Unit1:

1. Define Internet of things and characteristics of IOT and protocols used in Link Layer

A. Internet of Things(loT)comprises things that have unique identities and are connected to the Internet.

The characteristics of IoT

1. Self-Configuring
2. Dynamic and Self-Adapting
3. Interoperable Communication Protocols
4. Unique Identify

IoT protocols used in Link Layer are

1.802.3-Ethernet
2. 802.11-WiFi
3. 802.16-WiMax
4. 802.15.4-LR_WPAN2G/3G/4G

2. Various enabling technologies and applications of IOT

A. IoT is enabled by several technologies including Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Embedded Systems, Security Protocols and architectures, Communication Protocols, Web Services, Mobile internet and semantic search engines.

1) WirelessSensorNetwork(WSN): Comprisesofdistributeddeviceswithsensorswhich areusedtomonitortheenvironmentalandphysicalconditions.ZigBeeisoneofthemostpopular wireless technologies used by WSNs.

WSNs used in IoT systems are described as follows:

- Weather Monitoring System: in which nodes collect temp, humidity and other data, which is aggregated and analyzed.
- Indoor air quality monitoring systems: to collect data on the in door air quality and concentration of various gases.
- Soil Moisture Monitoring Systems: to monitor soil moisture at various locations.
- Surveillance Systems: use WSNs for collecting surveillance data (motion data detection).
- Smart Grids: use WSNs for monitoring grids at various points.

2) **Cloud Computing:** Services are offered to users in different forms.
   - Infrastructure-as-a-service(IaaS):provides users the ability to provision computing andstorageresources.Theseresourcesareprovidedtotheusersasavirtualmachine instances and virtual storage.
   - Platform-as-a-Service(PaaS): provides users the ability to develop and deploy application in cloud using the development tools, APIs, software libraries and services provided by the cloud service provider.
   - Software-as-a-Service(SaaS): provides the user a complete software application or the user interface to the application itself.

3) **Big Data Analytics:** Some examples of big data generated by IoT are
   - Sensor data generated by IoT systems.
   - Machine sensor data collected from sensors established in industrial and energy systems.
   - Health and fitness data generated IoT devices.
   - Data generated by IoT systems for location and tracking vehicles.
   - Data generated by retail inventory monitoring systems.

4) **Communication Protocols:** form the back-bone of IoT systems and enable network connectivity and coupling to applications.
   - Allow devices to exchange data over network.
   - Define the exchange formats, data encoding addressing schemes for device and routing of packets from source to destination.
   - It includes sequence control, flow control and retransmission of lost packets.

5) **Embedded Systems:** is a computer system that has computer hardware and software embedded to perform specific tasks. Embedded System range from low cost miniaturized

devices such as digital watches to devices such as digital cameras, POS terminals, vending machines, appliances etc.,

3. Communication APIs of IOT

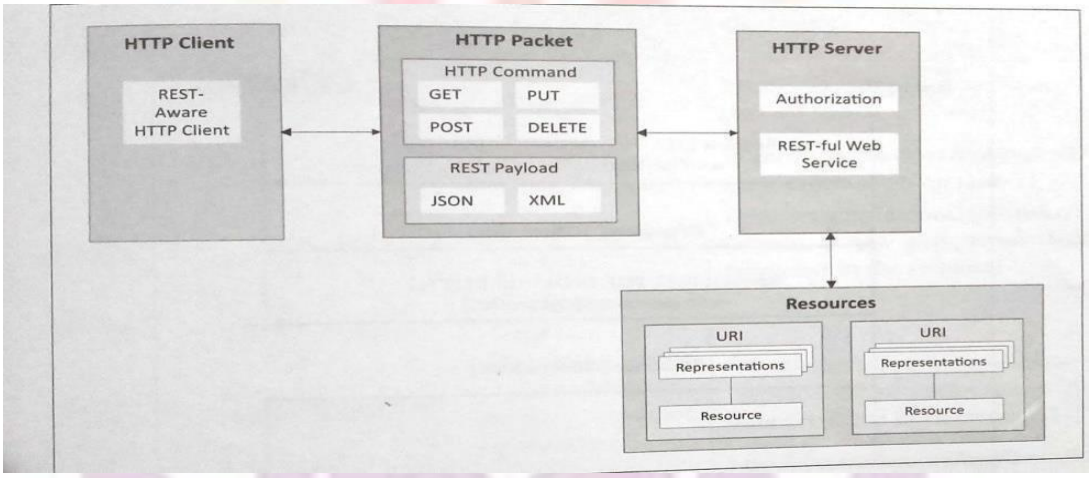
A. IoT Communication APIs:

a) REST based communication APIs(Request-Response Based Model)

b) Web Socket based Communication APIs(Exclusive Pair Based Model)

a) REST based communication APIs: Representational State Transfer(REST) is a set of architectural principles by which we can design web services and web APIs that focus on a system's resources and have resource states are addressed and transferred.

The REST architectural constraints: Fig.shows communication between client server with REST APIs.



Client-Server:

Theprinciplebehindclient-serverconstraintistheseparationofconcerns.Separation allows client and server to be independently developed and updated.

Stateless:

Each request from client to server must contain all the info. Necessary to understand the request, and cannot take advantage of any stored context on the server.

Cache-able:

Cache constraint requires that the data within a response to a request be implicitly or explicitly labeled as cache-able or non-cacheable.

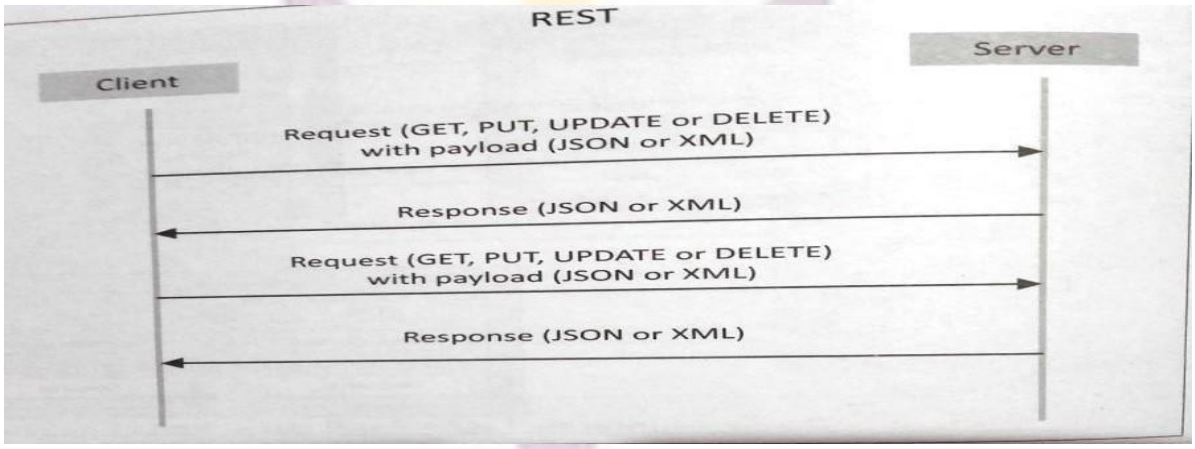
Layered System:

constraints the behavior of components such that each component cannot see beyond the immediate layer with which they are interacting.

User Interface:
constraint requires that the method of communication between a client and a server must be uniform.

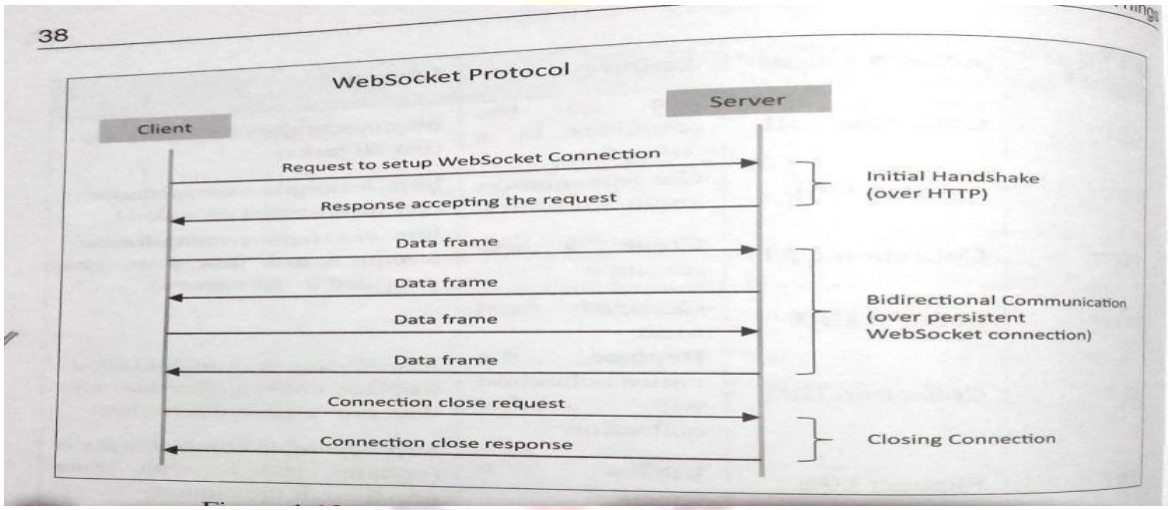
Code on Demand:
Servers can provide executable code or scripts for clients to execute in their context. This constraint is the only one that is optional.

Request-Response model used by REST:



RESTful webservice is a collection of resources which are represented by URIs. RESTful web API has a base URI(e.g: http://example.com/api/tasks/). The clients and requests to these URIs using the methods defined by the HTTP protocol(e.g: GET, PUT, POST or DELETE). A RESTful web service can support various internet media types.

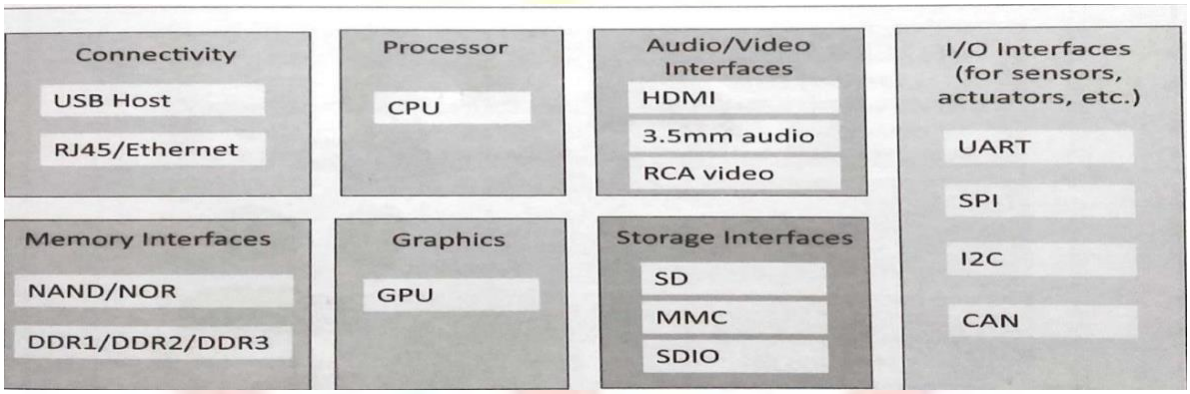
b) Web Socket Based Communication APIs: WebSocket APIs allow bi-directional, full duplex communication between clients and servers. WebSocket APIs follow the exclusive pair communication model.



4. Physical design of IOT with neat diagram

A. Physical Design Of IoT

1) Things in IoT:



The things in IoT refers to IoT devices which have unique identities and perform remote sensing, actuating and monitoring capabilities. IoT devices can exchange data with other connected devices applications. It collects data from other devices and process data either locally or remotely.

An IoT device may consist of several interfaces for communication to other devices both wired and wireless. These includes

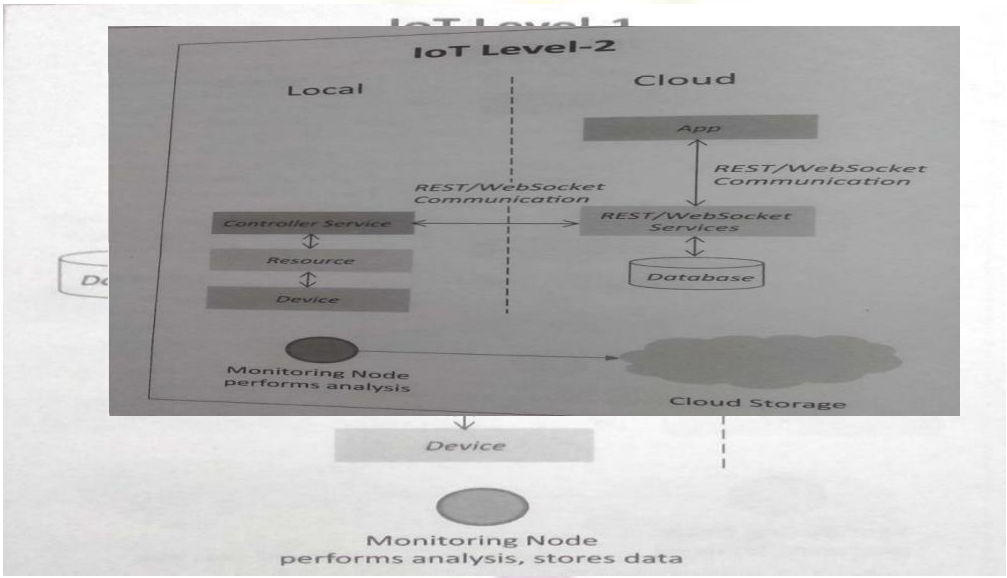
1. I/O interfaces for sensors,
2. Interfaces for internet connectivity
3. Memory and storage interfaces
4. audio/video interfaces.

1)IoT Protocols:

a)LinkLayer: Protocolsdeterminehowdataisphysicallysentoverthenetwork'sphysical layer or medium. Local network connect to which host is attached. Hosts on the same link exchange data packets over the link layer using link layer protocols. Link layer determines how packets are coded and signaled by the h/w device over the medium to which the host is attached.

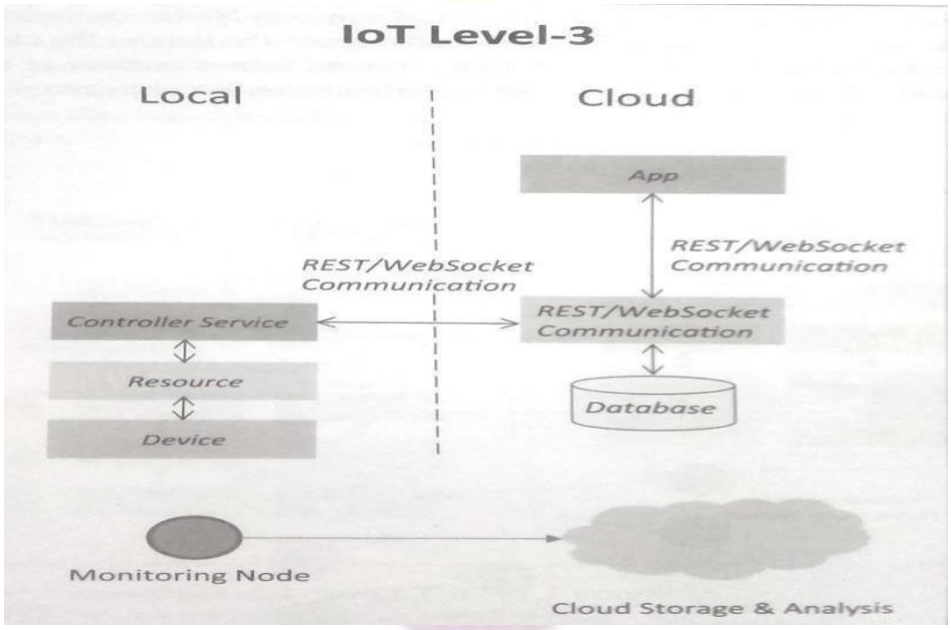
5. IOT levels with neat diagramAns:

A. IoT Level 1: System has a single node that performs sensing and/or actuation, stores data, performs analysis and host the application as shown in fig. Suitable for modeling low cost and low complexity solutions where the data involved is not big and analysis requirement are not computationally intensive. An e.g., of IoT Level1 is Home automation.

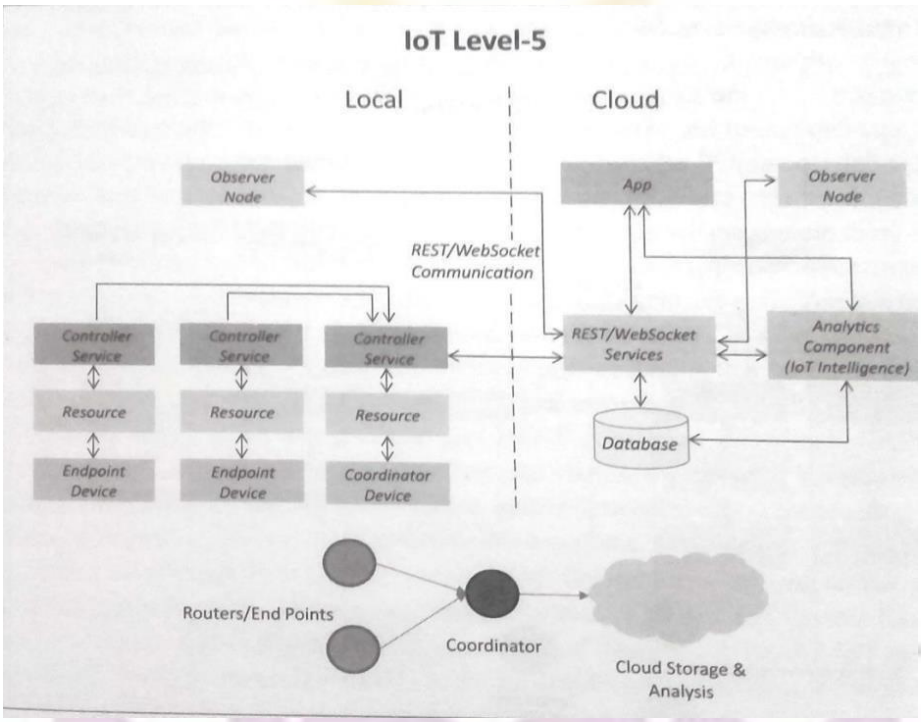


IoT Level2: has a single node that performs sensing and/or actuating and local analysis as showninfig.Dataisstoredincloudandapplicationisusuallycloudbased. Level2IoTsystems are suitable for solutions where data are involved is big, however, the primary analysis requirementisnotcomputationallyintensiveandcanbedonelocallyitself.Ane,g.,ofLevel2 IoT system for Smart Irrigation.

IoTLevel3: system has a single node. Data is stored and analyzed in the cloud application is cloud based as shown in fig. Level3 IoT systems are suitable for solutions where the data involved is big and analysis requirements are computationally intensive. An example of IoT level3 system for tracking package handling.



IoT Level5: System has multiple end nodes and one coordinator node as shown in fig.The end nodes that perform sensing and/or actuation. Coordinator node collects data from the end nodes and sends to the cloud. Data is stored and analyzed in the cloud and application is cloud based. Level5 IoT systems are suitable for solution based on wireless sensor network, in which data involved is big and analysis requirements are computationally intensive. An example of Level5 system for Forest Fire Detection.



IoT Level6: System has multiple independent end nodes that perform sensing and/or actuation, and send sensed data to the cloud. Data is stored in the cloud, and the application is cloud-based as shown in the figure. The analytics component analyses the data and stores the result in the cloud database. The results are visualized with a cloud-based application. The centralized controller is aware of the status of all the end nodes and sends control commands to the nodes. An example of a Level 6 IoT system is a Weather Monitoring System..