Scheme of Evaluation

Internal Assessment Test 1 – March.2022

Sub:	Internet of Things							**Code:**	18CS81
Date:	11/03/2023	Duration:	90mins	Max Marks:	50	**Sem:**	VIII	**Branch:**	ISE

Note: Answer Any Five Questions

Question #	Description	Marks Distribution	Max Marks
1	• Characteristics of fog computing utilizing IoT Data Management & Compute Stack	10M	10 M
2	• Core IoT functional Stack	10 M	10 M
3	• IoT reference model published by IoTWF	10M	10 M
4	• One M2M IoT Standardized Architecture • Genesis of IoT	7M3 M	10 M
5	• Topologies used for IoT connecting devices • IT and OT networks with the various challenges.	6M 4M	10 M
6	• The most useful classification schemes for pragmatic Application of sensors in a IoT network • Sensors and identify its characteristics	8M 2M	10 M

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1. Characteristics of fog computing utilizing IoT Data Management & Compute Stack

In most cases, the processing location is outside the smart object. A natural location for thisprocessing activity is the cloud. Smart objects need to connect to the cloud, and data processing is centralized.
However, this model also has limitations. As data volume, the variety of objects connecting to the network, and the need for more efficiency increase. These new requirements include the following:

- *Minimizing latency*: Analyzing data close to the device that collected the data can make a difference between averting disaster and a cascading system failure.
- *Conserving network bandwidth*: It is not practical to transport vast amounts of data from thousands or hundreds of thousands of edge devices to the cloud. Nor is it necessary because many critical analyses do not require cloud-scale processing and storage.
- *Increasing local efficiency*: Collecting and securing data across a wide geographic area with different environmental conditions may not be useful.

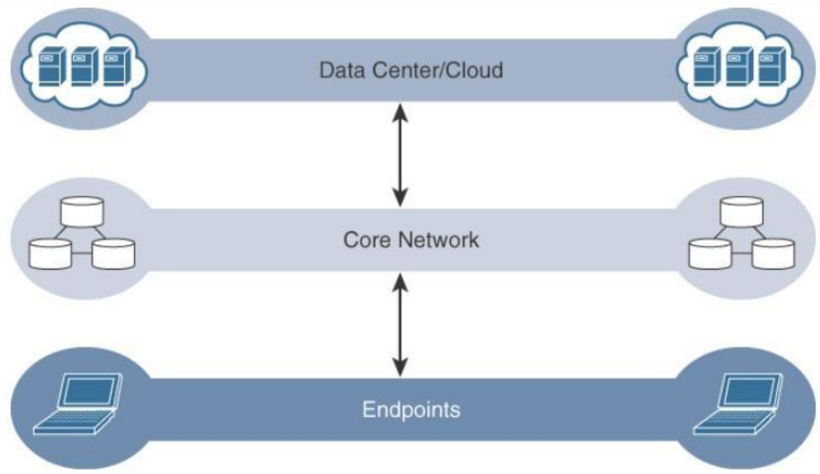

Figure 2-14 *The Traditional IT Cloud Computing Model*

2. Core IoT functional Stack

A. **"Things" layer**: At this layer, the physical devices need to fit the constraints of the environment in which they are deployed while still being able to provide the information needed.
B. **Communications network layer**: When smart objects are not self-contained, they need to communicate with an external system. In many cases, this communication uses a wireless technology. This layer has four sublayers:

C. **Access network sublayer**: The last mile of the IoT network is the access network. This is typically made up of wireless technologies such as 802.11ah, 802.15.4g, and LoRa. The sensors connected to the access network may also be wired.

D. **Gateways and backhaul network sublayer**: A common communication system organizes multiple smart objects in a given area around a common gateway. The gateway communicates directly with the smart objects. The role of the gateway is to forward the collected information through a longer-range medium (called the backhaul) to a headend central station where the information is processed. This information exchange is a Layer 7 (application) function, which is the reason this object is called a gateway. On IP networks,this gateway also forwards packets from one IP network to another, and it therefore acts as a router.

E. **Network transport sublayer**: For communication to be successful, network and transport layer protocols such as IP and UDP must be implemented to support the variety of devices to connect and media to use.

F. **IoT network management sublayer**: Additional protocols must be in place to allow the headend applications to exchange data with the sensors. Examples include CoAP and MQTT.

G. **Application and analytics layer**: At the upper layer, an application needs to process the collected data, not only to control the smart objects when necessary, but to make intelligent decision based on the information collected and, in turn, instruct the "things" or other systems to adapt to the analyzed conditions and change their behaviors or parameters.

3. IoT reference model published by IoTWF

Layer 1: Physical Devices and Controllers Layer

- This layer is home to the "things" in the Internet of Things, including the various endpoint devices and sensors that send and receive information.
- The primary function is generating data

Layer 2: Connectivity Layer

- The primary function of this IoT layer is the reliable and timely transmission of data.

Layer 3: Edge Computing Layer

- Here emphasis is on data reduction and converting information that is ready for storage and processing by higher layers.

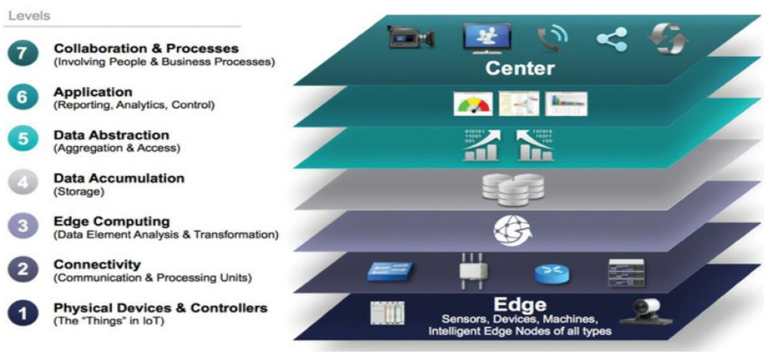

Figure 2-2 IoT Reference Model Published by the IoT World Forum

4. a. One M2M IoT Standardized Architecture b. Genesis of IoT

- It was created with a goal of accelerating Machine to machine applications & devices.
- It expanded to include IoT.
- One M2M was launched with a goal to promote efficient M2M communication systems and IoT.
- OneM2M Goal: create a common services layer.
- Its framework focuses on IoT services , applications, and platforms.
- It divides IoT functions into 3 major domains.
- It supports wide range of IoT technologies.

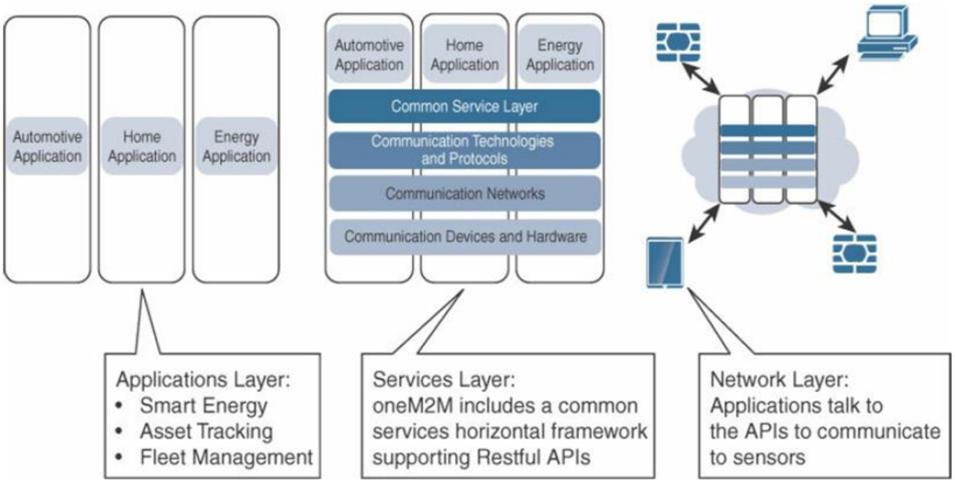

Figure 2-1 The Main Elements of the oneM2M IoT Architecture

b. Genesis of IoT

The IoT started between the years 2008 and 2009. "Internet of Things" is invented by Kevin Ashton.Kevin quoted as saying: "In the 20th century, computers were brains without senses—they only knew what we told them." Computers depended on humans to input data and knowledge. Butin the 21st century, computers are sensing things too.

The evolution of the Internet can be categorized into four phases:

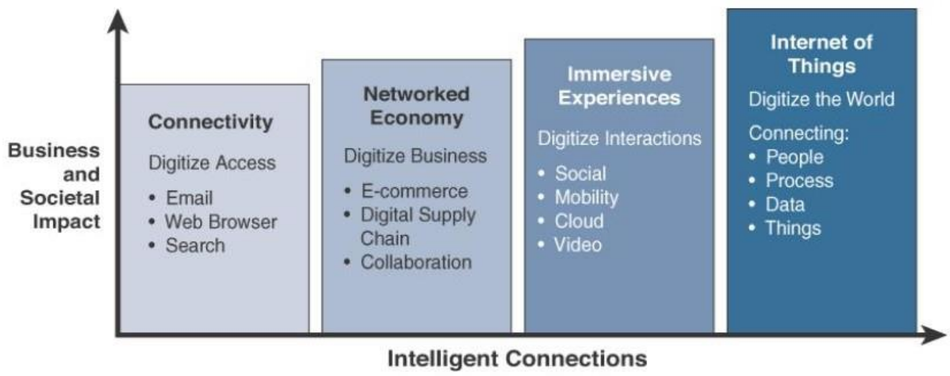

Figure 1-1 *Evolutionary Phases of the Internet*

	Internet Phases	Definition

1.	Connectivity (Digitize access)	• Connect people using email, web services… • Search and access the information
2.	Networked Economy(Digitize business)	• Enable e-commerce and supply-chain enhancements • Collaborative engagement to increase efficiency
3.	Immersive Experiences(Digitize interactions)	• Extend Internet using social media while always beingconnected through mobility. • Most applications are cloud-based.
4.	Internet of Things (Digitize the world)	• Connect objects and machines in real world. • Enable connecting the unconnected.

5. a. Topologies used for IoT connecting devices

Among the access technologies available for connecting IoT devices, three main topology schemes are dominant: star, mesh, and peer-to-peer. For long-range and short-range technologies, a star topology is prevalent, as seen with cellular, LPWA, and Bluetooth networks. Star topologies utilize a single central base station or controller to allow communications with endpoints.

For medium-range technologies, a star, peer-to-peer, or mesh topology is common, as shown in Figure 4-2. Peer-to-peer topologies allow any device to communicate with any other device as longas they are in range of each other. Obviously, peer-to-peer topologies rely on multiple full-function devices. Peer-to-peer topologies enable more complex formations, such as a mesh networking topology.

A mesh topology helps cope with low transmit power, searching to reach a greater overall distance, and coverage by having intermediate nodes relaying traffic for other nodes. Mesh topology requires the implementation of a Layer 2 forwarding protocol known as mesh-under or a Layer 3 forwarding protocol referred to as mesh-over on each intermediate node. An intermediate node or full-function device (FFD) is simply a node that interconnects other nodes. A node that doesn’t interconnect or relay the traffic of other nodes is known as a leaf node, or reduced-function device (RFD).

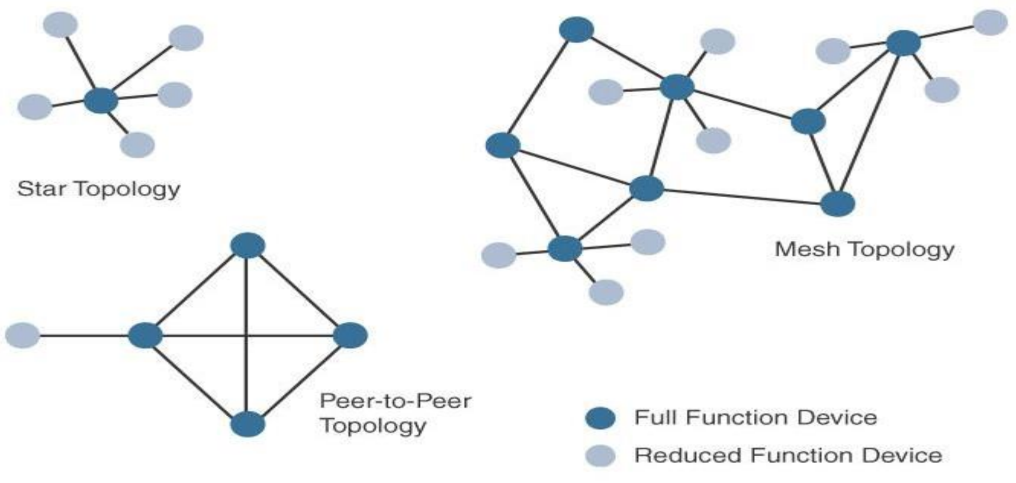

Figure 4-2 *Star, Peer-to-Peer, and Mesh Topologies*

b. IT and OT networks with the various challenges

IT supports connections to the Internet along with related data and technology systems and is focused on the secure flow of data across an organization.
OT monitors and controls devices and processes on physical operational systems. These systems include assembly lines, utility distribution networks, production facilities, roadway systems, and many more.

Criterion	Industrial OT Network	Enterprise IT Network
Operational focus	Keep the business operating 24x7	Manage the computers, data, and employee communication system in a secure way
Priorities	1. Availability 2. Integrity 3. Security	1. Security 2. Integrity 3. Availability
Types of data	Monitoring, control, and supervisory data	Voice, video, transactional, and bulk data
Security	Controlled physical access to devices	Devices and users authenticated to the network
Implication of failure	OT network disruption directly impacts business	Can be business impacting, depending on industry, but workarounds may be possible
Network upgrades (software or hardware)	Only during operational maintenance windows	Often requires an outage window when workers are not onsite; impact can be mitigated
Security vulnerability	Low: OT networks are isolated and often use proprietary protocols	High: continual patching of hosts is required, and the network is connected to Internet and requires vigilant protection

Source: Maciej Kranz, *IT Is from Venus, OT Is from Mars*, blogs.cisco.com/digital/it-is-from-venus-ot-is-from-mars, July 14, 2015.

Table 1-3 *Comparing Operational Technology (OT) and Information Technology (IT)*

6. a. The most useful classification schemes for pragmatic Application of sensors in a IoT network

Sensor Types	Description	Examples
Position	A position sensor measures the position of an object; the position measurement can be either in absolute terms (absolute position sensor) or in relative terms (displacement sensor). Position sensors can be linear, angular, or multi-axis.	Potentiometer, inclinometer, proximity sensor
Occupancy and motion	Occupancy sensors detect the presence of people and animals in a surveillance area, while motion sensors detect movement of people and objects. The difference between the two is that occupancy sensors generate a signal even when a person is stationary, whereas motion sensors do not.	Electric eye, radar
Velocity and acceleration	Velocity (speed of motion) sensors may be linear or angular, indicating how fast an object moves along a straight line or how fast it rotates. Acceleration sensors measure changes in velocity.	Accelerometer, gyroscope
Force	Force sensors detect whether a physical force is applied and whether the magnitude of force is beyond a threshold.	Force gauge, viscometer, tactile sensor (touch sensor)
Pressure	Pressure sensors are related to force sensors, measuring force applied by liquids or gases. Pressure is measured in terms of force per unit area.	Barometer, Bourdon gauge, piezometer
Flow	Flow sensors detect the rate of fluid flow. They measure the volume (mass flow) or rate (flow velocity) of fluid that has passed through a system in a given period of time.	Anemometer, mass flow sensor, water meter

Sensor Types	Description	Examples
Acoustic	Acoustic sensors measure sound levels and convert that information into digital or analog data signals.	Microphone, geophone, hydrophone
Humidity	Humidity sensors detect humidity (amount of water vapor) in the air or a mass. Humidity levels can be measured in various ways: absolute humidity, relative humidity, mass ratio, and so on.	Hygrometer, humistor, soil moisture sensor
Light	Light sensors detect the presence of light (visible or invisible).	Infrared sensor, photodetector, flame detector
Radiation	Radiation sensors detect radiation in the environment. Radiation can be sensed by scintillating or ionization detection.	Geiger-Müller counter, scintillator, neutron detector
Temperature	Temperature sensors measure the amount of heat or cold that is present in a system. They can be broadly of two types: contact and non-contact. Contact temperature sensors need to be in physical contact with the object being sensed. Non-contact sensors do not need physical contact, as they measure temperature through convection and radiation.	Thermometer, calorimeter, temperature gauge
Chemical	Chemical sensors measure the concentration of chemicals in a system. When subjected to a mix of chemicals, chemical sensors are typically selective for a target type of chemical (for example, a CO_2 sensor senses only carbon dioxide).	Breathalyzer, olfactometer, smoke detector
Biosensors	Biosensors detect various biological elements, such as organisms, tissues, cells, enzymes, antibodies, and nucleic acid.	Blood glucose biosensor, pulse oximetry, electrocardiograph

6.b. Sensors and identify its characteristics

A sensor does exactly as its name indicates: It senses. More specifically, a sensor measures some physical quantity and converts that measurement reading into a digital representation.

That digital representation is typically passed to another device for transformation into useful data that can be consumed by intelligent devices or humans.

sensors are fundamental building blocks of IoT networks. In fact, they are the foundational elements found in smart objects—the "things" in the Internet of Things.

Smart objects are any physical objects that contain embedded technology to sense and/or interact with their environment in a meaningful way by being interconnected and enabling communication among themselves or an external agent.

Sensors are not limited to human-like sensory data. They can measure anything worth measuring. In fact, they are able to provide an extremely wide spectrum of rich and diverse measurement data with far greater precision than human senses; sensors provide superhuman sensory capabilities

Active or passive: Sensors can be categorized based on whether they produce an energy output and typically require an external power supply (active) or whether they simply receive energy and typically require no external power supply (passive).

■ Invasive or non-invasive: Sensors can be categorized based on whether a sensor is part of the environment it is measuring (invasive) or external to it (non-invasive).

■ Contact or no-contact: Sensors can be categorized based on whether they require physical contact with what they are measuring (contact) or not (no-contact).

■ Absolute or relative: Sensors can be categorized based on whether they measure on an absolute scale (absolute) or based on a difference with a fixed or variable reference value (relative).

Area of application: Sensors can be categorized based on the specific industry or vertical where they are being used.

■ How sensors measure: Sensors can be categorized based on the physical mechanism used to measure sensory input (for example, thermoelectric, electrochemical, piezoresistive,
optic, electric, fluid mechanic, photoelastic).

■ What sensors measure: Sensors can be categorized based on their applications or what physical variables they measure.