USN | | | | | | | | | | |

CMRIT CMR INSTITUTE OF TECHNOLOGY, BENGALURU. ACCREDITED WITH A++ GRADE BY NAAC

Internal Assessment Test 3 – June 2024

Sub:	**Introduction to Internet of Things (IoT)**				**Sub Code:**	BETCK205H	**Branch**	**(Physics Cycle)**
Date:	**27/06/2024**	**Duration:**	**90 min's**	**Max Marks:**	**50**	**Sem/Sec:**	**2nd (Physics Cycle)**	**OBE**

	Answer any FIVE FULL Questions	Marks	CO	RBT
1	What is virtualization? How is it useful for end users? Explain the types of virtualizations.	3+2+5	CO4	L1

The technique of sharing a single resource among multiple end user organizations or end users is known as virtualization. In the virtualization process, a physical resource is logically distributed among multiple users. However, a user perceives that the resource is unlimited and is dedicatedly provided to him/her. Figure 10.2(a) represents a traditional desktop, where an application (App) is running on top of an OS, and resources are utilized only for that particular application. On the other hand, multiple resources can be used by different end users through virtualization software, as shown in Figure 10.2(b). Virtualization software separates the resources logically so that there is no conflict among the users during resource utilization.

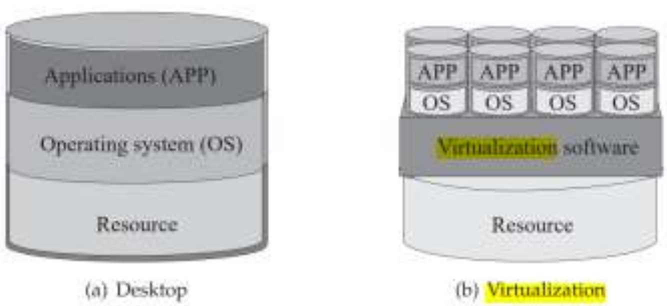


Figure 10.2 Traditional desktop versus virtualization

Advantages for End Users:

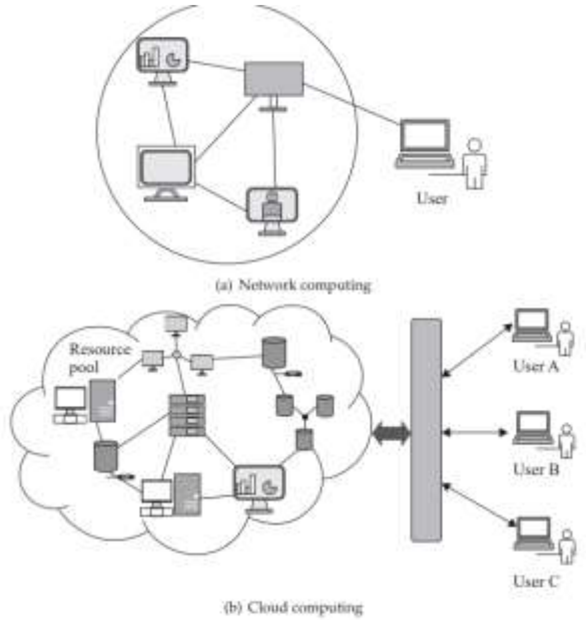
Variety: The process of virtualization in cloud computing enables an end user organization to use various types of applications based on the requirements.

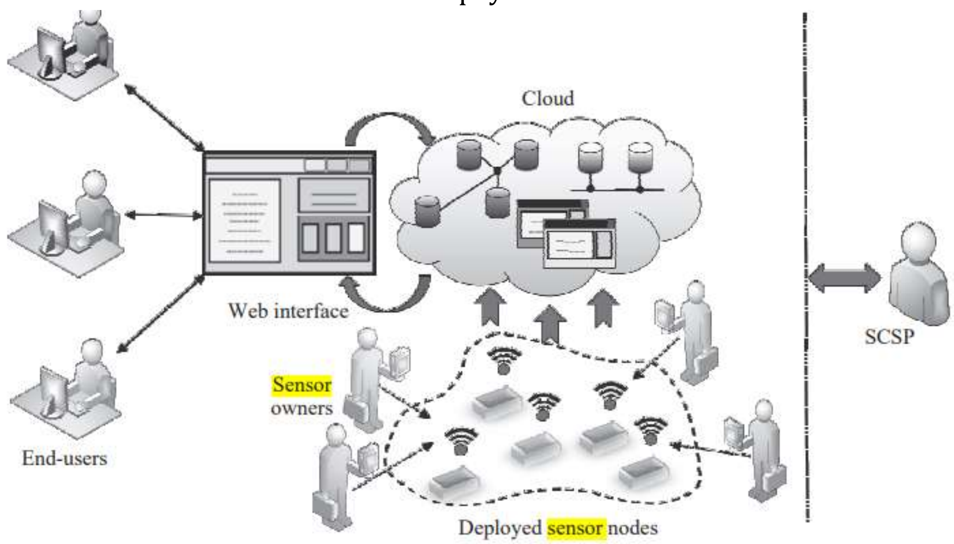
Availability: Virtualization creates a logical separation of the resources of multiple entities without any intervention of end users. Consequently, the concept of virtualization makes available a considerable amount of resources as per user requirements. The end users feel that there are unlimited resources present dedicatedly for him/her.

Portability: Portability signifies the availability of cloud computing services from anywhere in the world, at any instant of time.

Elasticity: Through the concept of virtualization, an end user can scale-up or scale-down resource utilization as per requirements.

	Types of virtualization Based on the requirements of the users, we categorized virtualization as shown in Figure 10.3. (i) Hardware Virtualization: This type of virtualization indicates the sharing of hardware resources among multiple users. For example, a single processor appears as many different processors in a cloud computing architecture. Different operating systems can be installed in these processors and each of them can work as stand-alone machines. (ii) Storage Virtualization: In storage virtualization, the storage space from different entities are accumulated virtually, and seem like a single storage location. Through storage virtualization, a user's documents or files exist in different locations in a distributed fashion. However, the users are under the impression that they have a single dedicated storage space provided to them. (iii) Application Virtualization: A single application is stored at the cloud end. However, as per requirement, a user can use the application in his/her local computer without ever actually installing the application. Similar to storage virtualization, in application virtualization, the users get the impression that applications are stored and executed in their local computer. (iv) Desktop Virtualization: This type of virtualization allows a user to access and utilize the services of a desktop that resides at the cloud. The users can use the desktop from their local desktop.			
2	Differentiate between network computing and cloud computing. Explain different cloud service models. Cloud computing is more than traditional network computing. Unlike network computing, cloud computing comprises a pool of multiple resources such as servers, storage, and network from single/multiple organizations. These resources are allocated to the end users as per requirement, on a payment basis. In cloud computing architecture, an end user can request for customized resources such as storage space, RAM, operating systems, and other software to a cloud service provider (CSP) as shown in Figure 10.1. For example, a user can request for a Linux operating system for running an application from a CSP; another end user can request for Windows 10 operating system from the same CSP for executing some application. The cloud services are accessible from anywhere and at any time by an authorized user through Internet connectivity. Cloud computing comprises a shared pool of computing resources, which are accessible dynamically, ubiquitously, and on-demand basis by the users. This shared pool of resources includes networks, storage, processor, and servers. These resources are accessible by multiple users through a regular command-line terminal at the same or different time instants. The services of cloud computing are based on the pay-per-use model. The concept is the same as paying utility bills based on consumption. In cloud computing, a user pays for the cloud services as per the duration of their resource usage. On the other hand,	5+5	CO4	L2

	there is a CSP, that provides cloud services to end user organizations.  **Figure 10.1** Network computing versus cloud computing			
3	What is a sensor-cloud? Explain about the architecture of a sensor cloud platform. sensor-cloud, virtualization of sensors plays an essential role in providing services to multiple users. Typically, in a sensor-cloud architecture, multiple users receive services from different asensor nodes, simultaneously. However, the users remain oblivious to the fact that a set of sensor nodes is not dedicated solely to them for their application requirements. In reality, a particular sensor may be used for serving multiple user applications, simultaneously. The main aim of sensor-cloud infrastructure is to provide an opportunity for the common mass to use Wireless Sensor Networks (WSNs) on a payment basis. Similar to cloud computing, sensor-cloud architecture also follows the pay-per-use model. In a traditional cloud computing architecture, two actors, cloud service provider (CSP) and end users (customer) play the key role. Unlike cloud computing, in sensor-cloud architecture, the sensor owners play an important role along with the service provider and end users. However, a service provider in sensor-cloud architecture is known as a sensor-cloud service provider (SCSP). The detailed architecture of a sensor-cloud is depicted in Figure 10.7. Typically, in a sensor-cloud architecture, three actors are present. We briefly describe the role of each actor. (i) End User: This actor is also known as a customer of the sensor-cloud services. Typically, an end user registers him/herself with the infrastructure through a Web portal. Thereafter, he/she chooses the template of the services that are available in the sensor-cloud architecture to which he/she is registered. Finally, through the Web portal, the end user receives the services, as shown in Figure 10.7. Based on the type and usage duration of service, the end user pays the charges to the SCSP. (ii) Sensor Owner: We have already discussed that the sensor-cloud architecture is based on the concept of Se-aaS. Therefore, the deployment of the sensors is essential in order to provide services to the end users. These sensors in a sensor- cloud architecture are owned and deployed by the sensor owners, as depicted in Figure 10.7. A particular sensor owner can own multiple homogeneous or heterogeneous sensor nodes. Based on the requirements of the users, these sensor nodes are virtualized and assigned to serving multiple applications at the same time. On the other hand, a sensor owner receives rent depending upon the duration and usage of his/her sensor node(s). (iii) Sensor-Cloud Service	5+5	CO4	L2

	Provider (SCSP): An SCSP is responsible for managing the entire sensor-cloud infrastructure (including management of sensor owners and end users handling, resource handling, database management, cloud handling etc.), centrally. The SCSP receives rent from end users with the help of a pre-defined pricing model. The pricing scheme may include the infrastructure cost, sensor owners' rent, and the revenue of the SCSP. Typically, different algorithms are used for managing the entire infrastructure. The SCSP receives the rent from the end users and shares a partial amount with the sensor owners. The remaining amount is used for maintaining the infrastructure. In the process, the SCSP earns a certain amount of revenue from the payment of the end users.  **Figure 10.7** Architecture of a sensor-cloud platform			

4	With a diagram explain the architecture of Leaf Area Index system. LAI is a dimensionless quantity which indicates the total leaf area per unit ground area. For determining the canopy (the portion of the plant, which is above the ground) light, LAI plays an essential role. Architecture The authors integrated the hardware and software components of their implementation in order to develop the IoT-based agricultural system for LAI assessment. One of the important components in this system is the wireless sensor network (WSN), which is used as the LAI assessment unit. The authors used two types of sensors: (i) ground-level sensor (G) and (ii) reference sensor (R). These sensors are used to measure photosynthetically active radiation (PAR). The distance between the two types of sensors must be optimal so that these are not located very far from one another. In this system, the above-ground sensor (R) acts as a cluster head while the other sensor nodes (Gs) are located below the canopy. These Gs and R connect and form a star topology. A solar panel is used to charge the cluster head. The system is based on IoT architecture. Therefore, a cluster head is attached to a central base station, which acts as a gateway. Further, this gateway connects to an IoT infrastructure. The architecture of the system is depicted in Figure 12.4.	10	CO4	L2

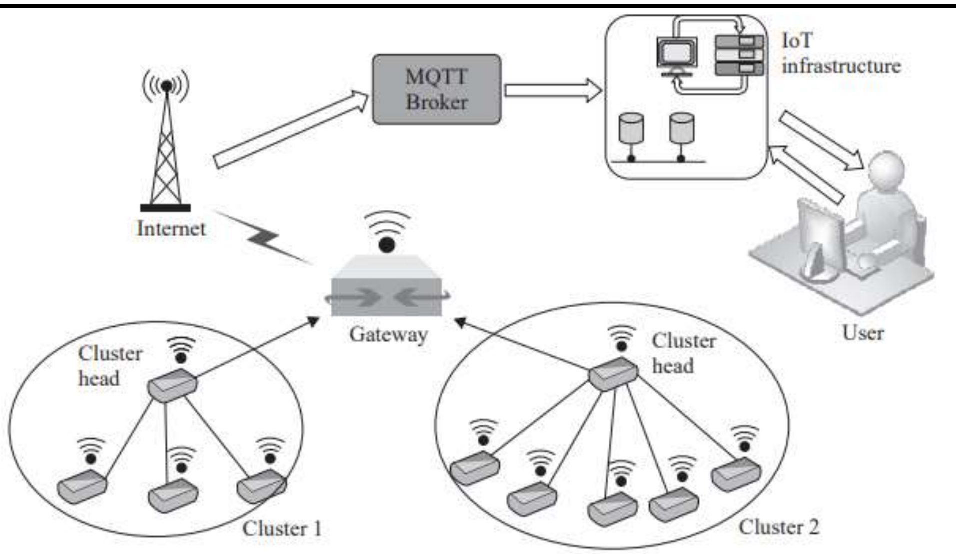


Figure 12.4 System architecture

Hardware

For sensing and transmitting the data from the deployment fields to a centralized unit, such as a server and a cloud, different hardware components are used in the system. The commercial off-the-shelf (COTS) TelosB platform is used in the system. The TelosB motes are equipped with three types of sensors: temperature, humidity, and light sensors. With the help of an optical filter and diffuser accessory on the light sensors, the PAR is calculated to estimate the LAI.

The system is based on the cluster concept. A Raspberry-Pi is used as a cluster head, which connects with four ground sensor motes. The Raspberry-Pi is a tiny single board, which works as a computer and is used to perform different operations in IoT. Humidity and wet plants intermittently cause attenuation to the system, which is minimized with the help of forward error coding (FEC) technique. The real deployment of the LAI assessment system involves various environmental and wild-life challenges. Therefore, for reliable data delivery, the authors take the redundant approach of using both wired and wireless connectivity.

In the first deployment generation, USB power supply is used to power-up the sensors motes. Additionally, the USB is used for configuring the sensor board and accessing the failure as per requirement. In this setup, a mechanical timer is used to switch off the sensor nodes during the night. In the second deployment generation, the cluster is formed with wireless connectivity. The ground sensor motes consist of externa antennas, which help to communicate with the cluster head. A Raspberry-Pi with long-term evolution (LTE) is used as a gateway in this system.

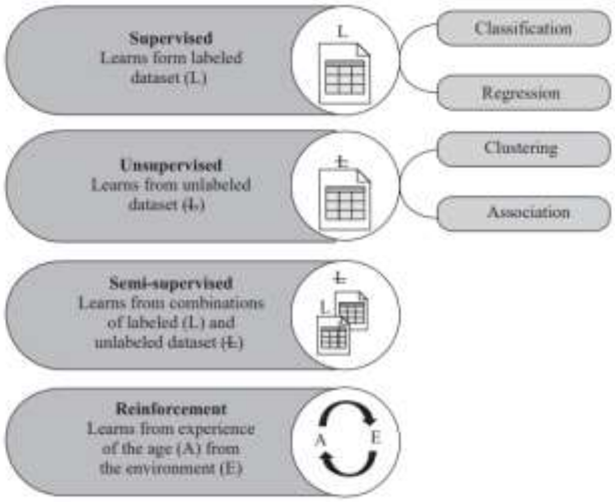
Communication

The LAI system consists of multiple components, such as WSN, IoT gateway, and IoT based network. All of these components are connected through wired or wireless links. The public land mobile network (PLMN) is used to establish connectivity between external IoT networks and the gateway. The data are analyzed and visualized with the help of a farm management information system (FMIS), which resides in the IoT-based infrastructure. Further, a prevalent data transport protocol: MQTT, is used in the system. We have already explored the details of MQTT in Chapter 8. MQTT is a very light-weight, publish/subscribe messaging protocol, which is widely used for different IoT applications. The wireless LAN is used for connecting the cluster head with a gateway. The TelosB motes are based on the IEEE 802.15.4 wireless protocol.

Software

Software is an essential part of the system by which different operations of the system are executed. In order to operate the TelosB motes, TinyOS, an open-source, low-power operating system, is used. This OS is widely used for different WSN applications. Typically, in this system, the data acquired from the sensor node is stored with a timestamp and sequence number (SN). For wired deployments (the first generation deployment), the sampling rate used is 30

	samples/hour. However, in the wireless deployment (the second generation), the sampling rate is significantly reduced to 6 samples/hour. The TinyOS is capable of activating low-power listening modes of a mote, which is used for switching a mote into low-power mode during its idle state. In the ground sensor, TelosB motes broadcast the data frame, and the cluster head (Raspberry-Pi) receives it. This received data is transmitted to the gateway. Besides acquiring ground sensor data, the Raspberry-Pi works as a cluster head. In this system, the cluster head can re-boot any affected ground sensor node automatically. IoT Architecture The MQTT broker runs in the Internet server of the system. This broker is responsible for receiving the data from the WSN. In the system, the graphical user interface (GUI) is built using an Apache server. The visualization of the data is performed at the server itself. Further, when a sensor fails, the server informs the users. The server can provide different system-related information to the smartphone of the registered user.			
5	Define Machine learning and explain the advantages of ML. Explain different types of Machine Learning models. The term “machine learning” was coined by Arthur Lee Samuel, in 1959. He defined machine learning as a “field of study that gives computers the ability to learn without being explicitly programmed”. ML is a powerful tool that allows a computer to learn from past experiences and its mistakes and improve itself without user intervention. Typically, researchers envision IoT-based systems to be autonomous and self-adaptive, which enhances services and user experience. To this end, different ML models play a crucial role in designing intelligent systems in IoT by leveraging the massive amount of generated data and increasing the accuracy in their operations. Self-learner: An ML-empowered system is capable of learning from its prior and run-time experiences, which helps in improving its performance continuously. Time-efficient: ML tools are capable of producing faster results as compared to human interpretation. For example, the weather monitoring system generates a weather prediction report for the upcoming seven days, using data that goes back to 6–9 months. Self-guided: An ML tool uses a huge amount of data for producing its results. These tools have the capability of analyzing the huge amount of data for identifying trends autonomously. Minimum Human Interaction Required: In an ML algorithm, the human does not need to participate in every step of its execution. The ML algorithm trains itself automatically, based on available data inputs. Diverse Data Handling: Typically, IoT systems consist of different sensors and produce diverse and multi-dimensional data, which are easily analyzed by ML algorithms. Diverse Applications: ML is flexible and can be applied to different application domains such as healthcare, industry, smart traffic, smart home, and many others.  **Figure 17.1** Advantages of ML Types of ML Typically, ML algorithms consist of four categories: (i) Supervised (ii)	5+ 5	CO5	L1

	Unsupervised (iii) Semi-supervised (iv) Reinforcement Learning (Figure 17.2). (i) Supervised Learning: This type of learning supervises or directs a machine to learn certain activities using labeled datasets. The labeled data are used as a supervisor to make the machine understand the relation of the labels with the properties of the corresponding input data.  **Figure 17.2** Types of ML (ii) Unsupervised Learning: Unsupervised learning algorithms use unlabeled datasets to find scientific trends. (iii) Unsupervised learning algorithms try to create different clusters based on the features of the formulae and relate it with the input equations. Unsupervised learning is usually applied to solve two types of problems: clustering and association. Clustering divides the data into multiple groups. In contrast, association discovers the relationship or association among the data in a dataset. (iv) Semi-Supervised Learning: Semi-supervised learning belongs to a category between supervised and unsupervised learning. Algorithms under this category use a combination of both labeled and unlabeled datasets for training. Labeled data are typically expensive and are relatively difficult to label correctly. Unlabeled data is less expensive than labeled data. Therefore, semi-supervised learning includes both labeled and unlabeled dataset to design the learning model. (v) Reinforcement Learning: Reinforcement learning establishes a pattern with the help of its experiences by interacting with the environment. Consequently, the agent performs a crucial role in reinforcement learning models. It aims to achieve a particular goal in an uncertain environment. Typically, the model starts with an initial state of a problem, for which different solutions are available. Based on the output, the model receives either a reward or a penalty from the environment. The output and reward act as inputs for proceeding to the next state. Thus, reinforcement learning models continue learning iteratively from their experiences while inducing correctness to the output.			
6	Explain fog framework for intelligent public safety in vehicular environment FISVER with block diagram. The system highlights a fog framework for intelligent public safety in vehicular environments (fog-FISVER) The primary aim of this system is to ensure smart transportation safety (STS) in public bus services. The system works through the following three steps: The vehicle is equipped with a smart surveillance system, which is capable of executing video processing and detecting criminal activity in real time. (ii) A fog computing architecture works as the mediator between a vehicle and a police vehicle. (iii) A mobile application is used to report the crime to a nearby police agent.	10	CO5	L3

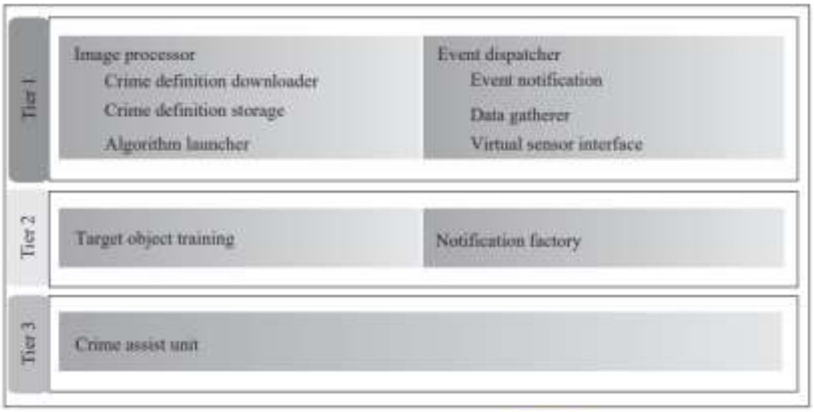


Figure 13.4 Architecture of Fog-FISVER

Fog-FISVER is based on a three-tiered architecture, as shown in Figure 13.4. We will discuss each of the tiers as follows:

(i) Tier1—In-vehicle FISVER STS Fog: In this system component, a fog node is placed for detecting criminal activities. This tier accumulates the real sensed data from within the vehicle and processes it to detect possible criminal activities inside the vehicle. Further, this tier is responsible for creating crime-level metadata and transferring the required information to the next tier. For performing all the activities, Tier 1 consists of two subsystems: Image processor and event dispatcher

(ii) Tier 2—FISVER STS Fog Infrastructure: Tier 2 works on top of the fog architecture. Primarily, this tier has three responsibilities—keep updating the new object template definitions, classifying events, and finding the most suitable police vehicle to notify the event.

(iii) Tier 3 consists of mobile applications that are executed on the users' devices. The application helps a user, who witnesses a crime, to notify the police.

CI Signature *CCI Signature* *HOD Signature*