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CE-B 32263

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Q1. Explain the steps involved in the IOT design methodology

- The IOT Design methodology provides a systematic process to develop IOT based applications or systems. The key steps are

1. Purpose & Requirement Identification
- Define the main purpose of IOT application
- Identify the user requirement devices to be connected, expected output

2. Process specification
- Describe the process that will occur in IOT system
- Example: In a smart agriculture system → soil moisture sensing data transmission, irrigation control

3. Domain model specification
- model the entities & their relationships
- Ex: Soil sensor → sends data to cloud → desicion engine → water pump actuator.

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4. Information model specification
- Define the type, format & structure of data
- Ex. temperature as float, time a timestamp

5. service specification
- Identify the services the system will provide
(Ex. Real time monitoring, remote control, alerts)

6. IOT level specification
- Decide which IOT level (out of 5 levels: perception, Network, Edge middleware, Application) will be used

7. Functional view specification
- map functionalities to IOT levels and identify iterations between devices and services

8. operational view specification
- Define how system operates in real world conditions (connectivity, availability, scalability)

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9. Device & component Integration
- choose appropriate sensors, actuators communication protocols, cloud platforms and integration.

10. Testing & Deployment
- Test the IOT system in real world scenarios and deploy it for end users.

Q2. Illustrate the different pillars of IOT

→ The pillars of IOT are fundamental building blocks that enable IOT systems to function

1) RFID (Radio-Frequency Identification)
- wireless tech to identify & track objects people using radio waves

core parts
- Tags (passive / Active):
- store ID's / data
- Readers / Antennas:
- Read tag data
- middleware / DB
- Filter, aggregate, route data

- provides automatic identification, linking physical assets to digital records
- Foundation for inventory, asset tracking, access control

- Examples: Retail inventory, library books

- Note: Passive tags are low cost & battery less. Active tags have range but need power

2] WSN (Wireless Sensor Network)
- Network of sensor nodes (MCU + sensor(s) + radio + power) that sense environment and communicate often multi-hop

Core parts:
- Sensor Nodes: Temperature, humidity, motion, etc.
- Topology: star / mesh / tree
- Gateway / sink: bridges WSN to IP / cloud.

- protocols / Tech : IEEE 802.15.4 (ZigBee) 6 LOWPAN / Thread, BLE Mesh.

A provides scalable, low-power data acquisition from the physical world.

Ex. smart agriculture fields, environment monitoring, smart buildings

3) M2M (machine to machine communication)

- Direct device to device / cloud data exchange with little / no human involvement

- connecting : cellular (2G/3G/4G/5G), ~~Ethernet~~, WiFi, LPWAN, ZigBee, BLE

- Protocol : MQTT, COAP, HTTP / REST AMQP, SMS - based in legacy M2M

- Real time, telemetry, commands and event-driven automation across heterogeneous devices.

Ex. smart meters, vending machine restock alerts,

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4] SCADA (supervisory control and Data Acquisition)

- Industrial control architecture for monitoring and controlling process across sites.

- core parts :
  - Field Devices : RTU's, PLC's, sensors / actuators
  - communication : Fieldbuses / industrial Ethernet
  - SCADA server & HMI : data acquisition, alarms, trends, operator control.

- Brings supervisors control / telemetry from plants, grids, pipelines into IOT world.
- Modern IIOT integrates SCADA data with cloud analytics

Ex. Power grid monitors, water treatment oil & gas pipelines, Factory automation.

Note : security is critical (Network segmentation, authentication, Patching)

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Q3. Explain the concept of machine to machine (M2M) communication in context of IOT.

- Machine-to-machine communication refers to the direct exchange of data between devices without human intervention.

- Role in IOT :
  - IOT heavily depends on M2M communication for automation & real time control
  - Devices communicate over wired/wireless networks to perform tasks intelligently

- Features

1. Autonomus communication
   - Devices talk to each other automatically
2. Real time Data sharing
   - Fast transmission of data
3. Protocol support
   - Uses Rpl
   - Reduces human effort & error

- Example in IoT

- In smart homes : Motion sensor detects movement → informs smart light → light turns on automatically

- In smart healthcare : wearable monitors patients heartbeat → sends data to doctors system → alerts if abnormal

Q4. Describe device & component integration for IoT based home automation system.

→ In an IoT based home automation system, multiple devices & components must be integrated for smooth & functioning

1. Devices & components used :
   - sensor : - motion, temperature, humidity, gas, smoke
   - Actuators : smart lights, fans smart locks, alarms.
   - microcontroller : Arduino, Raspberry Pi, ESP 32
   - communication module : WiFi, Bluetooth, zigbee

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- Cloud Platform : AWS IOT, Blynk, Google Firebase
- User Interface : mobile App, voice Assistance
- Integration Process

steps:

1) sensors detect environmental changes (motion detected, temperature rise)
2. Data is sent to microcontroller via communication modules
3. microcontroller processes data and sends it to cloud for storage.
4. Cloud sends command back to actuators
5. Actuators perform action
6. User can monitor/control through app or voice command.

Q5. What are horizontal & vertical IOT application.

→ IOT applications are broadly classified into horizontal & vertical models

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1. Horizontal IOT applications

- provide general-purpose IOT solutions usable across industries
- Focus is on connectivity, cloud storage & device management

Ex -
- cloud IOT platforms (AWS, IOT Azure (IOT) Hub)
- Data analysis platforms.
- connectivity services (LORAWAN)

2. Vertical IOT applications

- Industry - specific or domain specific solution
- Tailored to solve a particular sectors needs

Ex -
- Healthcare : Remote patient monitoring, wearable devices
- Agriculture : smart irrigation systems.
- smart Home : Home automation & security systems.

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