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Total No. of Questions – [04]

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OCTOBER 2019/ INSEM (T1)
T. Y. B. TECH. ALL PROGRAMS (SEMESTER -I)

COURSE NAME: INTERNET OF THINGS

COURSE CODE: IE31175CS

(PATTERN – 2017)

SOLUTION

Time: [1 Hour]

[Max. Marks: 30]

Instructions to candidates:

- 1) Answer Q.1 OR Q.2 and Q.3 OR Q.4.
- 2) Figures to the right carry marks.

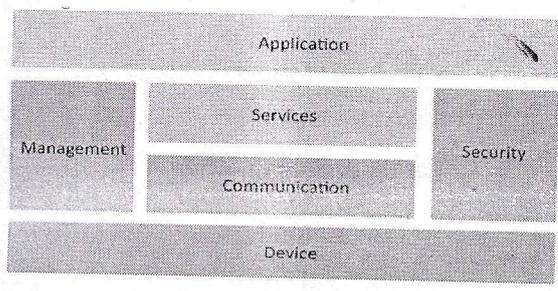
Q.1) a) Draw and explain logical design of IoT.

[6]

Figure [2 Marks], Explanation [4 marks]

Answer: Logical design of an IoT system refers to an abstract representation of the entities and processes without going into the low-level specifics of the implementation.

An IoT system comprises a number of functional blocks that provide the system the capabilities for identification, sensing, actuation, communication and management.



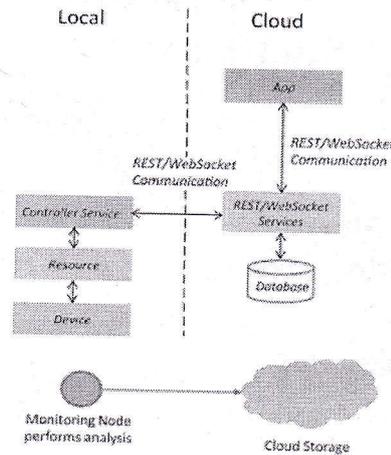
- Device: Devices such as sensing, actuation, monitoring and control functions.
- Communication: IoT Protocols
- Services like device monitoring, device control services, data publishing services and device discovery
- Management: Functions to govern the system
- Security: Functions as authentication, authorization, message and content integrity, and data security

- Applications: IoT applications provide an interface that the users can use to control and monitor various aspects of the IoT system. Applications also allow users to view the system status and the processed data.

b) Design deployment Level two IoT System for Smart Irrigation System and explain it. [6]

Figure [2 Marks], Description [4 Marks]

Answer: A level-2 IoT system has a single node that performs sensing and/or actuation and local analysis. Data is stored in the cloud and the application is usually cloud-based.



Level-2 IoT systems are suitable for solutions where the data involved is big; however, the primary analysis requirement is not computationally intensive and can be done locally. System consists of a single node that monitors the soil moisture level and controls the irrigation system

- Device used in this system collects moisture data from sensors.
- Controller service continuously monitors the moisture levels.
- If moisture level drops below a threshold, irrigation system turns on.
- Actuators like solenoid valves can be used.
- The controller also sends the moisture data to computing cloud
- A cloud based application is used for visualizing the moisture levels over a period of time, which can help in making decisions about irrigation schedules.

c) Define REST-based communication API, list down its constraints. [4]

Definition [2 Marks], Constraints [2 Marks]

Answer: Representational State Transfer (REST) – set of architectural principles to design web services and web APIs that focus on system's resources and how resources are addressed and transferred. REST APIs follow the request– response communication model. REST

architectural constraints apply to the components, connectors and data elements within a distributed hypermedia system. The REST Architectural constraints are as follows:

1. Client-Server
2. Stateless
3. Cache-able
4. Layered System
5. Uniform Interface
6. Code on demand

OR

Q2. a) List four Communication models of IOT and explain any two of them. [6]

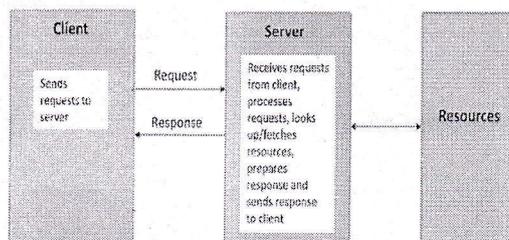
List [2 Marks], each of two model with figure and explanation [2 Marks]

Answer: Four Communication models:

1. Request-Response
2. Publish-Subscribe
3. Push-Pull
4. Exclusive Pair

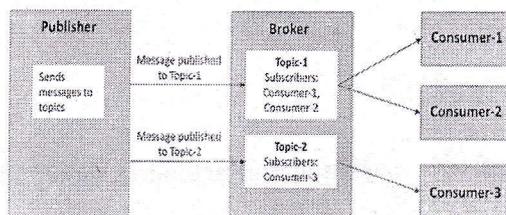
Request-Response

- Client-Server communication
- When server receives request, it decides how to respond, fetches data, retrieves resource representations, prepares the response and sends to the client
- Stateless communication model (each request-response is independent of others)



Publish-Subscribe

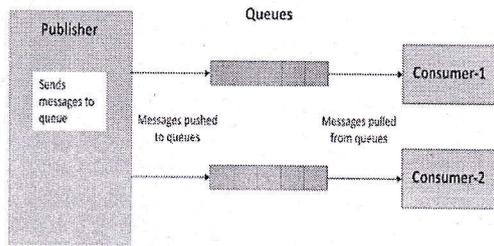
- Communication model that involves publishers, brokers and consumers
- Publishers- source of data
- Publishers send data to topics which are managed by broker (publishers not aware of consumers)
- Consumers subscribe to topics which are managed by broker.
- When broker receives data for a topic from the publisher, it sends the data to all the subscribed consumers



Push-Pull

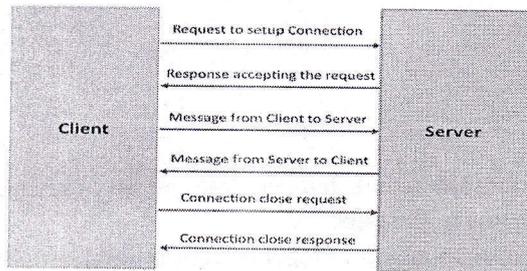
- Data producers push data to queue and consumers pull data from queue
- Producers not aware of consumers

- Queues also act as buffer which helps in situations when there is mismatch between rate at which producers push and consumers pull.



Exclusive Pair

- Bi-directional , full duplex communication model
- Persistent connection between client and server
- Connection remains open until client sends request to close the connection
- Client-server can communicate once connection setup is done.
- Stateful communication model and server is aware of all open connections.

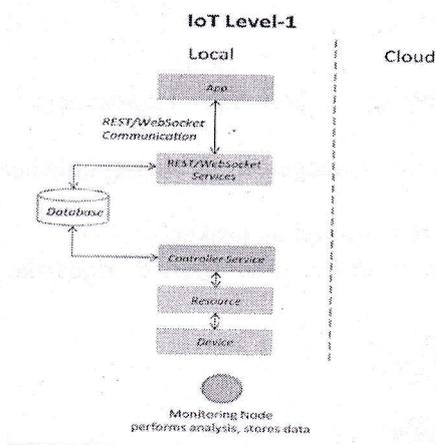


b) Design deployment level one IoT System for Home Automation.

[6]

Figure [2 Marks], Explanation [4 Marks]

Answer:



- L1 IoT system has a single node/device that performs sensing and/or actuation, stores data and hosts the application.
- Suitable for modelling low cost and low complexity solution where data involved is not big and analysis requirements are computationally inexpensive.

Home Automation System:

- System with single node that allows controlling the lights and appliances in a home remotely
- Device used interfaces with lights and appliances using electronic relay switches
- The status information of each light or appliance is maintained in a local database
- REST services deployed locally allow retrieving and updating state of each light and triggers the relay switches accordingly.
- Application deployed locally has an user interface for controlling the lights or appliances
- With internet connectivity application can be accessed remotely as well.

c) Explain IoT enabling technologies Cloud Computing, Data Analytics. [4]
Enabling technology Explanation [2 Marks each]

Answer:

1. Cloud Computing :

Deliver applications and services over internet.

Provides computing, networking and storage resources on demand.

Cloud computing performs services such as Iaas, Paas and Saas

- Iaas: Rent Infrastructure
- Paas: supply an on-demand environment for developing, testing, delivering and managing software applications.
- Saas: method for delivering software applications over the Internet, on demand and typically on a subscription basis.

2. Data analytics :

Collection of data whose volume, velocity or variety is too large and difficult to store, manage,

process and analyze the data using traditional databases.

- It involves data cleansing, processing and visualization
- Lots of data is being collected and warehoused
- Web data, e-commerce
- Purchases at department/ grocery stores
- Bank/Credit Card transactions
- Social Network

Variety includes different types of data:

Structured, Unstructured, Semi Structured, All of above

Velocity Refers to speed at which data is processed

Batch, Real-time, Streams

Volume refers to the amount of data

Terabyte, Records, Transactions, Files, Tables

Q. 3) a) Explain MQTT and four messaging modes of CoAP protocol with appropriate figure. [6]

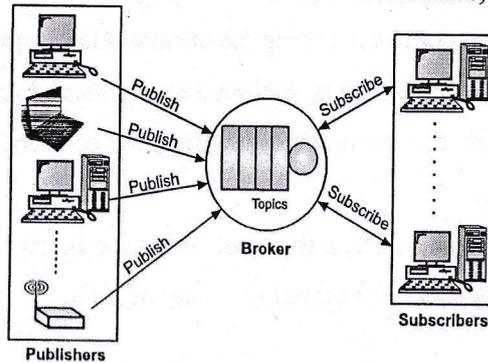
MQTT [2 Mark] CoAP Modes [1 Mark each]

Answer: MQTT aims at connecting embedded devices and networks with applications and middleware.

The connection operation uses a routing mechanism (one-to-one, one-to-many, many-to-many) and enables MQTT as an optimal connection protocol for the IoT and M2M.

- MQTT utilizes the publish/subscribe pattern to provide transition flexibility and simplicity of implementation as depicted in Fig. Also, MQTT is suitable for resource constrained devices that use unreliable or low bandwidth links.

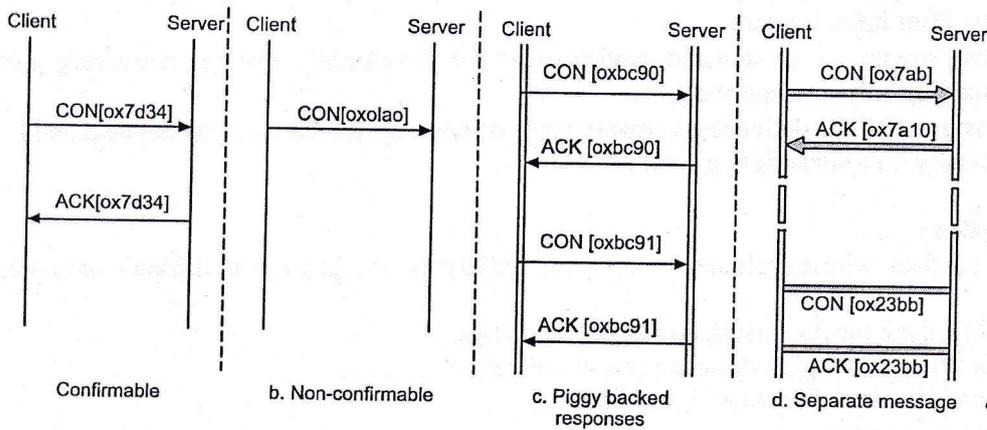
- MQTT is built on top of the TCP protocol. It delivers messages through three levels of QoS. The specifications provide three elements: connection semantics, routing, and endpoint.



Constrained Application Protocol (CoAP)

This protocol works in an application layer protocol for IoT applications. The CoAP defines a web transfer protocol based on Representational State Transfer (REST) on top of HTTP functionalities.

The four messaging modes of CoAP are as follows:



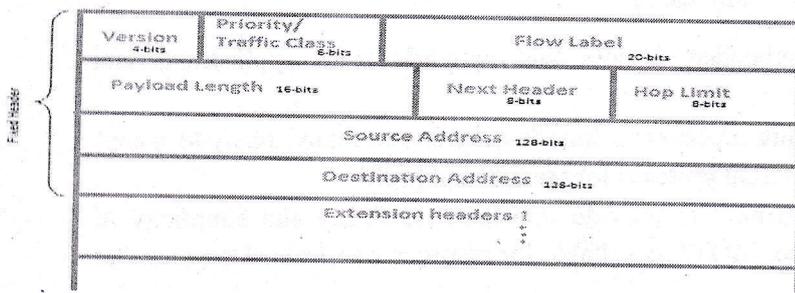
b) Explain IPv6 protocol along with its header

[4]

Figure [2 Marks], Explanation [2 Marks]

Answer: IPv6 (Internet Protocol version 6) is a set of specifications from the Internet Engineering Task Force (IETF) that is essentially an upgrade of IP version 4 (IPv4), a category of addresses in IPv4-based routing. The basics of IPv6 are similar to those of IPv4 devices can use IPv6 as source and destination addresses to pass packets over a network, and tools like ping work for network testing as they do in IPv4, with some slight variations.

IPv6 Header is as follows:



Version (4-bits) : Indicates version of Internet Protocol which contains bit sequence 0110.

Traffic Class (8-bits): The Traffic Class field indicates class or priority of IPv6 packet which is similar to *Service Field* in IPv4 packet. It helps routers to handle the traffic based on priority of the packet.

Flow Label (20-bits): Flow Label field is used by source to label the packets belonging to the same flow in order to request special handling by intermediate IPv6 routers, such as non-default quality of service or real time service. In order to distinguish the flow, intermediate router can use source address, destination address and flow label of the packets. Between a source and destination multiple flows may exist because many processes might be running at the same time. Routers or Host that do not support the functionality of flow label field and for default router handling, flow label field is set to 0. While setting up the flow label, source is also supposed to specify the lifetime of flow.

Payload Length (16-bits): It is a 16-bit (unsigned integer) field, indicates total size of the payload which tells routers about amount of information a particular packet contains in its payload. Payload Length field includes extension headers (if any) and upper layer packet. In case length of payload is greater than 65,535 bytes (payload up to 65,535 bytes can be indicated with 16-bits), then the payload length field will be set to 0 and jumbo payload option is used in the Hop-by-Hop options extension header.

Next Header (8-bits): Next Header indicates type of extension header(if present) immediately following the IPv6 header. Whereas In some cases it indicates the protocols contained within upper-layer packet, such as TCP, UDP.

Hop Limit (8-bits): Hop Limit field is same as TTL in IPv4 packets. It indicates the maximum number of intermediate nodes IPv6 packet is allowed to travel. Its value gets decremented by one, by each node that forwards the packet and packet is discarded if value decrements to 0. This is used to discard the packets that are stuck in infinite loop because of some routing error.

Source Address (128-bits): Source Address is 128-bit IPv6 address of the original source of the packet.

Destination Address (128-bits): Destination Address field indicates the IPv6 address of the final destination (in most cases). All the intermediate nodes can use this information in order to correctly route the packet.

Extension Headers: In order to rectify the limitations of *IPv4 Option Field*, Extension Headers are introduced in IPversion 6. The extension header mechanism is very important part of the IPv6 architecture. Next Header field of IPv6 fixed header points to the first Extension Header and this first extension header points to the second extension header and so on.

c) Explain Wi-Fi and elements of Wi-Fi

[4]

Wi-Fi [2 Marks], Elements of Wi-Fi [2 Marks]

Answer: Wi-Fi is a popular wireless networking technology. Wi-Fi stands for “wireless fidelity”. The Wi-Fi was invented by NCR corporation/AT&T in Netherlands in 1991. By using this technology we can exchange the information between two or more devices. Wi-Fi has been developed for mobile computing devices, such as laptops, but it is now extensively using for mobile applications and consumer electronics like televisions, DVD players and digital cameras. There should be two possibilities in communicating with the Wi-Fi connection that may be through access point to the client connection or client to client connection. Wi-Fi is a one type of wireless technology. It is commonly called as wireless LAN (local area network). Wi-Fi allows local area networks to operate without cable and wiring. It is making popular choice for home and business networks. A computer’s wireless adaptor transfers the data into a radio signal and transfers the data into antenna for users.

Elements of Wi-Fi:

Access Point (AP) - The AP is a wireless LAN transceiver or “base station” that can connect one or many wireless devices simultaneously to the Internet.

Wi-Fi cards- They accept the wireless signal and relay information. They can be internal and external.

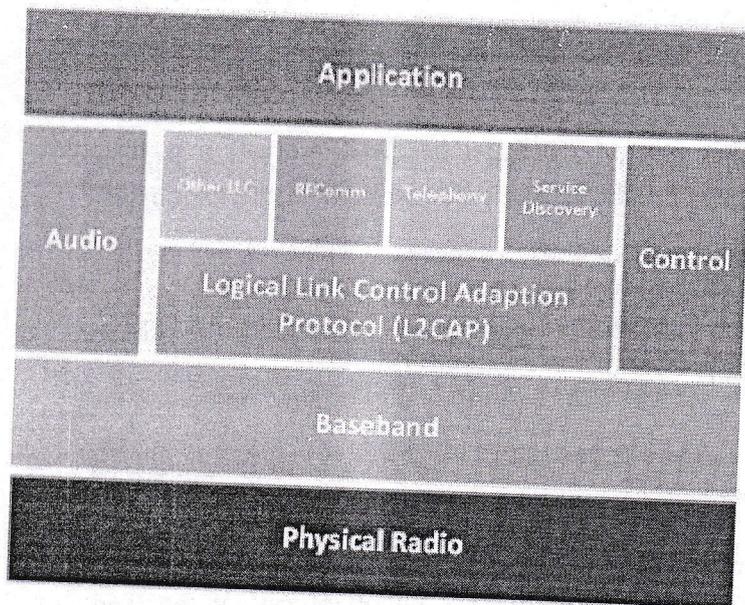
Safeguards- Firewalls and anti-virus software protect networks from uninvited users and keep information secure.

a) Draw and explain the Bluetooth protocol stack.

Figure [2 Marks], Explanation [4 Marks]

[6]

Answer:



Physical layer /physical radios

These are radio waves used for connecting the device wirelessly.

Baseband layer

This layer manages physical channels and links.

It handles packets, paging and inquiry.

Other services include:

- Error correction
- Data whitening
- Hop selection
- Bluetooth security

L2CAP layer (The Logical Link Control and Adaptation Protocol)

It is used to multiplex multiple logical connections between two devices.

It provides connection-oriented and connectionless data services to upper layer protocols.

It provides:

- Protocol multiplexing capability
- Segmentation and reassembly operation
- Group abstractions

Middle ware layer

LLC: It consist of protocols which supports link layer functionalities.
Radio Frequency Communications (RFCOMM).

- It is a cable replacement protocol used for generating a virtual serial data stream.
- RFCOMM provides for binary data transport.
- RFCOMM provides a simple reliable data stream to the user, similar to TCP.
- Supports up to 60 simultaneous connections between two BT devices.

Telephony: It consist of protocols which supports traditional telephony.

Service Discovery:

- It consist of protocols which supports service discovery.
- Enables applications to discover available services and their features.
- Can function over a reliable packet transfer protocol.
- Uses a request/response model.

Application layer

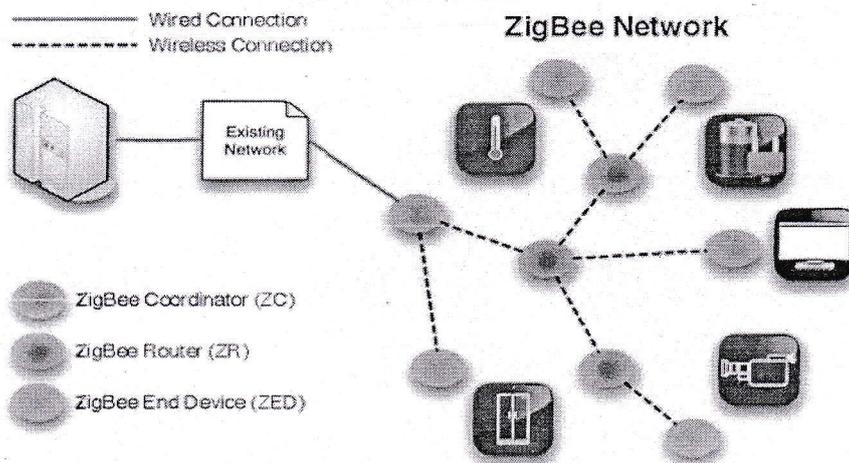
It consist of protocols which are used to in different applications such as Home automation, Smartphones, Toys etc.

Q2.) Draw and explain ZigBee system structure.

[4]

Figure [2 Marks], Explanation [2 Marks]

Answer: Zigbee system structure consists of three different types of devices such as Zigbee coordinator, Router and End device.



ZigBee Coordinator (ZC)

The Coordinator forms the root of the ZigBee network tree and might act as a bridge between networks. There is a single ZigBee Coordinator in each network, which originally initiates the network. It stores information about the network under it and outside it. It acts as a Trust Center & repository for security keys.

ZigBee Router (ZR):

Capable of running applications, as well as relaying information between nodes connected to it.

ZigBee End Device (ZED):

It contains just enough functionality to talk to the parent node, and it cannot relay data from other devices. This allows the node to be asleep a significant amount of the time thereby enhancing battery life. Memory requirements and cost of ZEDs are quite low, as compared to ZR or ZC.

c) Compare MQTT and HTTP protocol.
4 comparisons [1 Mark each]

[4]

Answer:

| MQTT | HTTP |
|--|--|
| Message Queue Telemetry Transport | Hyper Text Transfer Protocol |
| It uses publish subscribe model. | It uses Request –Response model. |
| It is simple. | It Is complex. |
| It provides asynchronous communication | It provides asynchronous communication |
| It provides quality of service | It do not provide quality of service |
| MQTT is data centric | HTTP is document-centric |
| MQTT has short specification | HTTP specifications are much longer |
| It runs over TCP. | It runs over TCP and UDP |
| Message format is binary with 2Byte header | Message format is ASCII |

2