology. Users can also connect to the internet to access websites or server-based applications.

3. Write a short note on IEEE 802.15.4 standard for wireless communication.

IEEE 802.15.4 is a low-cost, low-data-rate wireless access technology for devices that are operated or work on batteries. This describes how low-rate wireless

personal area networks (LR-WPANs) function.802.15.4e for industrial applications and 802.15.4g for the smart utility networks (SUN) The 802.15.4e improves the old standard by introducing mechanisms such as time slotted access, multichannel communication and channel hopping.

- IEEE 802.15.4e introduces the following general functional enhancements:

1. Low Energy (LE): This mechanism is intended for applications that can trade latency for energy efficiency. It allows a node to operate with a very low duty cycle.

2. Information Elements (IE) It is an extensible mechanism to exchange information at the MAC sublayer.

3. Enhanced Beacons (EB): Enhanced Beacons are an extension of the 802.15.4 beacon frames and provide a greater flexibility. They allow to create application-specific frames.

4. Multipurpose Frame: This mechanism provides a flexible frame format that can address a number of MAC operations. It is based on IEs.

5. MAC Performance Metric: It is a mechanism to provide appropriate feedback on the channel quality to the networking and upper layers, so that appropriate decision can be taken.

6. Fast Association (FastA) The 802.15.4 association procedure introduces a significant delay in order to save energy. For time-critical application latency has priority over energy efficiency.

- IEEE 802.15.4e defines five new MAC behavior modes:

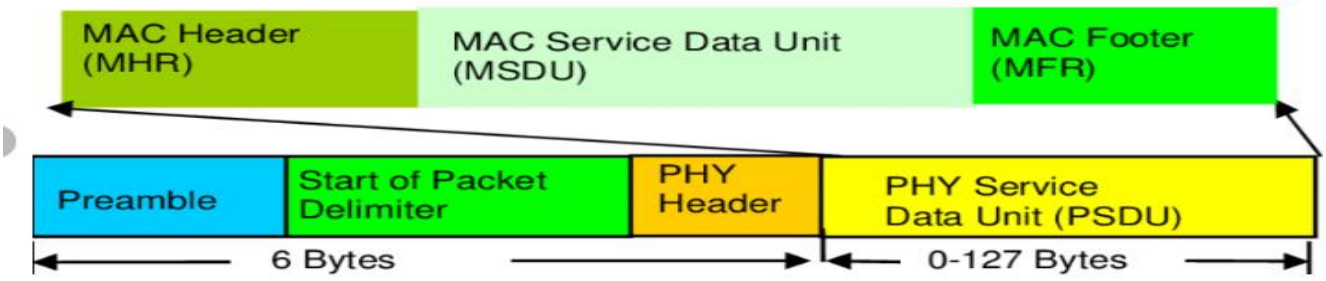
1. Time Slotted Channel Hopping (TSCH): It targets application domains such as industrial automation and process control, providing support for multi-hop and multichannel communications, through a TDMA approach.

2. Deterministic and Synchronous Multi-channel Extension (DSME): It is aimed to support both industrial and commercial applications.

3. Low Latency Deterministic Network (LLDN): Designed for single-hop and single channel networks

4. Radio Frequency Identification Blink (BLINK): It is intended for application domains such as item/people identification, location and tracking.

4. Illustrate the frame format of IEEE 802.15.4?



5. Explain the different types of sensors.

Types of sensors –

- Electrical sensor:

Electrical proximity sensors may be contact or non-contact. Simple contact sensors operate by making the sensor and the component complete an electrical circuit. Non-contact electrical proximity sensors rely on the electrical principles of either induction for detecting metals or capacitance for detecting non-metals as well.

- Light sensor:

Light sensor is also known as photo sensors and one of the important sensor. Light dependent resistor or LDR is a simple light sensor available today. The property of LDR is that its resistance is inversely proportional to the intensity of the ambient light i.e. when the intensity of light increases, it's resistance decreases and vice versa.

- Touch sensor:

Detection of something like a touch of finger or a stylus is known as touch sensor. Its name suggests that detection of something. They are classified into two types:

1. Resistive type
2. Capacitive type

Today almost all modern touch sensors are of capacitive types. Because they are more accurate and have better signal to noise ratio.

- Range sensing:

Range sensing concerns detecting how near or far a component is from the sensing position, although they can also be used as proximity sensors. Distance or range sensors use non-contact analog techniques. Short range sensing, between a few millimetres and a few hundred millimetres is carried out using electrical capacitance, inductance and magnetic technique. Longer range sensing is carried out using transmitted energy waves of various types egg radio waves, sound waves and lasers.

- Mechanical sensor:

Any suitable mechanical / electrical switch may be adopted but because a certain amount of force is required to operate a mechanical switch it is common to use micro-switches.

- Pneumatic sensor:

These proximity sensors operate by breaking or disturbing an air flow. The pneumatic proximity sensor is an example of a contact type sensor. These cannot be used where light components may be blown away.

- Optical sensor:

In their simplest form, optical proximity sensors operate by breaking a light beam which falls onto a light sensitive device such as a photocell. These are examples of non-contact sensors. Care must be exercised with the lighting environment of these sensors for example optical sensors can be blinded by flashes from arc welding processes, airborne dust and smoke clouds may impede light transmission etc.

- Speed Sensor:

Sensor used for detecting the speed of any object or vehicle which is in motion is known as speed sensor. For example – Wind Speed Sensors, Speedometer ,UDAR ,Ground Speed Radar .

- Temperature Sensor:

Devices which monitors and tracks the temperature and gives temperature's measurement as an electrical signal are termed as temperature sensors .These electrical signals will be in the form of voltage and is directly proportional to the temperature measurement .

- PIR Sensor:

PIR stands for passive infrared sensor and it is an electronic sensor that is used for the tracking and measurement of infrared (IR) light radiating from objects in its field of view and is also known as Pyroelectric sensor .It is mainly used for detecting human motion and movement detection .

- Ultrasonic Sensor:

The principle of ultrasonic sensor is similar to the working principle of SONAR or RADAR in which the interpretation of echoes from radio or sound waves to evaluate the attributes of a target by generating the high frequency sound waves .

6. Describe the Application and Analytics sub layer of IoT Architecture.

• Once connected to a network, our smart objects exchange information with other systems. • As soon as our IoT network spans more than a few sensors, the power of the Internet of Things appears in the applications that make use of the information exchanged with the smart objects.

• From an architectural standpoint, basic classification can be as follows: ′ Analytics Versus Control Applications ′ Data Versus Network Analytics Analytics Versus Control Applications ′ Multiple applications can help increase the efficiency of an IoT network. ′ Each application collects data and provides a range of functions based on analysing the collected data.

- Analytics Application: This type of application collects data from multiple smart objects, processes the collected data, and displays information resulting from the data that was processed.
- The display can be about any aspect of the IoT network, from historical reports, statistics, or trends to individual system states.
- Control Application : This type of application controls the behaviour of the smart object or the behaviour of an object related to the smart object.

7. Illustrate which topology will you prefer to develop a smart city? Justify your answer.

There is no one-size-fits-all answer to this question as the topology of a smart city will depend on various factors, such as the size of the city, the population density, and the existing infrastructure. However, some general topologies that can be considered for the development of a smart city are:

1. Mesh Topology:

In a mesh topology, every node is connected to every other node. This topology is highly resilient as it can still function even if some nodes fail, making it suitable for critical applications in a smart city such as public safety systems and emergency response networks.

2. Star Topology:

In a star topology, every node is connected to a central hub. This topology is relatively easy to manage and maintain, making it suitable for applications such as smart lighting, traffic management, and waste management.

3. Hybrid Topology:

A hybrid topology combines two or more topologies to take advantage of their strengths and minimize their weaknesses. For example, a combination of mesh and star topology can be used to create a resilient network that is easy to manage.

4. Bus Topology: In a bus topology, every node is connected to a single cable that runs throughout the city. This topology is cost-effective and suitable for applications such as smart parking and environmental monitoring.

5. Ring Topology: In a ring topology, each node is connected to two other nodes forming a circular network. This topology is highly resilient as it can still function even if some nodes fail, making it suitable for applications such as smart transportation and public transportation systems

8. Exemplify the impact of IOT in at least 2 domains of normal human life.

-smart microwaves,

- self-driving car

-wearable fitness devices

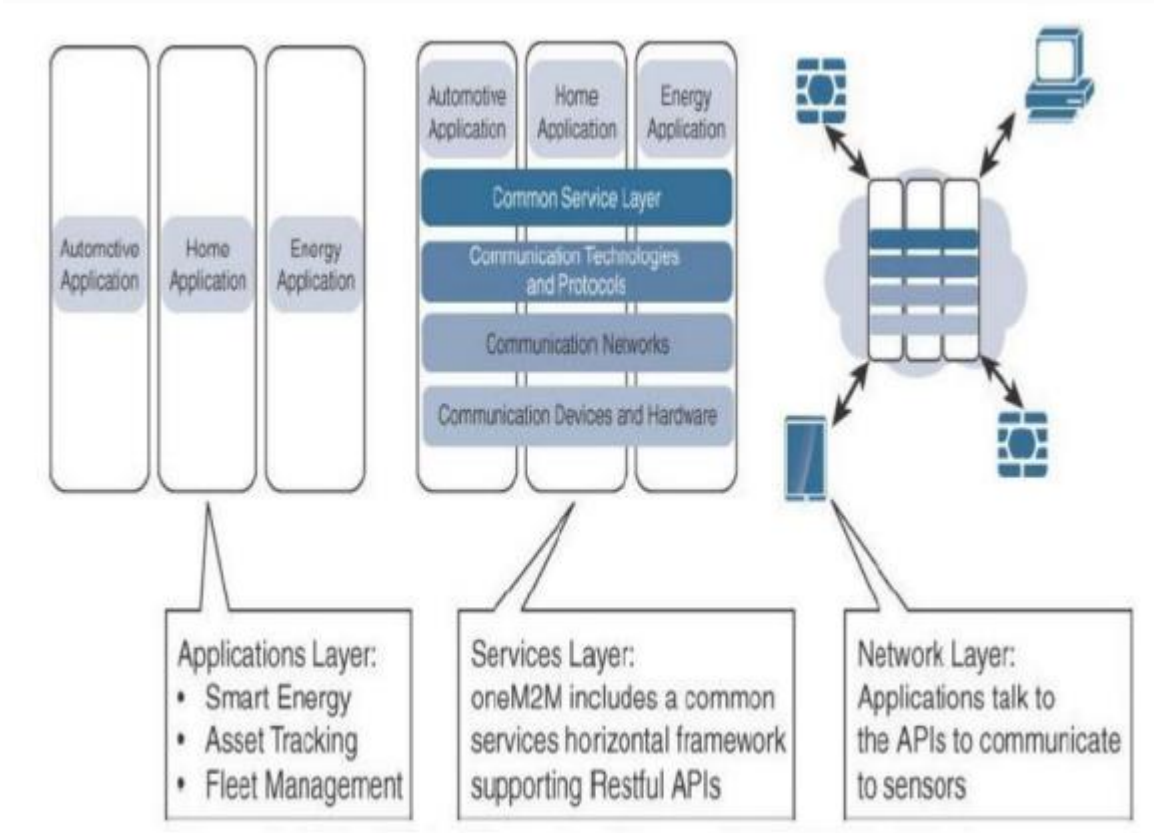
9. Explain the Standardized IOT architectures.

The oneM2M architecture divides IoT functions into three major domains: the application layer, the services layer, and the network layer.

i. Applications layer This domain includes the application-layer protocols and attempts to standardize API definitions for interaction with business intelligence (BI) systems.

ii. Services layer At this layer, horizontal modules include the physical network that the IoT applications run on, the underlying management protocols, and the hardware.

iii. Network Layer This is the communication domain for the IoT devices and endpoints. It includes the devices themselves and the communications network that links them.



10. Clarify the advantages and disadvantages of OT and IT Technology.

OT (Operational Technology) and IT (Information Technology) are two distinct technology domains that serve different purposes. Here are the advantages and disadvantages of each:

Advantages of OT Technology:

1. Improves efficiency: OT technology is designed to control and monitor physical processes such as manufacturing, power generation, and transportation. By automating these processes, OT technology improves efficiency, reduces errors, and enhances safety.
2. Better asset management: OT technology helps businesses manage their physical assets, such as machinery, equipment, and tools. By providing real-time monitoring and analytics, OT technology enables predictive maintenance and reduces downtime.
3. Increased safety: OT technology is used to manage critical infrastructure and improve safety in industries such as oil and gas, transportation, and utilities. With advanced monitoring and control systems, OT technology can identify and mitigate safety risks.

Disadvantages of OT Technology:

1. Limited connectivity: OT technology systems are designed to operate independently and are often not connected to the internet or other IT systems. This can make it difficult to integrate with other systems or share data.
2. Vulnerable to cyber attacks: OT systems are often not designed with security in mind, making them vulnerable to cyber attacks. Attackers can exploit vulnerabilities in these systems to gain unauthorized access, causing significant damage and disruption.
3. High cost: OT technology systems are expensive to implement and maintain. The cost of sensors, controllers, and other hardware components can be significant, and specialized expertise is required to operate and maintain these systems.

Advantages of IT Technology:

1. Enhanced productivity: IT technology provides businesses with tools and software to improve productivity, automate tasks, and streamline workflows. This can help organizations operate more efficiently and effectively.
2. Improved communication: IT technology enables businesses to communicate and collaborate with customers, partners, and employees in real-time, regardless of their location. This can lead to better decision-making and faster problem-solving.

3. Data-driven insights: IT technology enables businesses to collect, analyze, and visualize data to gain insights into their operations, customers, and markets. This can help organizations make informed decisions and identify new opportunities.

Disadvantages of IT Technology:

1. Vulnerable to cyber attacks: IT systems are often the target of cyber attacks due to the sensitive data they store and the potential impact of disruption to business operations.
2. Costly to implement: Implementing IT systems can be expensive, requiring significant investments in hardware, software, and personnel. Maintenance and upgrades can also add to the total cost of ownership.
3. Dependence on technology: Businesses that rely heavily on IT systems may face significant disruptions if these systems fail or are unavailable. This can lead to lost productivity, revenue, and customer trust.