

IoT (Internet of Things) Notes

Q.1 What are Sensors? Classification? Types?

- Sensors are used for sensing things and devices, etc.
- Sensors are devices that perform input function in system as they 'sense' the changes in quantity.
- Example of sensor is mercury thermometer. Here the quantity is being measured is heat or temp.
- Criteria to choose sensor :
 - i) Type of sensing
 - ii) Operating principle
 - iii) Power consumption
 - iv) Accuracy
 - v) Environmental conditions
 - vi) Cost
 - vii) Range
 - viii) Calibration & repeatability
- Classification of sensors :
 - i) Passive sensor : ex. Soil moisture sensor
 - ii) Active sensor : ex. Radar, laser
 - iii) Analog : ex. Temp sensor
 - iv) Digital : ex. Digital temp sensor (DS1620)
 - v) Scalar : ex. Smoke sensor
 - vi) Vector : ex. Gyroscope
- Types of sensor :
 - i) Electrical sensor
 - ii) Light sensor
 - iii) Touch sensor
 - iv) Range sensing
 - v) Mechanical
 - vi) Optical
 - vii) Speed

Q.2 What are Actuators? Types?

- Actuator is a machine or part of machine used to convert externally available energy motion based on control signals.
- Actuator consist of :
 - i) Energy source
 - ii) Power converter
 - iii) Controller
 - iv) load
- Types of actuators :
 - i) Electromagnetic actuators :
 - Makes use of electricity and magnetism to perform actuation.
 - Most commonly used.
 - ii) Stepper motor actuators :
 - Used for applications where angular position of shaft needs to be accurately controlled.

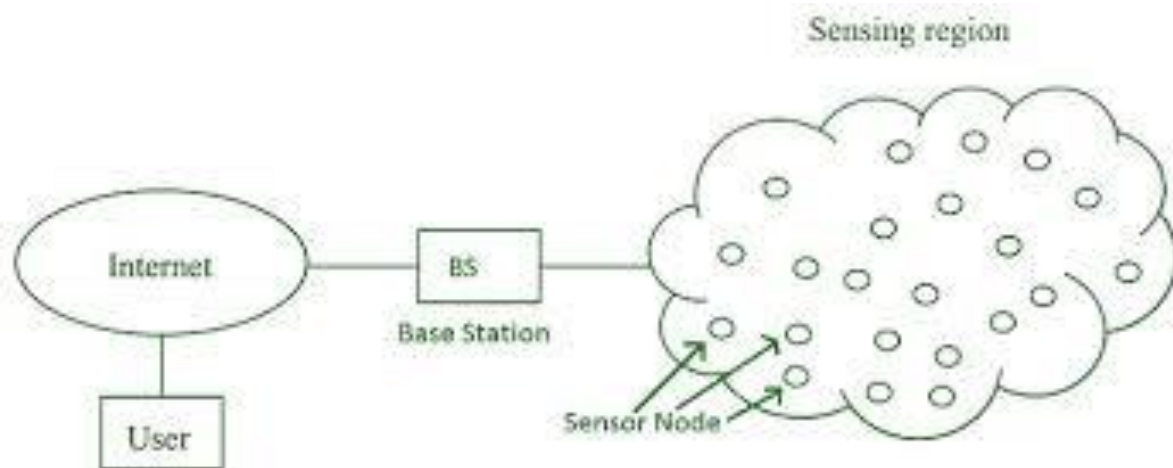
- iii) Hydraulic actuators :
 - Makes use of liquids as driving force to produce mechanical work.
- iv) Mechanical actuators :
 - Used to interconvert rotary & linear motion in **m/c**
- v) Thermal actuators :
 - Makes use of materials that expand or contract by application of heat.
 - Used to sense temperature.

Q.3 What is IOT digitization?

- i) Simplest form in conversion of information into digital format.
- ii) Digitization has changed whole scenario.
- iii) The digital format data can be used to improve efficiency, productivity & decision making.
- iv) Benefits :
 - Improved efficiency
 - Increased productivity
- v) Ex. Whole photography industry have been digitized.
 - Most of people are using digital cameras to take photos because it stores photos in memory.
 - And cameras are available in phones also.
 - People are not buying films or there is no need to develop them.

Q.4 Explain WSN?

- The architecture used in WSN is sensor network architecture.
- This kind of architecture is used different places such as hospitals, schools, roads, buildings, etc.
- Wireless sensor network is an infrastructure.
- Less wireless network that is deployed in a large number of wireless sensors in an ad-hoc manner that is used to monitor the system, physical or environmental conditions.
- Ex. 1) Wealth monitoring system.
2) Soil moisture monitoring system.



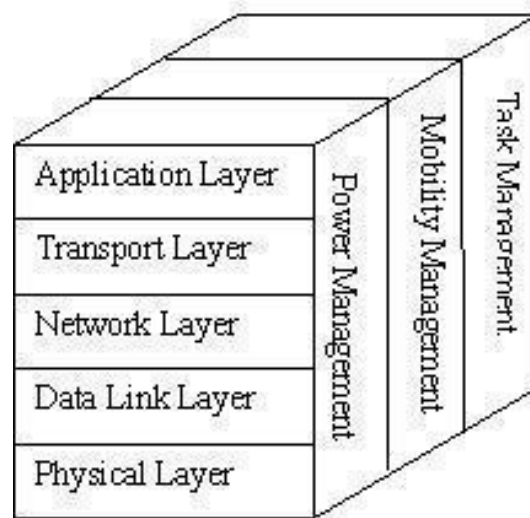
2 types :

- i) Layered network architecture

ii) Clustered architecture

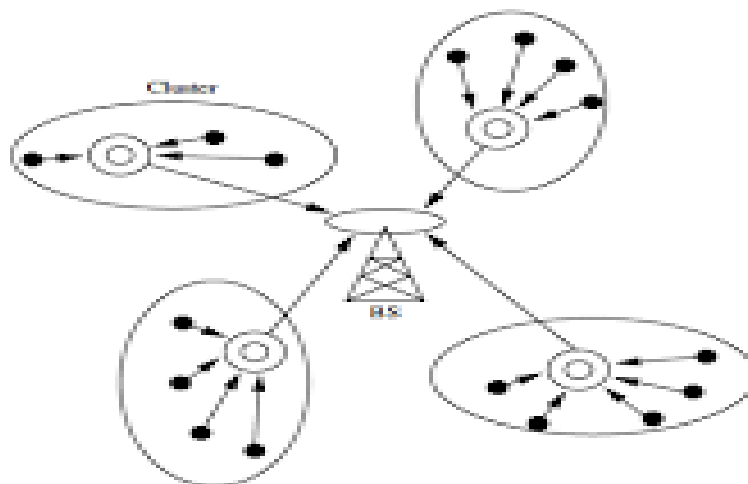
i) Layered network architecture :

- It makes use of few hundred sensor nodes & single powerful based station.
- Network nodes are organized into concentric layers.
- 5 layer :
 - 1) Application layer
 - 2) Transport layer
 - 3) Network layer
 - 4) Data link layer
 - 5) Physical layer
- 3 cross layers :
 - 1) Power management plane
 - 2) Mobility management plane
 - 3) Task management plane



ii) Clustered network architecture :

- In clustered network architecture, sensor nodes automatically clubs into groups called clusters.
- It is based on leach protocol which makes use of clusters. Leach protocol **stands** for low energy adaptive clustering hierarchy.
- Cluster network architecture is very useful sensor node because of property of data fusion.



Q.5 What are Smart objects?

Any physical object could be considered as smart object if it allows some form of remote control, communication & has processing capabilities.

- 1) Controlling system :
 - The controlling system controls, manages & operates the smart object.
 - It typically run a real time operating system environment.
 - The controlling system is also called as processing unit.
- 2) Sensors :
 - Sensors get various inputs from operating environment.
 - A smart object may have one or more sensors depending upon requirements.
 - Sensors provides inputs to controlling system based on which controlling system may decide further processing steps.
- 3) Actuator :
 - It controls the operating environment.
 - They take input from controlling system & perform operations in operating environment as directed.
 - A Smart object may have one or more actuator depending on requirements.
- 4) Communication interface :
 - It enables smart object to communicate with other objects in environment as well as humans.
 - It could be either wired or wireless.

Characteristics of smart object :

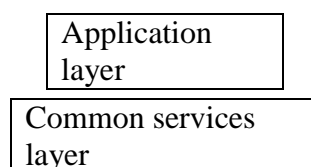
1. Data processing
2. Real time processing
3. Omni directional communication.

Trends :

1. Home automation
2. Personal & health care
3. Industrial IOT
4. Smart machinery
5. RFID systems.

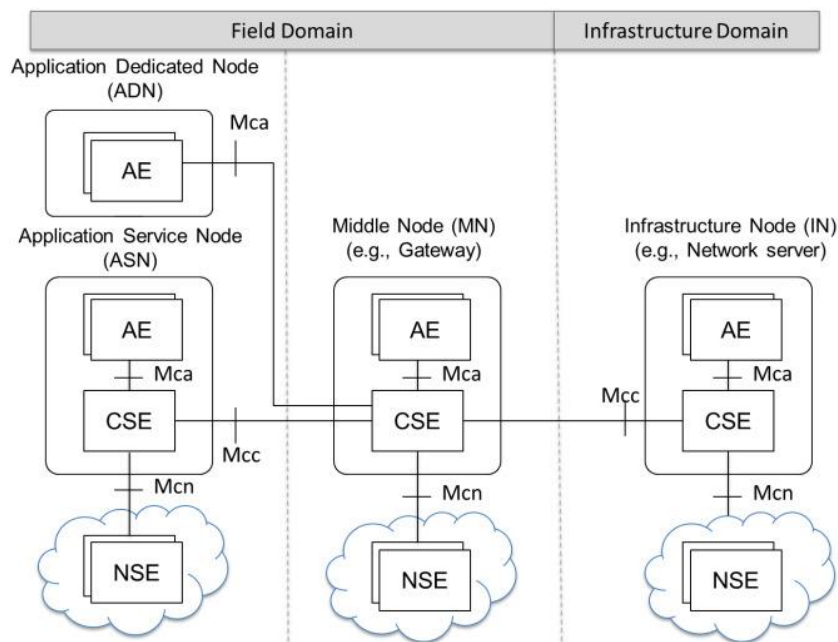
Q.6 Explain M2M DOT standardization architecture.

- There are several efforts that are undergoing for standardizing IOT architectures and frameworks.
- One M2 is one such M2M architecture standardization approach.
- It take following layered model approach for supporting end to end (E2E) M2M services.



Network services layer

➤ High level one M2M architecture :



1. Application entity (AE) :
 - It is an entity in application layer that implements on M2M application service logic.
 - Each execution instance of an application service logic is termed as an “ Application entity”.
 - Ex. 1. A remote blood sugar monitoring application.
 - 2. A power metering application.
2. Common service entity (CSE) :
 - It represents an instantiation of set of “common service functions” of M2M equipments.
 - Such service functions are exposed to other entities through Mca and Mcc reference points.
 - Ex. 1. Data management
 - 2. Device management
3. Underlying network services entity (NSE) :
 - It provides the services from underlying network to the CSE.
 - Ex. 1. Location services
 - 2. Device triggering
 - The underlying networks provide transport services between entities in one M2M system.
 - Such data transport services are not included in NSE.
4. Reference points :
 - It consists of one or more reference points of any kinds.
 - The following reference points are supported by CSE :
 1. Mca reference point
 2. Mcc reference point
 3. Mcn reference point
 4. Mcc reference point

Q.7 Short note on RFID.

1. Radio frequency identification (RFID) is a method that is used to track or identify an object by radio transmission uses over the web.
2. Data digitally encoded in an RFID tag which might be read by the reader.
3. This device works as a tag or label during which data reads from tags that are stored in the database through the reader as compared to traditional bar codes or QR codes.
4. Flow diagram.
5. There are two types of RFIDs :
Active RFID
Passive RFID
 - i) Active RFID :
In this device RF tags are attached by a power supply that emits a signal and there is an antenna which receives the data.
 - ii) Passive RFID :
In this device RF tags are not attached by a power supply and passive RF tag stored their power.
6. It is used in Asset tracking and personal tracking.
7. If utilized in tracking ship containers, cars, rail road, trucks, etc.
8. Advantages :
 - cost effective
 - rewritable
9. Disadvantages
 - security issues
 - difficult to program

Q.8 Short note onNFC.

NFC works on RFID principles :

- a) NFC stands for Near Field Communication
- b) It enables short range communication between compatible devices.
- c) At least one transmitting device and another receiving device is needed to transmit the signal.
- d) Many devices can use the NFC standard and are considered either passive or active.
- e) Like other wireless signals Bluetooth and Wi-Fi, NFC works on the principle of sending information over radio waves.
- f) The NFC standard currently has three distinct modes of operation to determine what sort of information will be exchanged between devices :-
 - i) peer to peer mode
 - ii) read /write mode
 - iii) card emulation
- g) There is a 13.56 Mhz transmission frequency for data across NFC.
- h) It's distance is less than 10 cm.

Q.9 Short note on LiFi.

1. LiFi (Light Fidelity) is a wireless communication technology that utilizes the visible light spectrum to facilitate high-speed data transfer between devices, servers, and terminals.
2. It is not reliant on radio frequencies, so it works well in areas where there is no WiFi. Plus, digital signals carried by light turn out to be way faster than those transmitted via radio waves.
3. The capabilities of LiFi that make it a crucial technology in shaping IOT.
 - i) Revolutionary Speed : - Same LiFi companies have tested LiFi Speed, and they have projected that it can be up to 1000 times faster than Wifi. It can transfer or share 224 GB data per second.
 - ii) Enhanced availability : - With LiFi, devices can connect online and to one another as long as their LED light source in the room.
 - iii) Superior efficiency : - LiFi holds the potential to be more affordable and energy efficient than other forms of wireless communication.

Q.10 Explain Edge, cloud, fog computing.

Edge computing : -

1. Computing that takes place at edge of device's network which is known as edge computing.
2. Edge computing is also known as mist computing.
3. Edge computing is referred as, in real life, that it is lowest part means edge like on road.
4. It means that a computer is connected with network of device which processes data and sends data to cloud in real time. That computer is known as "edge node".

Fog computing : -

1. It is an extension of cloud computing.
2. It is layer between edge of cloud computing.
3. When edge computers send huge amount of data to cloud, Fog nodes receives that data & analyze what is important then Fog node transfers important data to cloud to be stored & delete the unimportant data or keep it with themselves for further analysis.
4. In this way Fog computing saves lot of space in cloud & transfers important data quickly.
5. Characteristics
 - i) High scalability
 - ii) Mobility support
 - iii) Real time interactions

Cloud computing : -

1. On demand computing service over the internet is nothing but cloud computing.
2. With cloud computing, users can access any resources from anywhere, like databases, web servers, storage, device, software over internet.
3. Services
 - iii) IaaS (infrastructure as a service)
 - iv) PaaS (Platform as a service)
 - v) SaaS (Software as a service)
4. Ex.
 - a) App cloud
 - b) Google app engine
 - c) AWS

Q.11 Explain IOTWF. (IOT WORLD FORUM)

1. Physical devices & controller :
 - 1st layer
 - Has wide range of devices that send & receive information.
 - Main function is to generate data
2. Connectivity :
 - 2nd layer
 - Focuses on connectivity
 - Main function is reliable & timely transmission of data
 - Includes transmission between devices & network.
3. Edges computing ;
 - 3rd layer
 - Gives attention to data reduction
 - Converts network data that flows into information which is ready for storage & processing.
4. Data accumulation :
 - 4th layer
 - Here data is in motion
 - But applications typically uses “data at rest”
 - Data in motion is converted to data at rest
5. Data abstraction :
 - 5th layer
 - Needs multiple data storage to accommodate IOT device data
 - Focuses
 - * rendering data
 - * consolidate data
 - *visualize data
6. Application :
 - 6th layer
 - Interprets the information
 - S/W in this interacts with layer 5.
7. Collaborations & processes
 - Consumes & shares applications information
 - Gives right data at right time

Q.12 Explain Scada .

- Supervisory control and data acquisition
 - It is a control system architecture comprising of computers, network data & gui for high level process supervision, control and data acquisition in industrial area.
 - System are used to control dispersed assets where centralized data acquisition as well as control are important.
1. Sensors & actuators :

There could be many sensors are spread throughout plant site for collecting data & controlling facilities & equipment.
 2. Programmable logic controller (PLC) :
 - Connection to sensors & actuators
 - Collect data from sensors & provide control input to actuators
 - Cheap & provide flexibility
 3. Remote terminal unit (RTC) :
 - Connected to sensors & actuators

- Collect data from sensors & may provide control after used from remote plant side.
- 4. SCADA network :
 - Utilizes radio, telephone lines, fibre, satellites and other communication mechanisms as appropriate
 - It allows transfer of info and data back & forth between servers RTU & PLC
- 5. SCADA server :
 - Controls overall plant operations
 - Also called as control server
 - Collects data from RTU, PLC, then process it, stores it, provide control mechanism.
- 6. Human machine interface :
 - Could be single monitor depending on plant size & monitoring & controlling requests
 - User can usually monitor overall operation in real time.

Q.13 Explain IOT application layer protocol.

1. MQTT

- Message queue telemetry transport (MQTT) is a publish-subscribe protocol that facilitates one –to-many communication.
- Clients can publish messages to broker and subscribe to broker to receive certain messages.
- Messages are organized by topics, which essentially are “lables” that act as system for dispatching messages to subscribers.

2. COAP

- Constrained application protocol (COAP) is a client server protocol that unlike MQTT, is not yet standardized.
- With COAP, client node can command another node by sending CAP packet.
- The COAP server will interpret it extract payload and decide what to do depending on logic.

Q.14 Explain Raspberry Pi.

1. Series of credit card size single – board computer developed in UK in 2012.
2. The original Pi had single-core 100 MHz CPU & just 256 MB ram but latest model has quad core CPU over 1.5 GHZ & 4 GB Ram.
3. Price of raspberry Pi always been under \$ 100.



1. Power source
 - Easiest way to power raspberry Pi is via micro usb port.
 - Recommended input voltage is 5v & input current is 2A.
2. GPIO
 - General purpose input
 - Non specific pins on circuit to known as input or output pins can be controlled by client at run time.
3. Display DSI
 - Display serial interface
 - DSI connector is used for connecting LCD panel using 15 pin ribbon cable.
4. Audio jack
 - 3.5 mm connector for stereo sound field.
5. Status LEDS
 - OK – SD card access
 - Power – 3.3v power
 - FDX – full duplex LAN
 - LNK – link / activity
6. Ethernet port
 - Standard LAN port (RJH5)
7. CSI connector
 - Camera serial interface
 - Used for connecting camera
8. HDMI
 - High definition multimedia interface
 - Used for both video & sound field.

Q.15 Explain Arduino.

- Open source platform for building electronics projects
 - Consist of both physical circuit board & s/w
 - Can be directly connected computer via USB
 - Arduino IDE : software
1. Vin :
 - Input voltage pin
 - Provide input supply from external power supply
 2. 3.3 V :
 - Provide 3.3 v supply generated from voltage regular.
 3. GND :
 - Ground the Arduino
 4. Reset :
 - Reset the microcontroller.
 5. Analog pin:
 - Pins from A0-A5 are used as analog pins.
 6. Digital pin:
 - Pins from D0-D13 are used as digital input pins.
 7. Serial pin:
 - Serial pins are used for communication between Arduino and computer.
 8. PWM pin:
 - It converts digital signals into analog signals.

9. SPI pin:

- SPI pins are used for maintaining SPI connection.

10. AREF:

- It stands for analog reference pin.
- It provides reference voltage from external power supply.

Q.16 Difference between Arduino vs RaspberryPi.

	Parameters	Arduino	RaspberryPI
1	CPU type	Microcontroller	Microprocessor
2	OS	None	Linux or windows 10
3	Speed	16 MHz	1.2 GHz
4	h/w and s/w structure	Easy	Complex
5	Cost	Cheap	Expensive
6	RAM usage	2kb	1GB or more
7	GP10 pins	14 digital & 6 analog	26 digital

Q.17 Comparison of IOT board & platforms.

Parameters	Raspberry Pi.	Beaglebone black.
Model tested	It uses model B version	It uses Rev A5 version.
Processor type	It uses ARM11.	It uses ARM-cortex A8.
RAM	For functioning of Raspberry Pi, 512 MB SDRAM is used.	For functioning of beaglebone black 512 MB DDR 3L is used.
Processor speed	It uses 700 MHz.	It use 1 GHz.
Min power	It require power supply of 700 MA	It requires power supply of 210 MA.
USB master	It has 2 USB 2.0 ports	It has 1 USB 2.0 ports.

Q.18 Explain IOT hardware and software.

- IOT hardware

1. ARDUINO :

- Arduino is an open-source platform used for building electrics projects.
- Arduino consist of both physical programmable circuit board and piece of software.
- Arduino platform has become quite popular with people just starting out with electronics.

2. Raspberry Pi :

- Raspberry Pi launched in 2012, there have been several iterations & variations released since then
- The original Pi had single-core 700 MHz CPU & just 256 MB the latest model has quad-core CUP over 1.5 GHz and 4 GB RAM.
- The price of Raspberry Pi has always been under \$100.

3. ESP32 :

- ESP32 is series of low cost, low power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth.
- ESP32 is created & developed by Espressif systems, a shanghai based Chinese company.

- It is a successor to ESP8266 microcontroller.
- IOT software :
 1. Java :
 - When it comes to IOT development, JAVA stands out among the most popular programming languages.
 - One of the prominent features that make JAVA favorable for IOT development is write one, run anywhere concept which implies that compiled JAVA code can run on any platform that supports language.
 2. Python :
 - Python is another most-recommended programming language compatible for IOT development.
 - It is an interpreted language the supports OOP as well as structured programming.
 - The high level programming language has an easier syntax and better code readability that makes it one most preferred language for IOT development.
 3. LUA :
 - LUA is not one of the usual names in the computer programming world but when it comes to IOT development, it has already made its strong presence.
 - LUA is general purpose, high level programming language that is designed for embedded purposes.

Q.19 i) Home automation :

- a) Smart lighting :
- b) Smart appliances
- c) Intrusion detection :
- d) Smoke/Gas detector.

ii) Smart city :

- a) Smart parking
- b) Smart lighting for road
- c) Smart road
- d) Surveillance

iii) Logistics :

- a) Fleet tracking
- b) Shipment monitoring
- c) Remote vehicle Diagnostics

iv) Agriculture :

- a) Smart irrigation
- b) Green house control.

v) Health & life styles:

- a) Health & fitness monitoring
- b) Wearable electronics.

1. Smart city :
 - a) Smart parking : ex. Parking in mall
 - b) Smart road : ex. Traffic signal
 - c) Structural health monitoring : ex. Crack detection in building
 - d) Surveillance
 - Face recognition
 - Protect physical infrastructure
 - Monitor wide & dark areas
2. Home automation :
 - a) Smart lights : ex. Smart bulb
 - b) Smart appliances : ex. Smart fridge, washing m/c
 - c) Intrusion detection : ex. Smart cameras
 - d) Smoke/Gas detector
3. Environment in IOT :
 - a) Weather monitoring system : ex. Air speed, humidity.
 - b) Air pollution monitoring system : ex. Gaseous sensors for detection in industries.
 - c) Noise pollution monitoring system.
 - d) Forest fire detection.
 - e) River flood detection.
4. Agriculture :
 - a) Smart irrigation system
 - b) Greenhouse control.