

UNIT - V

5

Ubiquitous Clouds and the Internet of Things

Important Points to Remember

- Ubiquitous cloud computing refers to the use of Internet resources at any place and any time for any objectives.
- Nebula is an open-source cloud computing platform.
- SGI is a global leader in large-scale clustered computing, high performance storage, HPC and data center enablement and services.
- Mashup is a Web page or application that uses and combines data, presentation or functionality from two or more sources to create new services.
- A cloudlet is a mobility-enhanced small-scale cloud data center.
- FutureGrid is more than a Cloud; it is a general distributed Sandbox; a cloud grid HPC testbed.
- Every sensor node is equipped with a transducer, microcomputer, transceiver and power source.
- RFID is an Automatic Data Capture technology that uses radio-frequency waves to read a movable item to identify, categorize and track.
- Cyber-physical system(CPS) is an embedded system which integrates the computing process with the physical world as an interactive and intelligent system.

5.1 Cloud Trends in Supporting Ubiquitous Computing

Q.1 What is Ubiquitous computing ? Explain about IBM cloud project.

Ans. : • Ubiquitous computing is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user.

- Ubiquitous cloud computing refers to the use of Internet resources at any place and any time for any objectives.
- IBM cloud platforms are mostly built with IBM server clusters supported by IBM WebSphere. IBM Ensembles offer a virtualized cloud system for IaaS services. This system can put together a large resource pool to simplify management complexity.
- The purpose is to offer application flexibility and efficient resource deployment through dynamic server, storage, and network ensembles.
- IBM also developed the Tivoli Service Automation Manager (TSAM) for rapid design, deployment, and management of service processes.
- WebSphere CloudBurst (WCA) is another platform for managing private clouds. IBM LotusLive offers an SaaS cloud for application service development. The services include an online conference service, coordinated office management, and e-mail services.

IBM Blue Cloud System

- In November 2007, IBM announced the Blue Cloud Project based on open standards and open source software. The project is supported by more than 200 IBM web-scale researchers worldwide.
- Blue Cloud combines several existing software and virtualization packages on a specifically designed IBM hardware server platform.
- Open source and private software is combined to form the cloud computing environment. The Blue Cloud is built with x-servers, that are very similar to x86 processors.

- Linux runs on these servers supported by XEB-based virtualization software.

Q.2 Write short note on NASA's Nebula Cloud.

Ans. : • Nebula is an open-source cloud computing platform that was developed to provide an improved alternative to building additional expensive data centers and to provide an easier way for NASA scientists and researchers to share large, complex data sets with external partners and the public.

- Nebula is an excellent example of how NASA is championing ongoing partnerships with private industry and academia.
- Each component of the Nebula platform will be available individually, serving SaaS, PaaS, and IaaS needs across the agency.
- NASA will use Nebula for mission support, education, and public outreach and to encourage collaboration and public input.
- Nebula will provide NASA with an easy, efficient, and secure way to interact and share data with the public.
- Nebula is available to NASA's internal project groups and its research and academic partners. It is not available for use by private industry or the general public.
- Nebula's architecture is designed from the ground up for interoperability with commercial Cloud service providers such as Amazon Web Services, offering NASA researchers the ability to easily port data sets and code to run on commercial Clouds.

Q.3 Explain properties of High Performance Computing (HPC) cloud.

Ans. : • HPC clouds are viewed as having the following properties

- 1. Web Service-Based :** All resources from data storage to cluster job management are done via self-describing Web services.
- 2. Virtualization :** For flexibility, cloud computing will require the use of virtualization.

3. **Clusters Are Provided On-Demand** : Clients should be able to specify requirements and then discover an existing cluster for immediate use
4. **Guaranteed Performance** : Typically, if cluster nodes are allocated to clients, all nodes are expected to be within close proximity to each other.
5. **Use the Pay as You Go Model** : All HPC clients are billed for the resources they use and amounts thereof.

Q.4 Explain challenges for HPC cloud.

Ans. : • Challenges are listed below :

1. **Interface Challenges** : Most cloud and cluster solutions offer command line interfaces but rarely (if at all) present graphical interfaces. Even when provided, graphical interfaces tend to act as command line wrappers.
2. **Performance Challenges** : At the very least, a cluster hosted in a cloud should run applications as fast than existing physical clusters. Currently, there is no mechanism in place to evaluate performance factors such as current CPU utilization and network IO.
3. **Communication Challenges** : A common issue with clouds is their network performance, e.g., EC2. Network performance cannot be solved by using an Infiniband network alone. There is still the issue of network topologies within clouds. Even if a cloud is hosted within a single location, the virtualized nature of clouds may cause a single cluster to be hosted across multiple systems.
4. **Intelligence Challenges** : While cloud computing offers resources as a utility, they are not always intelligent when allocating resources to clients.
5. **Configuration Challenges** : As well as providing clusters in clouds, it has to be possible to reconfigure the specifications of existing clusters for different types of cluster applications.

6. SLA Challenges : One of the most difficult challenges is forming and maintaining agreements between clients and services.

7. Workflow : The final challenge when creating HPC clouds is supporting client workflows. Not all HPC problems are processed using a single application; some problems require a chain of multiple different applications.

Q.5 Write short note on SGI Cyclone Cloud for High-Performance Computing.

Ans. : • SGI is a global leader in large-scale clustered computing, high performance storage, HPC and data center enablement and services.

- SGI has developed a cluster named Cyclone based on their specific super computer technology. This system is based on a specific shared memory model, which enables to reach a large amount of shared resources.
- This IT system offer a direct access to the hardware with dedicated improvement provided by SGI compute nodes.
- Cyclone is an on-demand cloud computing service specifically dedicated to technical applications. It supports a number of leading application partners and five technical domains, including computational fluid dynamics, finite element analysis, computational chemistry and materials, computational biology, and ontology.
- Cyclone is available in two service models: SaaS and IaaS.
- With the SaaS model, Cyclone customers can significantly reduce time to results by accessing leading-edge open source applications and best-of-breed commercial software platforms from top independent software vendors.
- The IaaS model enables customers to install and run their own applications.

Q.6 Explain difference between HPC and Cloud.

Ans. :

HPC	Cloud
HPC size is small to medium.	Cloud size is small to large.
HPC uses homogeneous resources.	Cloud uses heterogeneous resources.
Initial capital investment cost is high.	Initial capital investment cost is low.
Network type is private .	Network type is public.
SLA requirement is very strict.	SLA requirement is low.

Q.7 What is mashup ? Explain different types of mashup.

- Ans. : • Mashup is a Web page or application that uses and combines data, presentation or functionality from two or more sources to create new services.
- The term implies easy, fast integration, frequently using open APIs and data sources to produce enriched results that were not necessarily the original reason for producing the raw source data.
 - The main characteristics of the mashup are combination, visualization, and aggregation. It is important to make existing data more useful, moreover for personal and professional use.
 - Mashup composition tools are usually simple enough to be used by end-users. They generally do not require programming skills and rather support visual wiring of GUI widgets, services and components together.
 - Mashup Architecture is 3-tier architecture.
 - Presentation : Mashups are almost always presented visually, in portals or portal-like applications.
 - Mashup Infrastructure : Technology for accessing, assembling, and processing mashups, as well as ultimately serving them to applications.
 - Information Sources : Virtually anything that is a 'service' can be an information source for a mashup. This includes internal

databases, flat files, Java objects, Web Services and REST and external RSS feeds.

- Mashups all share three salient characteristics :

1. They draw on sources of data directly on the web.
2. They transform, combine, and re-transform this data to create innovative new outputs. Maps and timeline displays are typical mashup output formats.
3. They can usually be done in a few hours. That means that the transformations are created rapidly in a high-productivity environment.

Types of Mashup :

- Consumer mashup is an application that combines data from multiple public sources within a browser and organizes it through a simple browser user interface.
- An enterprise mashup, also often called a business mashup, is an application that combines data from multiple internal and public sources, and publishes the results to enterprise portals, application development tools, or as a service in a service-oriented architecture.
- A data mashup, opposite to the consumer mashups, combine similar types of media and information from multiple sources into a single representation. The combination of all these resources create a new and distinct Web service that was not originally provided by either source.

Q.8 What is cloudlet ?

Ans. : • A cloudlet (also called micro data center) is a new architectural element that arises from the convergence of mobile computing and cloud computing. It represents the middle tier of a 3-tier hierarchy: mobile device - cloudlet - cloud.

- A cloudlet is a mobility-enhanced small-scale cloud datacenter. The main purpose of the cloudlet is supporting resource-intensive

and interactive mobile applications by providing powerful computing resources to mobile devices with lower latency.

- It builds on standard cloud technology.

Q.9 Explain Pros and Cons of the Mashup.

Ans. : Pros :

1. Mashups allow for the reuse of existing applications.
2. They also allow for rapid application development.
3. Development of a mashup does not necessarily involve extensive IT skills.
4. The associated cost of application development is greatly reduced.
5. Applications are better tailored to users' needs.

Cons :

1. A user might have no control over the quality and features of the content.
2. Even if reliability of the content source is established, a potential problem is scalability.
3. The integrity of the content can not be guaranteed either.
4. Most data sources are not yet built on a service-oriented architecture (SOA).
5. Only software that can be accessed with a web browser can be included in a mashup.

Q.10 What are the differences between local cloudlets and distant clouds ?

Ans. :

Local cloudlets	Distant clouds
It support only soft state.	It support soft state and hard state.
Decentralized ownership by local business	Centralized ownership by Amazon, Yahoo etc.

Cloud Computing

Bandwidth/network sharing is in between few number of users.	Internet bandwidth sharing in between 100 to 1000 uses at a time.
Self management	Professional administration is required.
Data center in a box at business premises as an environment	Machine room with power condition and cooling

**Q.11 Explain in brief mobile cloud computing with architecture.
Also given example, advantages and disadvantages.**

Ans. : One of the main benefits of cloud computing is reducing downtime and wasted expenditure for servers and other computer equipment. A given company is required to purchase the minimum amount of hardware necessary to handle the maximum points of stress on their system.

- Given situations where the strain and traffic are highly variable this leads to wasted money. For example, Amazon.com, a pioneer in cloud computing, at times used as little as 10% of their capacity so that they would have enough capacity to deal with those rarer high strain times.
- Mobile Cloud Computing (MCC)** at its simplest, refers to an infrastructure where both the data storage and data processing happen outside of the mobile device.

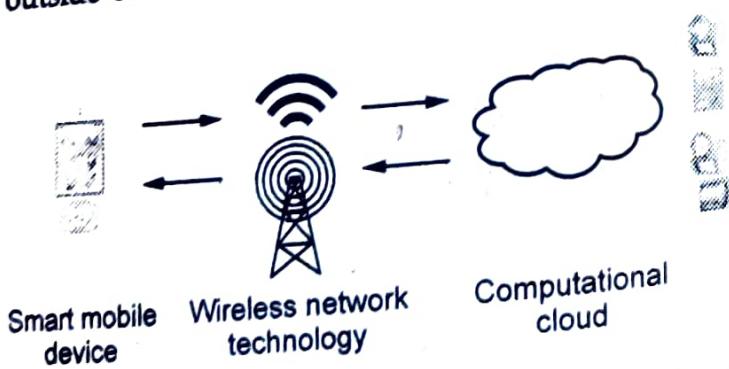


Fig. Q.11.1 Block diagram of mobile cloud

- Mobile cloud applications move the computing power and data storage away from mobile phones and into the cloud, bringing applications and mobile computing to not just smart phone users but a much broader range of mobile subscribers".

- Mobile cloud applications move the computing power and data storage away from the mobile devices and into powerful and centralized computing platforms located in clouds, which are then accessed over the wireless connection based on a thin native client.
- Mobile devices face many resource challenges (battery life, storage, bandwidth etc.). Cloud computing offers advantages to users by allowing them to use infrastructure, platforms and software by cloud providers at low cost and elastically in an on-demand fashion.
- Mobile cloud computing provides mobile users with data storage and processing services in clouds, obviating the need to have a powerful device configuration (e.g. CPU speed, memory capacity), as all resource-intensive computing can be performed in the cloud.
- Fig. Q.11.2 shows mobile cloud computing architecture.

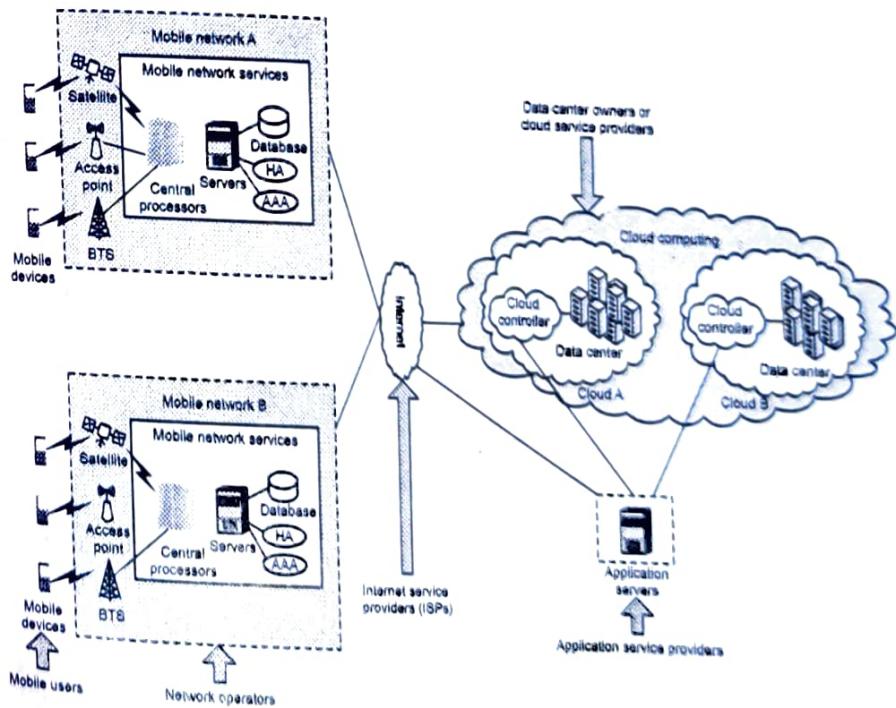


Fig. Q.11.2 Mobile cloud computing architecture

- In mobile cloud computing mobile network and cloud computing are combined, thereby providing an optimal services for mobile clients. Cloud computing exists when tasks and data are kept on individual devices. Applications run on a remote server and then sent to the client.
- Here the mobile devices are connected to the mobile networks through the base stations; they will establish and control the connections (air interface) and functional interfaces between the mobile networks and mobile devices.
- Mobile users send service requests to the cloud through a web browser or desktop application. The information's are transmitted to the central processors that are connected to the servers providing mobile network services. Here, services like AAA (Authentication, Authorization and Accounting) can be provided to the users based on Home Agent (HA) and subscriber's data stored in databases.
- Mobile devices are connected to the mobile networks via base stations that establish and control the connections and functional interfaces between the networks and mobile devices.
- Mobile users' requests and information are transmitted to the central processors that are connected to servers providing mobile network services.
- The subscribers' requests are delivered to a cloud through the Internet.
- In the cloud, cloud controllers process the requests to provide mobile users with the corresponding cloud services.

Advantages :

1. Saves battery power
2. Makes execution faster
3. Improves data storage capacity and processing power

4. Improves reliability and availability: Keeping data and application in the clouds reduces the chance of lost on the mobile devices.
5. Dynamic provisioning: Dynamic on-demand provisioning of resources on a fine-grained, self-service basis

Disadvantages :

1. Must send the program states (data) to the cloud server.
2. Network latency can lead to execution delay.

5.2 Performance of Distributed Systems and the Cloud

Q.12 What is FutureGrid ? List goals of FutureGrid. Explain essential and different features of FutureGrid.

Ans. : • FutureGrid is not a production system, but rather an environment supporting a flexible development and testing platform for middleware and application users looking at interoperability, functionality, and performance issues.

- FutureGrid will make it possible for researchers to conduct experiments by submitting an experiment plan that is then executed via a sophisticated workflow engine, preserving the provenance and state information necessary to allow reproducibility.
- Rather than loading images onto VM's, FutureGrid supports Cloud, Grid and Parallel computing environments by provisioning software as needed onto "bare-metal" or VM's/Hypervisors using (changing) open source tools.
- Essential and Different features of FutureGrid :

1. Unlike many clouds such as Amazon and Azure, FutureGrid allows robust reproducible .
2. FutureGrid is more than a Cloud; it is a general distributed Sandbox; a cloud grid HPC testbed.
3. Supports 3 different IaaS environments (Nimbus, Eucalyptus, OpenStack)

4. Supports research on cloud tools, cloud middleware and cloud-based systems as well as use of clouds in applications
5. FutureGrid has developed middleware and interfaces for Computing TestbedaaS e.g. Phantom (cloud user interface) Vine (virtual network) RAIN (deploy systems) and security/metric integration.
6. FutureGrid has experience in running cloud systems.

Q.13 What lessons learnt from FutureGrid ?

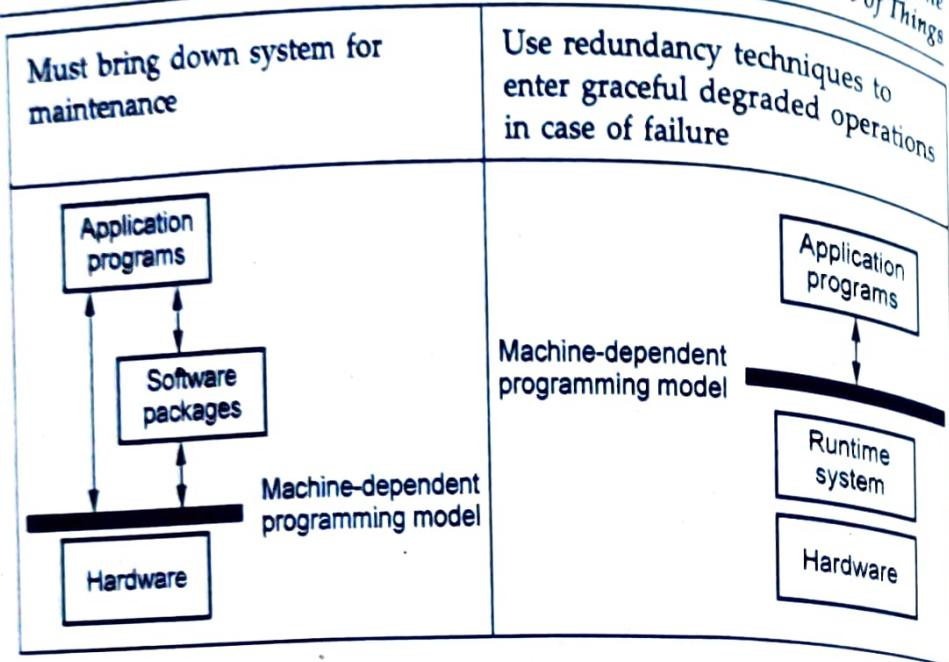
- Ans. : • Unexpected major use from Computer Science and Middleware
- Rapid evolution of Technology like Eucalyptus, Nimbus, OpenStack
 - Open source IaaS maturing as in "Paypal To Drop VMware From 80,000 Servers and Replace It With OpenStack" (Forbes) eBay to switch broadly?
 - Need interactive not batch use; nearly all jobs short
 - Substantial "TestbedaaS" technology needed and FutureGrid developed
 - Lessons more positive than DoE Magellan report but goals different
 - Still serious performance problems in clouds for networking and device (GPU) linkage; many activities outside FG addressing
 - One can get good Infiniband performance (MPI) on a peculiar OS + Mellanox drivers but not general yet
 - We identified characteristics of "optimal hardware"
 - Run system with integrated software (computer science) and systems administration team
 - Build Computer Testbed as a Service Community

Q.14 What is data-intensive scalable computing ? How it is different from conventional supercomputer ?

Ans. : • Data-intensive computing is a class of parallel computing applications which use a data parallel approach to process large volumes of data typically terabytes or petabytes in size and typically referred to as big data.

- Data-intensive computing platforms typically use a parallel computing approach combining multiple processors and disks in large commodity computing clusters connected using high-speed communications switches and networks which allows the data to be partitioned among the available computing resources and processed independently to achieve performance and scalability based on the amount of data.
- Difference between conventional supercomputer and data intensive scalable computing:

Conventional Supercomputers	Data-Intensive Scalable Computing
An HPC system by which data is retrieved from remote sites and brought into the system for execution. Heavy data movement overhead	An HTC data-center cluster which collects and maintains data. Computation collocated with storage for faster access.
Heavy data movement overhead.	No data movement overhead
Machine-dependent programs written at a very low level. Use fewer software tools; need specialists to optimize	Machine-independent application programs on data. Use runtime system controls to optimize execution through load balancing, etc
Main machine for batch processing when resources are ready. Uses offline visualization at remote site	Interactive access with priority control and user intervention over large number of users simultaneously
Brittle systems with which to recover from most recent checkpoint.	Flexible error detection and recovery



Q.15 Explain performance metrics for HPC/HTC systems.

Ans. : • Performance metrics are throughput, multitasking scalability, availability measure, data security, and cost-effectiveness.

1. **System throughput** measures the number of jobs that can be done per unit of time. The throughput measure is attributed to several key factors that affect the total execution time of all jobs processed in a given time window.
2. **Multitasking Scalability** : Multitasking implies the use of a system to handle many jobs simultaneously or concurrently. System services should be able to scale both horizontally across the machine or cluster size and vertically from applications to middleware, runtime and OS support, and hardware.
3. **System Availability** : System availability (λ) refers to the percentage of time the system is up and running normally. This percentage reflects the effects of downtime after unexpected failures and scheduled maintenance for software upgrades.
4. **Cloud security** is attributed to user confidentiality, data integrity, access control, firewalls, IDSes, defense capability.
5. **Cost Effectiveness** : This refers to the estimate of an effective scale of economy achievable by a given system.

5.3 Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS)

Q.16 What is Internet of Things? Explain characteristics of IoT.

Ans. : • The Internet of Things (IoT) is the network of physical objects i.e. devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data.

• **WSIS 2005 Definition :** By embedding short-range mobile transceivers into a wide array of additional gadgets and everyday items, enabling new forms of communication between people and things, and between things.

- A phenomenon which connects a variety of things. Everything that has the ability to communicate.
- The Internet of Things is the intelligent connectivity of physical devices driving massive gains in efficiency, business growth, and quality of life.
- The Internet of Things refers to the capability of everyday devices to connect to other devices and people through the existing Internet infrastructure. Devices connect and communicate in many ways. Examples of this are smart phones that interact with other smart phones, vehicle-to-vehicle communication, connected video cameras, and connected medical devices. They are able to communicate with consumers, collect and transmit data to companies, and compile large amounts of data for third parties.
- IoT data differs from traditional computing. The data can be small in size and frequent in transmission. The number of devices, or nodes, that are connecting to the network are also greater in IoT than in traditional PC computing.
- Machine-to-Machine communications and intelligence drawn from the devices and the network will allow businesses to automate certain basic tasks without depending on central or cloud based applications and services.
- The smart object is the building block of the IoT vision. By putting intelligence into everyday objects, they are turned into

smart objects able not only to collect information from the environment and interact /control the physical world, but also to be interconnected, to each other, through Internet to exchange data and information.

Characteristics of the Internet of Things

- 1. Interconnectivity :** Everything can be connected to the global information and communication infrastructure.
- 2. Heterogeneity :** Devices within IoT have different hardware and use different networks but they can still interact with other devices through different networks.
- 3. Things-related services :** Provides things-related services within the constraints of things, such as privacy and semantic consistency between physical and virtual thing.
- 4. Dynamic changes :** The state of a device can change dynamically.

Q.17 Explain architecture of the Internet of Things.

Ans. : • The IoT system is an event-driven architecture. Fig. Q.17.1 shows architecture of IoT.

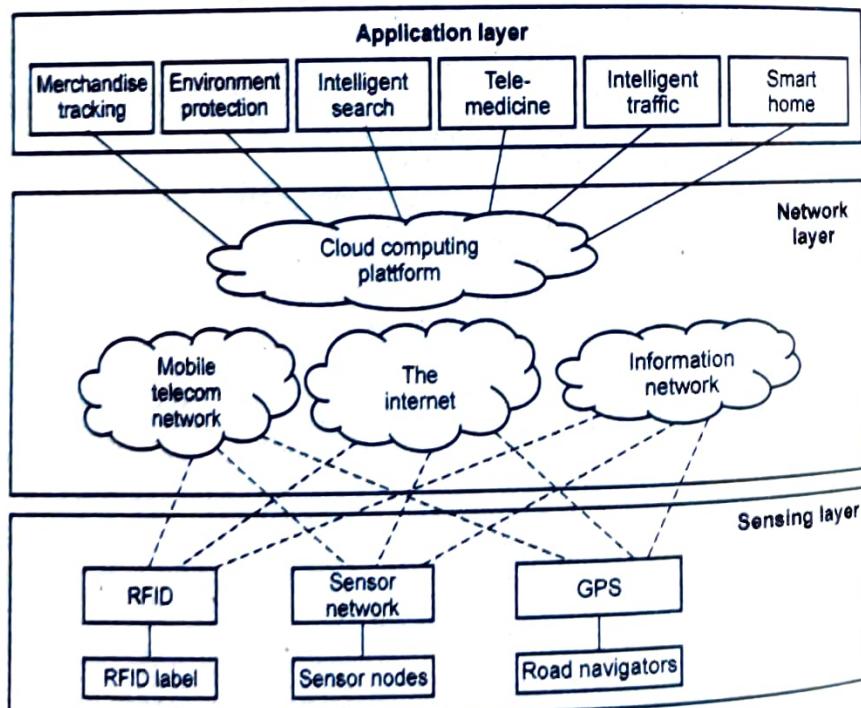


Fig. Q.17.1 IoT architecture

- The top or first layer is the IOT application layer which contains the application user interface.
- Application layer is at the top of the architecture and is responsible for delivery of various applications to different users in IoT.
- The applications can be from different industry segments such as: manufacturing, logistics, retail, environment, public safety, healthcare, food and drug etc.
- With the increasing maturity of RFID technology, numerous applications are evolving which will be under the umbrella of IoT.
- The bottom layers represent various types of sensing devices: namely RFID tags, ZigBee or other types of sensors, and road-mapping GPS navigators.
- The sensing devices are locally or wide-area-connected in the form of RFID networks, sensor networks, and GPSes. Signals or information collected at these sensing devices are linked to the applications through the cloud computing platforms at the middle layer.
- The signal processing clouds are built over the mobile networks, the Internet backbone, and various information networks at the middle layer.
- The sensors enable the interconnection of the physical and digital worlds allowing real-time information to be collected and processed. The sensors have the capacity to take measurements such as temperature, air quality, movement and electricity.
- Sensors are grouped according to their unique purpose such as environmental sensors, body sensors, home appliance sensors and vehicle telemetric sensors, etc.
- Many of these hardware elements provide identification and information storage (e.g. RFID tags), information collection (e.g.

sensors), and information processing (e.g. embedded edge processors).

Q.18 What is RFID and RFID tag ? Explain working of RFID.

Ans. : • Radio-Frequency Identification (RFID) is an Automatic Data Capture technology that uses radio-frequency waves to read a movable item to identify, categorize and track.

- It is fast and does not require physical sight or contact between reader/scanner and the tagged item.
- It performs the operation using low cost components. It attempts to provide unique identification and backend integration that allows for wide range of applications.
- RFID tags contain at least two major parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other special functions. The other part is an antenna for receiving and transmitting the radio signals.
- Tags can be read-only or read-write. Tag memory can be factory or field programmed and optionally permanently locked (security). Data written to the tag left unlocked, can be modified over more than 100,000 times, allowing the tag to be reused or updated.
- Major components of RFID hardware :
 1. **RFID tag** : A tiny silicon chip attached to a small antenna.
 2. **Reader antenna** : It used to radiate the energy and then capture the return signal sent back from the tag.
 3. **Reader** : The device station that talks with the tags. A reader may support one or more antennae.
- Fig. Q.18.1 shows working of RFID.
- In the active RFID system, the reader sends signal to the tag using an antenna. The tag receives this information and resends this information along with the information in its memory.

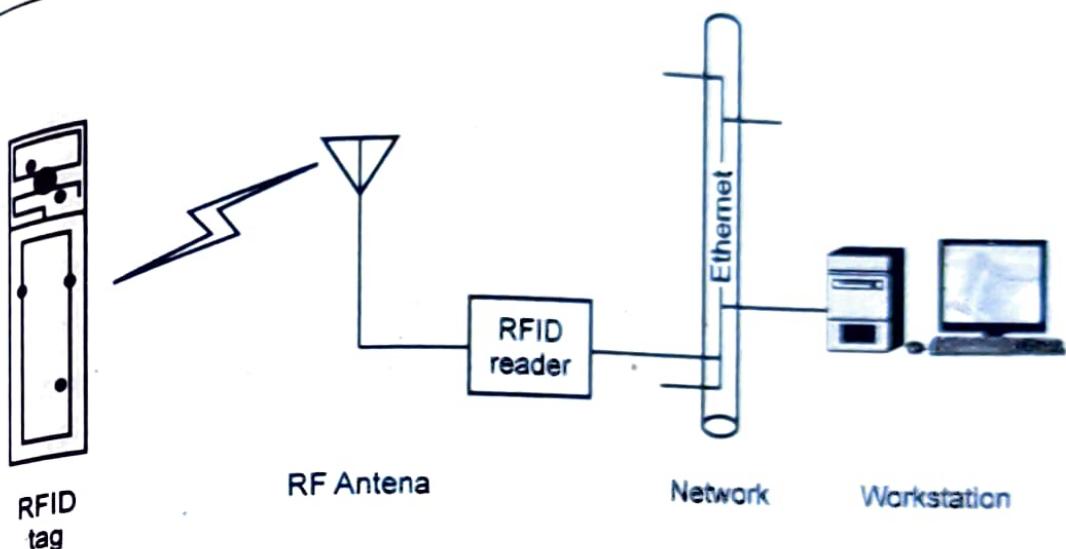


Fig. Q.18.1 RFID working

- The reader receives this signal and transmits to the processor for further processing.
- Processor or a Controller: It can be a host computer with a Microprocessor or a microcontroller which receives the reader input and process the data.
- Active and semi-passive RFID tags use internal batteries to power their circuits. An active tag can also use its own battery to broadcast radio waves to a reader, whereas a semi-passive tag relies on the reader to supply its power for broadcasting.
- Active and semi-passive tags are reserved for reading over 30 to 100 meters, if repeater batteries are used to boost a tag's range.
- **Types of RFID Systems :**
 1. **Active RFID system :** These are systems where the tag has its own power source like any external power supply unit or a battery. The only constraint being the life time of the power devices. These systems can be used for larger distances and to track high value goods like vehicles.
 2. **Passive RFID system :** These are systems where the tag gets power through the transfer of power from a reader antenna to the tag antenna. They are used for short range transmission.

Q.19 Write short note on wireless sensor network.

Ans. : Wireless Sensor Networks

- A wireless sensor network (WSN) is a network formed by a large number of sensor nodes where each node is equipped with a sensor to detect physical phenomena such as light, heat, pressure, etc.
- WSNs nowadays usually include sensor nodes, actuator nodes, gateways and clients. A large number of sensor nodes deployed randomly inside of or near the monitoring area, form networks through self-organization.
- Sensor nodes monitor the collected data to transmit along to other sensor nodes by hopping. During the process of transmission, monitored data may be handled by multiple nodes to get to gateway node after multi-hop routing, and finally reach the management node through the internet or satellite.
- A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight, and portable.
- Every sensor node is equipped with a transducer, microcomputer, transceiver, and power source. The transducer generates electrical signals based on sensed data.
- The microcomputer processes and stores the sensor output. The transceiver, which can be hard-wired or wireless, receives commands from a central computer and transmits data to that computer.
- The power for each sensor node is derived from the electric utility or from a battery.
- Standards for WSN technology have been well developed, such as Zigbee (IEEE802.15.4). The IEEE 802.15.4 is simple packet data protocol for lightweight wireless networks.
- It works well for long battery life, selectable latency for controllers, sensors, remote monitoring and portable electronics.

Q.20 Explain generation of wireless sensor network.

Ans. :

Parameters	First Generation	Second Generation	Third Generation
Node Architecture	Separate sensing, processing and communication	Integrated sensing, processing and communication	Full integrated sensing, processing and communication
Protocol	Proprietary	Proprietary	Standard (Wi-Fi, WiMax)
Topology	Point to point, Star and multi-hop	Client-server and peer to peer	Fully peer to peer
Power Supply	Large batteries	AA batteries	Solar
Life span	Hours, days and longer	Days to weeks	Months to years
Deployment mode	Physically installed	Hand placed	Embedded or nanotechnology based
Manufacturers	Custom constructors	Crossbow Technology, Inc., Sensoria Corp., Ember Corp	Dust, Inc., and others

Q.21 Write short note on ZigBee Network

Ans. : • In 2002, seeing that neither Wi-Fi nor Bluetooth could not fit some of their needs for embedded systems, a number of industrial companies formed the consortium called ZigBee Alliance, aimed at providing standards for low cost / low consumption wireless communications. Then, with the birth of IEEE 802.15.4 group.

- ZigBee communications can reach up to 500m, with a data rate of up to 250kbs, for a typical power consumption of 125 to 400 μ W.

- As ZigBee is based on IEEE 802.15.4, there is no wake-up signal, but slots for sleep or activity, or in asynchronous mode, devices sleeping anytime they have nothing to say, with an ever-vigilant coordinator.
- To use a ZigBee module with a microcontroller, you need to connect it to a UART. There are other, optional pins to use, including a number of analog inputs / digital IOs and a PWM output indicating the strength of the signal which you can directly connect to a LED pin for observation purposes.
- There are two modes of data transfer namely Beacon mode and Non Beacon mode.
- In Beacon mode, when the devices are not sending the data they may enter a low power state and reduces the power consumption.
- In Non-beacon mode, the end devices need to be wake up only while sending the data while the routers and coordinators need to be active most of the time.
- Fig. Q.21.1 shows star topology and peer-to-peer topology.

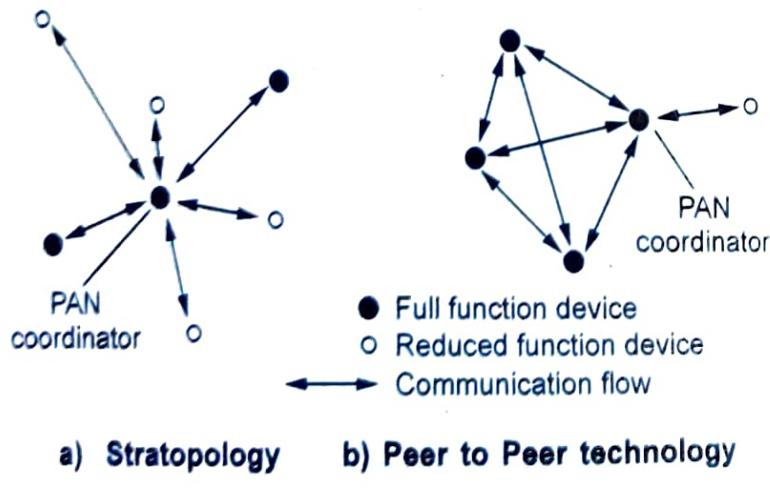


Fig. Q.21.1

- There are three different types of ZigBee devices :
- ZigBee coordinator (ZC) :** This is the most capable ZigBee device serving as the coordinator or the root of a ZigBee network. There

is exactly one coordinator in each network since it is the device that started the network. It is able to store information about the network, including acting as the trust center and repository of security keys.

- **ZigBee Router (ZR)** : This can act as an intermediate router, passing on data from end device to end device.
- **ZigBee End Device (ZED)** : This contains just enough functionality to talk to the parent node. The end device cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time, thereby ensuring a long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

Q.22 How wireless sensor network help health monitoring system ?

Ans. : • Wireless sensors support offer many possibilities for measuring different parameters of the human body and most of them are imperceptible and comfortable to use.

- IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants.
- Smart health systems provide health related services using a network, some kind of connection between intelligent agents. These intelligent agents could be computing devices, mobile phones, sensors, Fitbit smart bands, surgical devices, devices that measure your blood chemistry, or devices that measure your brainwaves. Any of these things could be intelligent agents.
- Fig. Q.22.1 shows smart health monitoring system using wireless sensor.
- The human actors, patients or healthcare providers for example could be intelligent agents in this system. The sensors, devices, computers, applications, and human actors are all intelligent agents that might be connected in the smart health system.

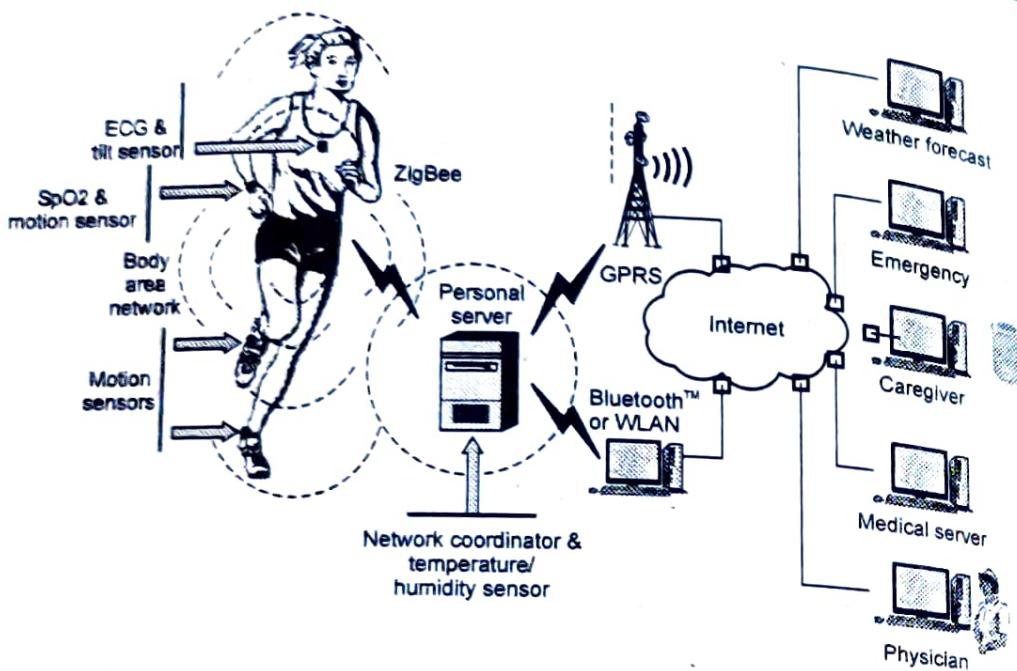


Fig. Q.22.1 Smart health monitoring system using wireless sensor

- Some challenges in the healthcare system are as follows :
1. **Smarter hospital** : A natural problem is how to build a smarter hospital for greatly improving medical services and patient experience.
 2. **Data integration/realtimeness** : How to combine heterogeneous health data sources in a unified and meaningful way enables the discovery and monitoring of health data from different sources.
 3. **Medical resource shortness** : There are not enough medical resources for the population. For example, there are fewer doctors and high-level healthcare institutions but more patients.
 4. **"Low" usage of community health service centers**. In contrast with community health service centers, people prefer the high-level healthcare institutions. This results in the low usage of community service centers.

- 5. **Bad health habits.** The citizens have some bad health habits that contribute to poor health, for instance, smoking and no sport.
 - 6. **Lack of information sharing.** Hospitals are not sharing enough information. This leads to the following two problems at least. First, the health information records of patients cannot be queried. Second, there is lack of medical cooperation between hospitals.
- The links between the many applications in health monitoring are :
 1. Applications require the gathering of data from sensors.
 2. Applications must support user interfaces and displays.
 3. Applications require network connectivity for access to infrastructural services.
 4. Applications have in-use requirements such as low power, robustness, durability, accuracy and reliability.
 - Connected medical devices and associated IoT technologies will primarily be used to achieve the following capabilities :
 1. Access real time visibility of the patient's condition, his/her activities, context and physiological parameters.
 2. Monitor compliance to prescribed treatment, diet and exercise regimes.
 3. Provide feedback and cues to patients, family members, doctors and caregivers in order to implement corrective action.
 4. Leverage high performance computing for real time feedback and use evidence-based medicine for better patient outcome.

Q.23 What is Global Positioning System (GPS)? Explain working of GPS.

Ans. : • Global Positioning System is a satellite navigation system that furnishes location and time information to the user.

- Fixed or orbiting satellite transmitters broadcast timing signals and receiving device response signals to locate the position of moving objects. GPS is used for navigation in planes, ships, cars and trucks also.
- The system gives critical abilities to military and civilian users around the globe. GPS provides continuous real time, 3-dimensional positioning, navigation and timing worldwide.
- The GPS system consists of three segments :
 - 1) The space segment: the GPS satellites
 - 2) The control system, operated by the U.S. military,
 - 3) The user segment, which includes both military and civilian users and their GPS equipment.

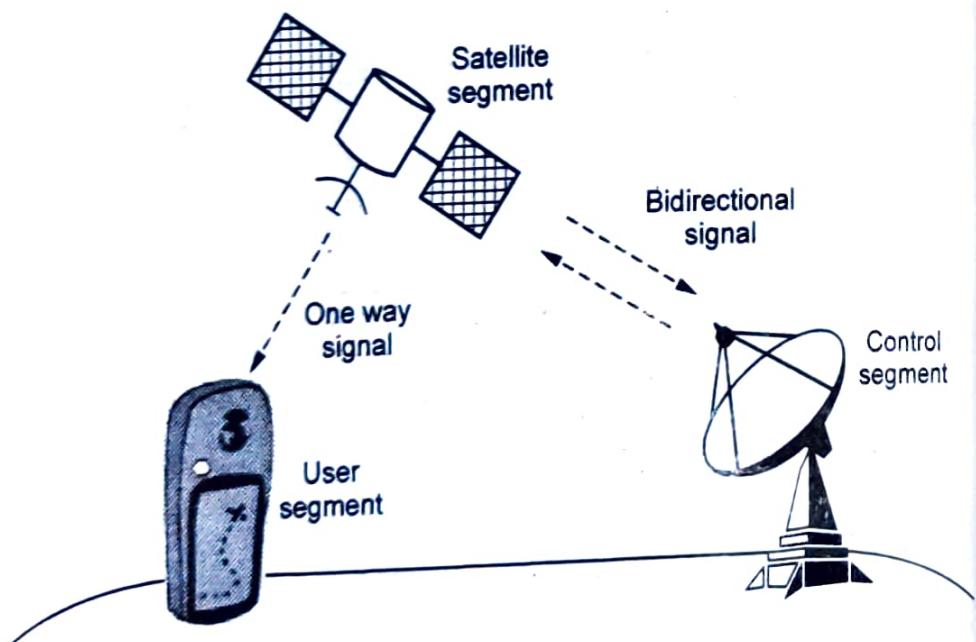


Fig. Q.23.1

- The space segment is the number of satellites in the constellation. It comprises of 29 satellites circling the earth.
- The control segment comprises of a master control station and five monitor stations outfitted with atomic clocks that are spread around the globe.

- The user segment comprises of the GPS receiver, which receives the signals from the GPS satellites and determine how far away it is from each satellite.
- The GPS operation uses data from satellites to calculate the location. Usually it requires data from at least three satellites to triangulate the position.
- There is a concept known as Time To Fix First (TTFF). TTFF is the time lapse required to download the data before the commencement of calculations.
- TTFF depends on the frequent use of the device. If the chip is not used frequently, then TTFF will be high. Usually, the transmission rate of data from satellite is around 6 bytes per second.
- It takes for a GPS receiver about 65 to 85 millisecond to receive a radio signal from GPS satellite. If the device is used frequently, then the TTFF will be small as the data have already been downloaded.
- GPS devices or trackers which are available in the market can broadly be divided into two types those are active GPS devices and passive GPS devices.

Q.24 What is difference between active and passive GPS?

Ans. : Active GPS :

- Active GPS trackers monitor movement in real-time. In active GPS devices, the user can view the speed, location, and other tracking details soon after the implementation of the device from any place.
- In active GPS trackers, GPRS module is in-built, which allows the device to transmit the data to the saver.
- If one has a web based tracking interface and source and map sources then the user will be able to track from anywhere; provided internet connection is available.

Passive GPS :

- Passive GPS devices do not allow the user to view tracking information in real time. The information in the device can only be viewed after that information is downloaded to a computer.
- Tracking details normally include the date of the information, time of the information, direction traveled and stops made.

5.4 Innovative Applications of the Internet of Things

Q.25 List the specific wireless sensor applications.

Ans. : Applications of sensor networks :

- **Military sensor networks** : used to detect and gain as much information as possible about enemy movements, explosions, and other phenomena of interest.
- **Sensor networks** : Used to detect and characterize chemical, biological, radiological, nuclear, and explosive attacks and materials.
- Sensor networks also used to detect and monitor environmental changes in plains, forests, oceans.
- Wireless traffic sensor networks to monitor vehicle traffic on highways or in congested parts of a city.
- Wireless surveillance sensor networks for providing security in shopping malls, parking garages.
- Wireless parking lot sensor networks to determine whether the lot is occupied or available area.

Q.26 How IoT helps to organization in supply chain management ?

Ans. : Supply line combines the processes, methodologies, tools, and delivery options to guide collaborative partners to work in a sequence to conduct business with high efficiency and delivery speed.

- A supply chain is an efficient network of facilities that procures materials, transforms these materials to finished products, and finally distributes the finished products to customers.
- Fig. Q.26.1 supply chain management.

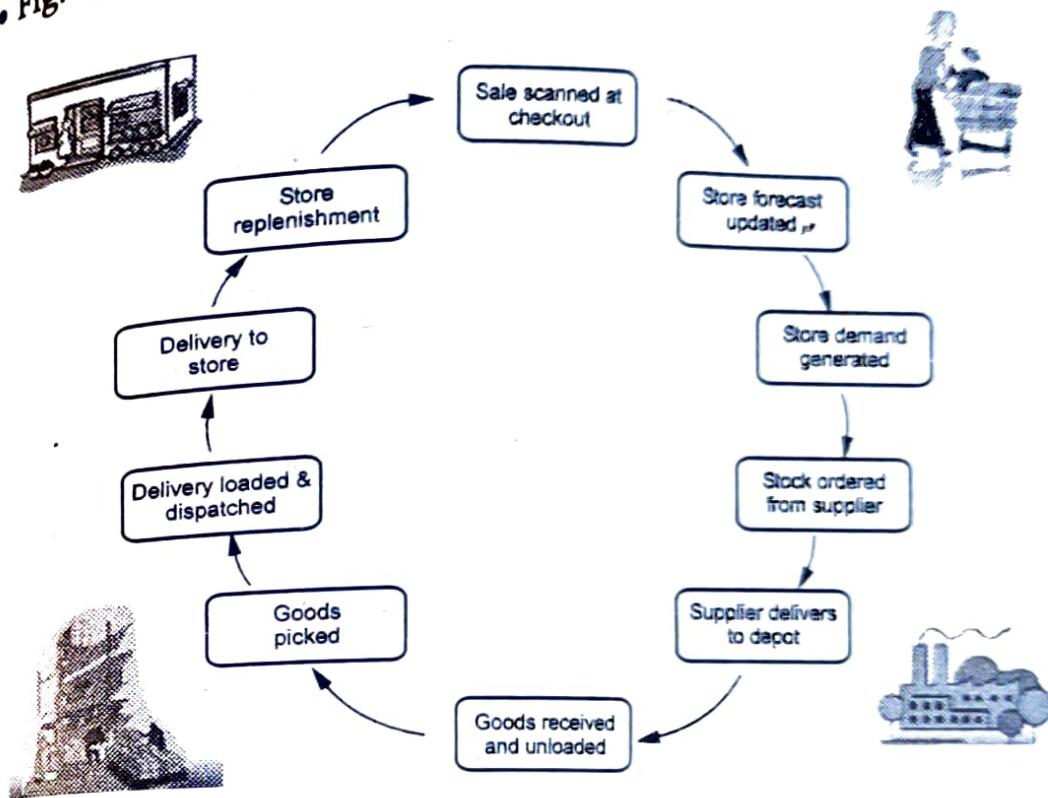


Fig. Q.26.1

- Supply chain involves material suppliers, distribution centers, communication links, cloud data centers, a large number of retail stores, corporate headquarters and bank payments.
- These business partners are linked by satellite, Internet, wired and wireless networks, truck, train, or shipping companies, and electronic banking, cloud providers.
- Sensors, RFID tags, and GPS devices could be placed everywhere along the supply chain. The idea is to promote online business, e-commerce, or mobile transactions.
- Supply chain management consists of five major stages :

1 : Planning and Coordination : A plan or strategy must be developed to address how a good or service can satisfy the needs of customers.

three-quarters of its resources. Moreover, more than 100 cities of 1 million people will be built in the next 10 years.

- Over the past decade, the city of Amsterdam, the Netherlands, has developed a vision for collaborating, envisioning, developing, and testing numerous connected solutions that could pave the way to a smarter, greener urban environment.
- Fig. Q.28.1 shows concept of smart city.

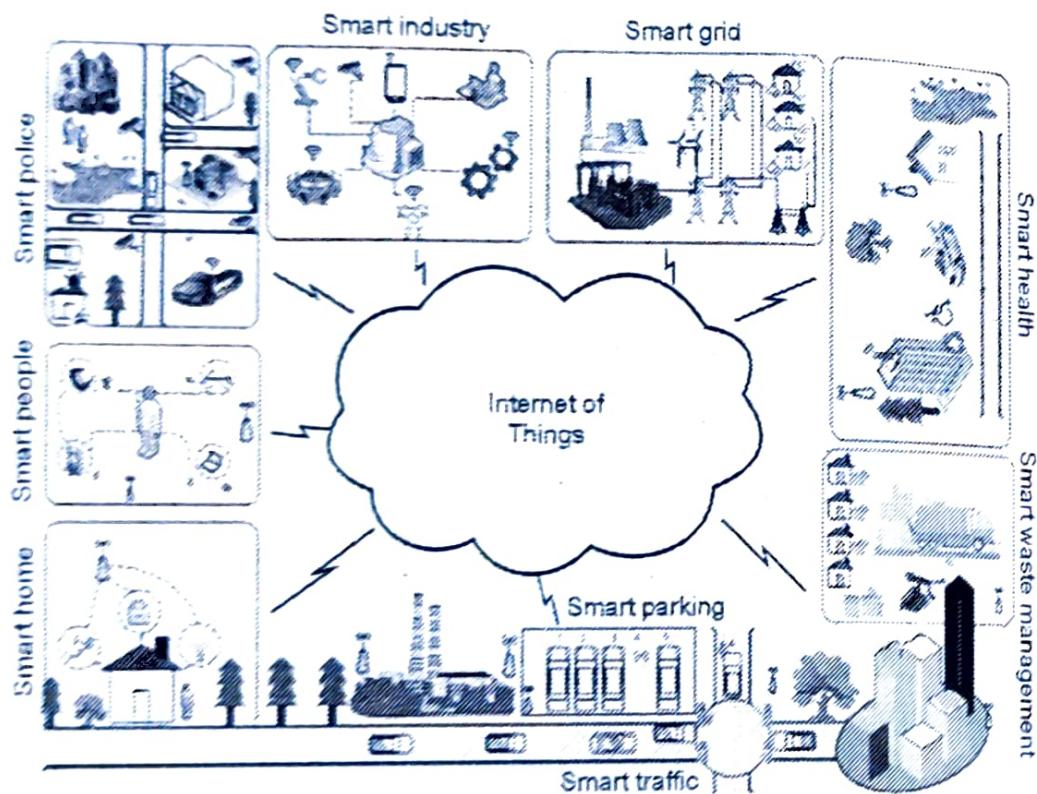


Fig. Q.28.1 Smart city

- Innovations will aim to improve the quality of life in cities, encompassing security issues and energy resourcefulness. Smart city includes :
1. Smarter management of city infrastructure using Big Data analytics.
 2. Collaboration across multiple and disparate agencies using cloud technologies.

- 3. Real-time data collection, enabling quick response using mobile technologies.
 - 4. Enhanced security : improved public safety and law enforcement, and more efficient emergency response.
 - 5. Better city planning improved schematics, project management and delivery.
 - 6. Networked utilities smart metering and grid management.
 - 7. Building developments more automation, and better management and security.
- With smart city applications producing continuous large data from heterogeneous sources, existing relational database technologies are inadequate to handle such huge amounts of data given the limited processing speed and the significant storage expansion cost.
- To address this problem, big data processing technologies, which are based on distributed data management and parallel processing, have provided enabling platforms for data repositories, distributed processing and interactive data visualization.

Q.29 What is Cyber-Physical System ? Explain in brief.

- Ans. :
- Cyber-physical system (CPS) is a mechanism that is controlled or monitored by computer-based algorithms, tightly integrated with the Internet and its users.
 - In cyber-physical systems, physical and software components are deeply intertwined, each operating on different spatial and temporal scales, exhibiting multiple and distinct behavioral modalities, and interacting with each other in a myriad of ways that change with context.
 - Examples of CPS include smart grid, autonomous automobile systems, medical monitoring, process control systems, robotics systems, and automatic pilot avionics.

- Cyber-physical system(CPS) is an embedded system which integrates the computing process with the physical world as an interactive and intelligent system. CPSes appear in many computer and TV game systems.
- Fig. Q.29.1 shows cyber physical space.

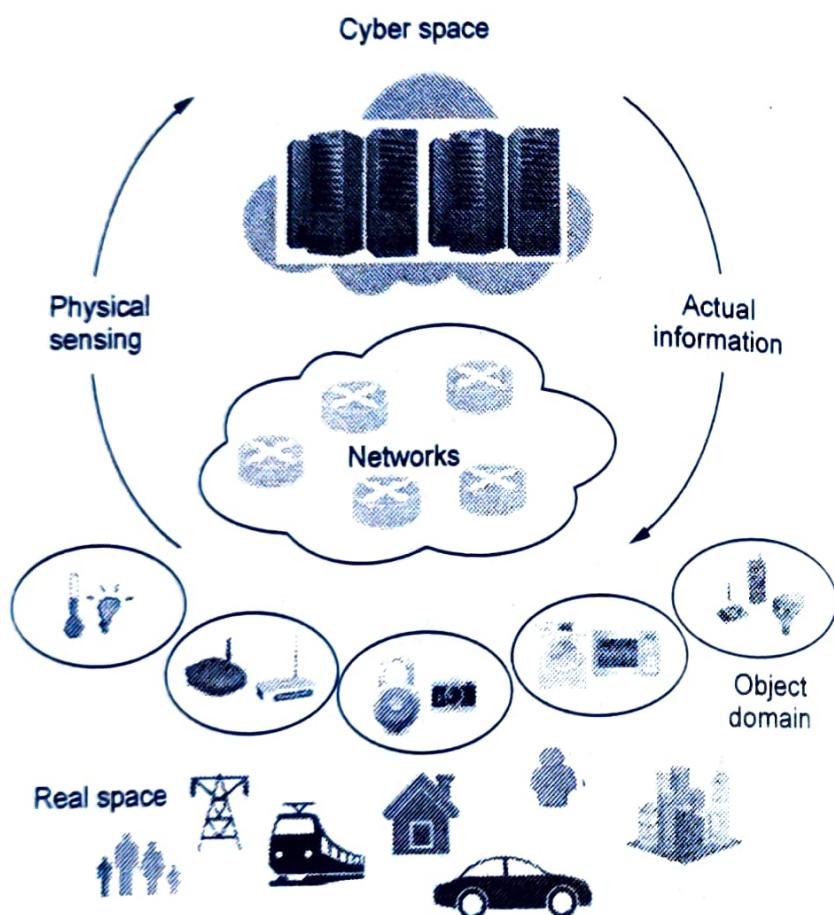


Fig. Q.29.1 Cyber physical space

- CPS features tight coordination between the system's computational and physical elements.

In CPS, computing elements coordinate and communicate with sensors, which monitor cyber and physical indicators, and actuators, which modify the cyber and physical environment where they are run.

CPSs often seek to control the environment in some way. CPSs use sensors to connect all distributed intelligence in the environment to gain a deeper knowledge of the environment, which enables a more accurate actuation.

In the manufacturing environment, CPSs can improve processes by sharing real-time information among the industrial machines, manufacturing supply chain, suppliers, business systems, and customers.

In smart building environments, smart devices and CPSs interact to reduce energy consumption, to increase safety and security, and to improve inhabitants' comfort.

In the transportation environment, individual vehicles and the infrastructure can communicate with each other, sharing real-time information about traffic, location, or issues, in order to prevent accidents or congestion, improve safety, and ultimately save money and time.

5.5 Online Social and Professional Networking

Q.30 What is social network ? Explain development of Social Network Analysis.

Ans. : • A social network is a group of collaborating and/or competing individuals or entities that are related to each other. It may be presented as a graph, or a multi-graph; each participant in the collaboration or competition is called an actor and depicted as a node in the graph theory.

- Valued relations between actors are depicted as links, or ties, either directed or undirected, between the corresponding nodes.
- Actors can be persons, organizations, or groups - any set of related entities. As such, SNA may be used on different levels, ranging from individuals, web pages, families, small groups, to large organizations, parties, and even to nations.
- In general, a social network consists of actors (e.g., persons, organizations) and some form of relation among them. The

network structure is usually modeled as a graph, in which vertices represent actors, and edges represent ties, i.e., the existence of a relation between two actors.

- The vocabulary, models and methods of network analysis also expand continuously through applications that require to handle ever more complex data sets.
- An example of this process are the advances in dealing with longitudinal data. New probabilistic models are capable of modelling the evolution of social networks and answering questions regarding the dynamics of communities. Formalizing an increasing set of concepts in terms of networks also contributes to both developing and testing theories in more theoretical branches of sociology.
- The purpose of social network analysis is to identify important actors, crucial links, roles, dense groups, and so on, in order to answer substantive questions about structure .
- Analysis methods available in visone are divided into four main categories according to the level or subject of interest: vertex, dyad, group, and network level.
- Available analysis methods include actor-level centrality indices, e.g. closeness, betweenness, and page rank, cohesive subgroups like cliques, k-cliques, and k-clans, centrality and connectedness.
- These levels break further down into measures of the same objective, e.g., connectedness or cohesiveness. Analysis methods are accessible using the analysis tab in the control area.

Q.31 List and explain ideas for providing of online social network services.

- Ans. :
- Personal page or profiles for each user linked by social connections
 - Social graph traversal along specific social links or networks
 - Communication tools among participants or registered users

- Ability to share music, photos, and videos with friends or professional groups
- Operation of a community in special niche areas like health care, sports, and hobbies
- Customized software tools or databases are used in OSN services
- Strong customer loyalty and fast membership growth are seen
- Provider revenue from embedded advertisement and access to premium content

Q.32 Explain Representative /application Online Social Networks.

Ans. : • Social network analysis (SNA) is an important and valuable tool for knowledge extraction from massive and un-structured data. Social network provides a powerful abstraction of the structure and dynamics of diverse kinds of inter-personal connection and interaction.

Facebook is a social networking service and website that connects people with other people, and share data between people. A user can create a personal profile, add other users as friends, exchange data, create and join common interest communities.

Twitter is a social net-working and microblogging service. The users of Twitter can exchange text-based posts called tweets. A tweet is a maximum 140 characters long but can be augmented by pictures or audio recording. The main concept of Twitter was to build a social network formed by friends and fol-lowers. Friends are people who you follow, followers are those who follow you.

The role of social networks in labor markets deserves attention for at least two reasons: first, because of the central role networks play in disseminating information about job openings they place a critical role in determining whether labor markets function efficiently; and second, because network structure ends up having implications for things like human capital investment as well as inequality.

- Social network analysis (SNA) primarily focuses on applying analytic techniques to the relationships between individuals and groups, and investigating how those relationships can be used to infer additional information about the individuals and groups.
- SNA is used in a variety of domains. For example, business consultants use SNA to identify the effective relationships between workers that enable work to get done; these relationships often differ from connections seen in an organizational chart.
- Law enforcement personnel have used social networks to analyze terrorist networks and criminal networks. The capture of Saddam Hussein was facilitated by social network analysis : military officials constructed a network containing Hussein's tribal and family links, allowing them to focus on individuals who had close ties to Hussein.

Q.33 List the benefits of Social Network.

Ans. : Benefits :

1. High return visit rate : Users return to the social network community frequently. This opens up the opportunity for great page impressions and a huge advertising inventory.
2. User loyalty : Users connect to their friends and will not abandon them easily.
3. Virtual growth : Members invite their friends to the social network community. This is effective marketing at a low cost, and the OSN grows by itself.
4. Business model : With a social network community you can earn revenues through subscriptions to premium content in addition to advertising revenues.

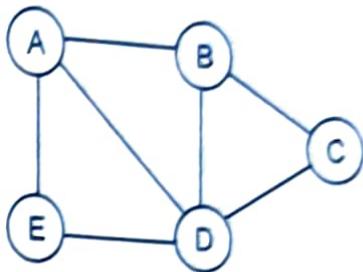
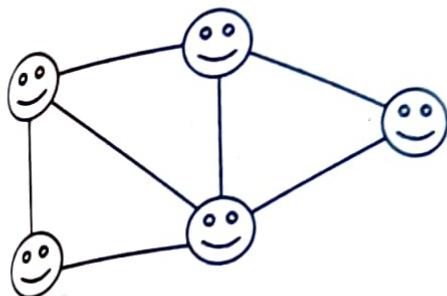
Q.34 Write short note on : Graph-Theoretic Analysis of Social Networks.

Ans. : • Social network can be represented as a graph $G = (V, E)$

where V = the finite set of vertices

E = finite set of edges such

The most network analysis methods work on an abstract, graph based representation of real world networks. It is shown in Fig. Q.34.1.



	A	B	C	D	E
A	0	1	0	1	1
B	1	0	1	1	0
C	0	1	0	1	0
D	1	1	1	0	1
E	1	0	0	1	0

Fig. Q.34.1 Graph based representation of real world networks

- When representing a network as a graph, all of the connections are pair-wise and hence represented by ties known as edges.
- Networks can be described using a mixture of local, global, and intermediate-scale perspectives. Accordingly, one of the key uses of network theory is the identification of summary statistics for large networks in order to develop a framework for analyzing and comparing complex structures
- SNA can produce maps like the one featured below, and provide statistical measures of relationships between actors. In SNA maps, the nodes represent the different actors in the network, and the lines represent the relationships between the various actors.

- The size of the node often represents the relative importance of that actor in the network, and the thickness of the connecting line denotes the strength of the relationship.
- Clustering for a single vertex can be measured by the actual number of the edges between the neighbors of a vertex divided by the possible number of edges between the neighbors.
- When taken the average over all vertices, we get to the measure known as clustering coefficient. The clustering coefficient of a tree is zero, which is easy to see if we consider that there are no triangles of edges (triads) in the graph. In a tree, it would never be the case that our friends are friends with each other.
- The coordination degree measures the ability of the vertices in a graph to interchange information. There are several ways in which we can model this magnitude. One of the easiest is to consider the coordination degree to be exponentially related with the distance between the vertices.
- To define the total co-ordination degree of a vertex "i" in a graph as the sum of all the coordination degrees between that particular vertex and the rest :

$$\Gamma_i = \sum_{j=1}^N Y_{ij}$$

where N is the order of the graph.

- Graph density (D) is defined as the total number of observed lines in a graph divided by the total number of possible lines in the same graph. Density ranges from 0 to 1.

$$\text{Density (D)} = \frac{\text{Number of lines (L)}}{(\text{Number of points} (\text{Number of points} - 1)) / 2} = \frac{2L}{g(g-1)}$$

Q.35 List and explain Social Networking communities.

Ans. : Social networking communities are as follows :

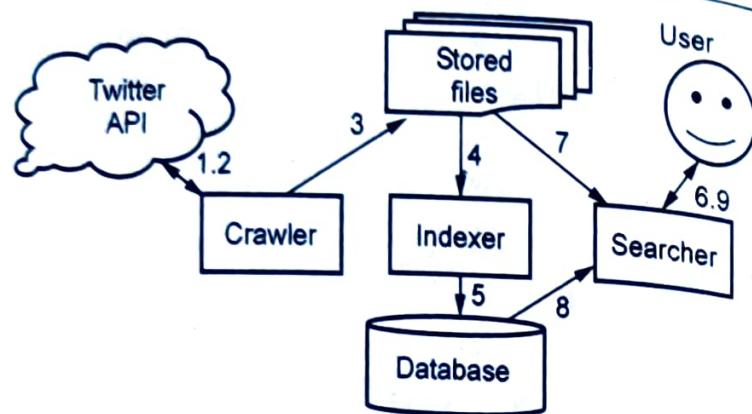
- Industry communities :** Special industrial workers or professionals are often connected with one another. They share knowledge and work experience.

- **Artist communities** : These network communities are specifically composed to enable artists, musicians, or celebrities to personalize and intensify their contact with their existing fans as well as enabling contact among community members.
- **Sport communities** : These are network communities for special interests and activities of athletes and sport fans. People can find friends, celebrate their passion, and exchange ideas.
- **Health communities** : These are dedicated to the needs of actors concerned about health issues.
- **Congresses and event communities** : These are customized to support all preparations necessary for congresses and events, as well as all processes thereafter.
- **Alumni communities** : After completing their studies, alumni can find fellow students, stay in touch, and foster friendships.

Q.36 Draw and explain Twitter architecture and access protocol sequence.

Ans. : • Twitter is known as a micro-blogging site. Twitter is a social networking site that relies on micro-blogging for communication.

- Twitter system consists of three components : crawler, indexer, and searcher.
 - Each component differs in the functions it performs. They are used together through balanced coordination to form a complete system.
 - Fig. Q.36.1 shows the Twitter access architecture. (See Fig. Q.36.1 on next page)
1. The crawler sends a request to the Twitter API.
 2. The Twitter API responds with the Twitter data.
 3. The crawler stores the data into files.
 4. The indexer reads the stored files as input.
 5. The indexer stores the data in a database as output.

**Fig. Q.36.1 : Twitter access architecture**

6. Users send a search query to the searcher.
 7. The searcher reads the data from the database and calculates a rank.
 8. The searcher reads associated raw tweets.
- Twitter calls microblog posts from users tweets. Each tweet has a 140-character limit which is inherited from text messaging.
 - Simplicity is provided with an HTTP-based open source API and sharing posts with third-party applications. Twitter's API consists of two different parts : a Search API and a REST API.

The REST API enables Twitter developers to access core Twitter data. This data includes tweets, timelines, and user data. The Search API enables developers to query the tweets. It also provides information about trending topics. The usage of both APIs is subject to rate limiting.

Q.37 Draw and explain architecture of Facebook platform.

Ans. : • The Facebook platform is the set of services, tools, and products provided by the social networking service Facebook for third-party developers to create their own applications and services that access data in Facebook.

- Facebook is simply a proxy, reading the browser requests, passing them onto your servers, reading your servers' responses, and then parsing that information back to the user in HTML format.

, Fig. Q.37.1 shows Facebook architecture.

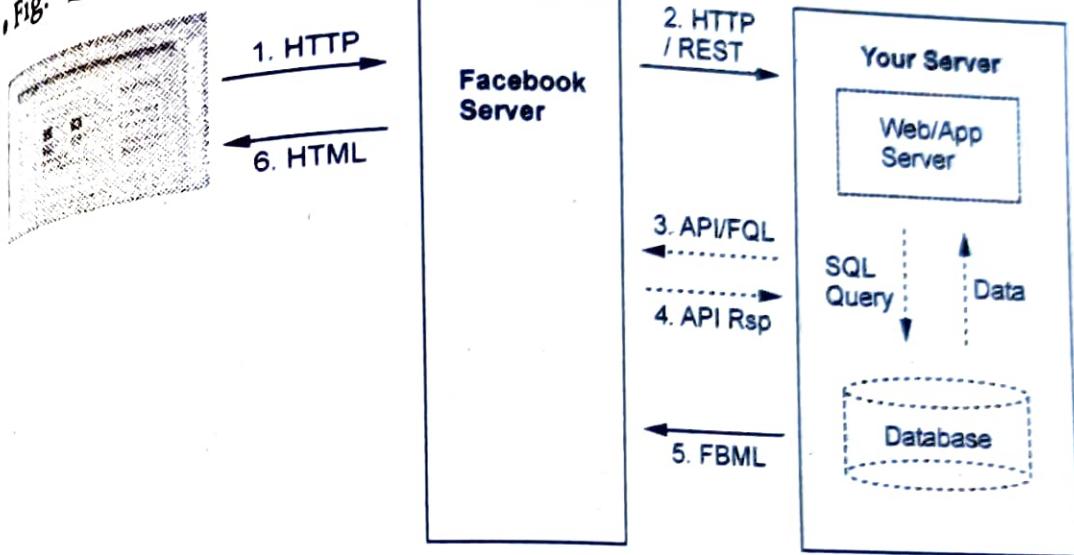


Fig. Q.37.1 Facebook architecture

- The platform offers a set of programming interfaces and tools which enable developers to integrate with the open "social graph" of personal relations and other things like songs, places, and Facebook pages.
- Applications on facebook.com, external websites, and devices are all allowed to access the graph. Platform components are as follows :
- 1. Graph API** : It is the core of Facebook platform, enabling developers to read from and write data into Facebook. The Graph API presents a simple, consistent view of the Facebook social graph, uniformly representing objects in the graph and the connections between them.
- 2. Authentication** : Facebook authentication enables developers' applications to interact with the Graph API on behalf of Facebook users, and it provides a single-sign on mechanism across web, mobile, and desktop apps.
- 3. Social plugins** : It includes button, recommendations, and activity Feed - enable developers to provide social experiences to their users with just a few lines of HTML.

4. Open Graph protocol : The Open Graph protocol enables developers to integrate their pages into Facebook's global mapping/tracking tool social graph. These pages gain the functionality of other graph objects including profile links and stream updates for connected users.

- Fig. Q.37.2 shows working.

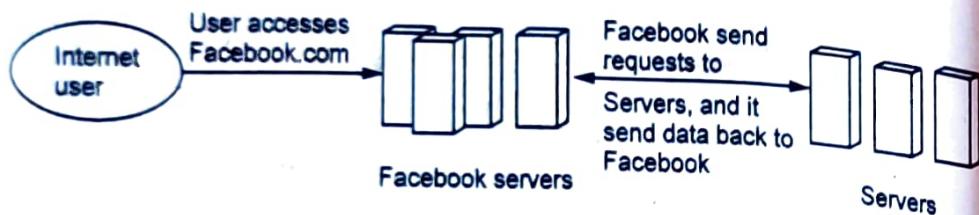


Fig. Q.37.2

Q.38 Write short note on ubiquitous system challenges and outlook.

Ans. : • Four scenarios illustrate a range of benefits and challenges of ubiquitous computing :

1. Personal memories
2. 21st Century scheduled transport service
3. Foodstuff management
4. Utility regulation

Personal memories :

- A digital camera automatically captures a visual of part of the physical world scene on an inbuilt display. The use of digital cameras enables photography to be far less intrusive for the subject than using film cameras.
- Fig. Q.38.1 shows example of a ubiquitous computing application.
- The camera can autofocus and auto-expose recorded images and video so that recordings are automatically in focus and selected parts of the scene are lit to the optimum degree.

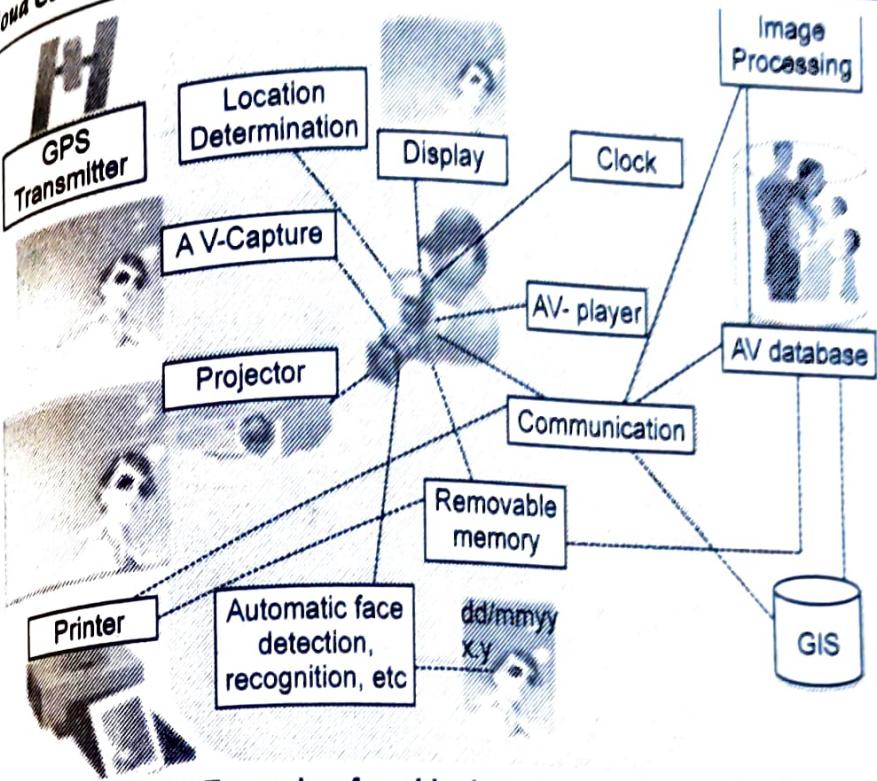


Fig. Q.38.1 Example of a ubiquitous computing application

- The context of the recording such as the location and date/time is also automatically captured using inbuilt location and clock systems.
- Ubiquitous computing (UbiCom) encompasses a wide spectrum of computers, not just devices that are general purpose computers, multi-function ICT devices such as phones, cameras and games consoles, ATMs, vehicle control systems, mobile phones, electronic calculators, household appliances, and computer peripherals such as routers and printers.

21st Century scheduled transport service :

- In a twentieth-century scheduled transport service, timetables for a scheduled transport service, e.g., taxi, bus, train, plane, etc. to pick up passengers or goods at fixed or scheduled point are only accessible at special terminals and locations.
- Passengers and controllers have a limited view of the actual time when vehicles arrive at designated way-points on the route. Passengers or goods can arrive and wait long times at designated pick-up points.

- The transport system may need to deal with conflicting goals such as picking up more passengers and goods to generate more revenue for services rendered versus minimizing how late the vehicle arrives at pre-set points along its route.

Foodstuff management :

- A ubiquitous home environment is designed to support healthy eating and weight regulation for food consumers. A conventional system performs this manually.
- A next generation system (semi-)automates this task using networked physical devices such as fridges and other storage areas for food and drink items which can monitor the food in and out.
- Sensors are integrated in the system, e.g., to determine the weight of food and of humans.
- Scanners can be used to scan the packaging of food and drink items for barcodes, text tables, expiry dates and food ingredients and percentages by weight.

Utility regulation :

- A ubiquitous home environment is designed to regulate the consumption of a utility (such as water, energy or heating) and to improve usage efficiency.
- For example, currently utility management, e.g., energy management, products are manually configurable by human users, utilize stand-alone devices and are designed to detect local user context changes.
- User context-aware energy devices can be designed to switch themselves on in a particular way, e.g., a light switches on, heating switches on when it detects the presence of a user otherwise it switches off.

END... ↗

UNIT - VI

6

Future of Cloud Computing

Important Points to Remember

- Location is a fundamental aspect of the new, exciting world of mobile web-enabled services.
- A set of compute, storage, memory and I/O components joined through a fabric interconnect and the software to configure and manage them
- HTML5 apps offer write once, run anywhere mobile app development
- Time to market (TTM) is the length of time it takes from a product being conceived until its being available for sale.
- Autonomic Computing is the ability of distributed system to manage its resources with little or no human intervention
- CometCloud is an autonomic computing engine for cloud and grid environments.
- CometCloud is composed of a programming layer, a service layer, and an infrastructure layer
- Multimedia cloud computing is the processing, accessing and storing of multimedia contents like audio, video and image using the services and applications available in the cloud without physically acquiring them
- Green computing is the environmentally responsible and eco-friendly use of computers and their resources.
- Jungle Computing System consists of all compute resources available to end-users, which includes clusters, clouds, grids, desktop grids, supercomputers, as well as stand-alone machines and even mobile devices.

- Docker is a tool that promises to easily encapsulate the process of creating a distributable artifact for any application, deploying it at scale into any environment, and streamlining the workflow and responsiveness of agile software organizations.

6.1 How the Cloud Will Change Operating Systems, Location-Aware Applications

Q.1 How cloud will impact future operating system ?

Ans. : • Cloud computing is a technology deployment approach that has the potential to help organizations better use IT resources to increase flexibility and performance.

- One of the most important ways to support the underlying complexity of well-managed cloud computing resources is through the operating system.
- An operating system such as Linux supports important standards that enhance portability and interoperability across cloud environments.
- Operating system platforms are designed to hide much of the complexity required to support applications running in complex and federated environments. Much of the functionality required for the efficient operation of many applications is built in to the operating system.
- The operating system implements the level of security and quality of service to ensure that applications are able to access the resources needed to deliver an acceptable level of performance.
- Operating system exists to allow users to run programs and store and retrieve data from one user session to the next.
- One of the most significant requirements for companies adopting cloud computing is the need to adopt a hybrid approach to computing. To do so, most organizations will continue to

maintain their traditional data center to support complex mixed workloads.

For example, an organization may choose a public cloud environment for development and test workloads, a private cloud for customer-facing web environments that deal with personal information, and a traditional data center for legacy billing and financial workloads.

Virtualization requires some level of workload isolation since virtualized applications are stored on the same physical server. However, cloud computing adds the concept of multi-tenancy.

Multi-tenancy is the sharing of resources by multiple organizations, which requires that each customer's data and applications be stored and managed separately from other customers' data and applications.

- Both virtualization and multi-tenancy support have to be implemented in a secure manner. As virtualization and multi-tenancy become the norm in cloud environments, it is critical that security be built in at the core.
- When servers are virtualized it makes it very easy for a new image to be created with little effort.

Q.2 What is Locations-Aware Applications ?

Ans. : • Location is a fundamental aspect of the new, exciting world of mobile web-enabled services.

- The usefulness of many of today's most popular mobile applications and services is determined by one key factor : where you are at the exact moment when you're using the service.
- Location based service is a service where
 1. The user is able to determine their location.
 2. The information provided is spatially related to the user's location.
 3. The user is offered dynamic or two-way interaction with the location information or content.

- Components of location based services are as follows :

1. Mobile device
2. Content provider
3. Communication network
4. Positioning component

Q.3 What Is Fabric-Based Infrastructure ? Which are the services provided by Intelligent Fabrics.

Ans. : • The term "fabric" is used by different vendors, analysts, and IT groups to describe different things.

- A set of compute, storage, memory and I/O components joined through a fabric interconnect and the software to configure and manage them.

- A fabric thus provides the capability to reconfigure all system components - server, network, storage, and specialty engines - at the same time, the flexibility to provide resources within the fabric to workloads as needed, and the capability to manage systems holistically.

- Services provided by Intelligent Fabrics are as follows :

1. It automatically adjust the room temperature when body temperature change.
2. It monitors the body functions such as blood presser, sugar level etc

6.2 The Future of Cloud TV, Future of Cloud-Based Smart Devices

Q.4 Write short note on Future of Cloud TV.

Ans. : • Today, consumers watch video on a variety of connected devices. New Over-The-Top (OTT) providers such as Netflix are offering direct-to-consumer services with low prices, advanced user interfaces and easy access to multi-screen video.

- Changing usage patterns brought on by subscriber desire to watch content at the time, location and on the device of their choosing are increasing content distribution costs.

- Pay TV providers are particularly susceptible to these trends and need to adapt their traditional TV delivery architectures to offer innovative services that attract and retain customers.
- The traditional Set-Top Box (STB) will disappear. The functions of today's STB hardware will be carried out in the network and by the connected device itself, eliminating the cost and complexity of managing home-based STBs.
- Traffic will be all unicast. Over time, device format fragmentation, time-shifting viewing habits and service personalization will erode broadcast and multicast efficiencies.
- Ultimately, every end user will be served with a unique stream. Services will be deployed in the cloud.
- Dedicated video platforms will migrate to cloud-based services, reducing costs and accelerating time to market.
- Operators will move from vertically integrated middleware stacks to more open architectures with best-of-breed components.
- Cloud DVR technology makes all TV content available on demand, on any device and in any location

6.3 Cloud and Mobile

Q.5 List and explain mobile cloud application.

Ans. :

Mobile Gaming	<ul style="list-style-type: none"> • M-game is a high potential market generating revenues for service providers. • Can completely offload game engine requiring large computing resource (e.g., graphic rendering) to the server in the cloud. • Offloading can also save energy and increase game playing time (eg. MAUI allows fine-grained energy-aware offloading of mobile codes to a cloud) • Rendering adaptation technique can dynamically adjust the game rendering parameters based on communication constraints and gamers' demands
---------------	---

Mobile Healthcare	<ul style="list-style-type: none"> • M-healthcare is to minimize the limitations of traditional medical treatment (eg. Small storage, security/privacy, medical errors, ...) • M-healthcare provides mobile users with convenient access to resources (eg. medical records) • M-healthcare offers hospitals and healthcare organizations a variety of on-demand services on clouds
Mobile Learning	<ul style="list-style-type: none"> • M-learning combines e-learning and mobility • Traditional m-learning has limitations on high cost of devices/network, low transmission rate, limited educational resources • Cloud-based m-learning can solve these limitations • Enhanced communication quality between students and teachers • Help learners access remote learning resources
Mobile Commerce	<ul style="list-style-type: none"> • M-commerce allows business models for commerce using mobile devices. • Examples : Mobile financial, mobile advertising, mobile shopping. • M-commerce applications face various challenges • Integrated with cloud can help address these issues • Example : Combining 3G and cloud to increase data processing speed and security level.

Q.6 How HTML5 will drive mobile applications ?

Ans. : • HTML5 apps offer write once, run anywhere mobile app development. They are a collection of web pages optimized for mobile devices that bring advanced capabilities for streaming video and audio data, handling graphics and animation and providing offline support.

- They also add semantic elements, form controls and multimedia components, as well as a number of new APIs that support geolocation services, drag-and-drop operations, local application caching and more.

HTML5 seldom works alone. Most HTML5 apps integrate Cascading Style Sheets (CSS), which define how the HTML components render within a browser, and JavaScript, which includes the APIs for working with text, objects and arrays.

All major browsers support these technologies, making it possible to implement Web-based apps across a wide range of devices.

HTML5 mobile application development framework toolkits contain libraries of CSS and JavaScript files that developers can include in the HTML.

Frameworks handle many of the issues that arise with building HTML5 apps. Memory and performance limitations are key considerations for HTML5 mobile application development

6.4 Faster Time to Market for Software Applications

Q Define time to market ? What do you mean faster time to market for software application ?

Ans. : • Time To Market (TTM) is the length of time it takes from a product being conceived until its being available for sale.

TTM is important in industries where products are outmoded quickly. A common assumption is that TTM matters most for first-of-a-kind products, but actually the leader often has the luxury of time, while the clock is clearly running for the followers.

Nowadays software companies clearly understand that time costs money and that they need all possible tools to get their products to market as fast as possible with no compromise to quality.

So they expect a wider range of features, a variety of services, scalability, high performance and flexible pricing out-of-the-box from their cloud providers.

This motivates hosting vendors to expand their offerings with PaaS and CaaS solutions, and migrate their current users from commodity VPS to the advanced platforms.

- The bottom line is that success in the mobile market can be driven as much by who is there first as much as it may be driven by the quality of the applications being delivered; as such minimizing the time to market is paramount.
- With so many cloud-based offerings available that can help speed up everything from development to deployment to runtime operations, it's no wonder that those who are serious about mobile development are leaning hard on the various PaaS, SaaS and IaaS offerings available on the market today.

6.5 Home-Based Cloud Computing

Q.8 How cloud computing is used in home application ?

- Ans. :**
- Cloud computing has been evolved as a key computing platform for sharing resources and services. People should have a relatively convenient environment for handling Home-appliances.
 - Existing Home-Appliance control systems are not providing complete control over Home-Appliances and also difficult to control from distant places.
 - Framework is composed of mobile users, Home-appliances and the cloud environment. Mobile that the user is going to use should contain Internet facility.
 - A mobile user can use a smart phone with internet connection to control and handle Home-appliances through Web2.0 Blog-based interfaces in Web2.0 Platform.
 - Mobile User can control the Home-appliances, using the Device Profile of Web Services in the cloud environment and can control completely by not only switching on and off but also can change settings of the devices and also from any far places.
 - Home-based healthcare could enable the care recipients to live independently at home. Healthcare providers could monitor the patients based on their shared daily health data, and provide some clinical suggestions, as well as giving feedback through

reports of medical examinations that the patients have undergone.

Cloud computing services can support almost any type of medical software applications for healthcare organizations.

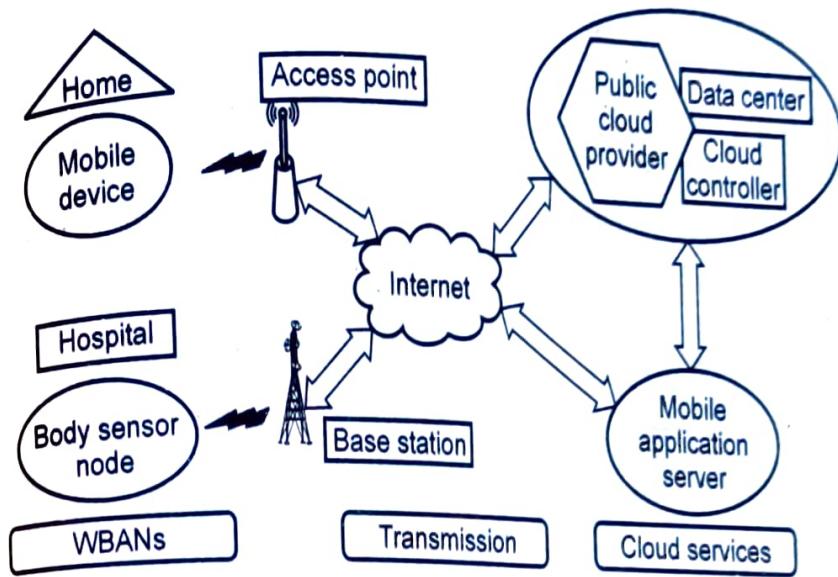


Fig. Q.8.1

- Cloud computing can offer practical solutions as in the new clinical information management system called "Collaborative Care Solution" that was developed in November 2010 by IBM and Active Health Management.
- It was beneficial for patients who were suffering from chronic conditions to connect with their physicians and follow up their prescribed medications.
- Management of data was more efficient in regards to the growing numbers of patients' data and information through electronic and personal health records.
- This could be viewed from the perspective of data storage and the number of servers needed to cope up with these enormous amounts of data.
- What facilitates the function of cloud computing is the usage of smart phones and tablets that support medical staff and patients to access healthcare services.

- Data storage services can help to build a healthcare information integration platform to integrate different healthcare providers. Thus, necessary medical information resources will be shared between healthcare providers and recipients

6.6 Autonomic Cloud Engine

Q.9 What do you mean autonomic cloud computing ? Explain system architecture for autonomic Cloud management.

Ans. : • Autonomic Computing is the ability of distributed system to manage its resources with little or no human intervention. It involves intelligently adapting to environment and requests by users in such a way the user does not even know.

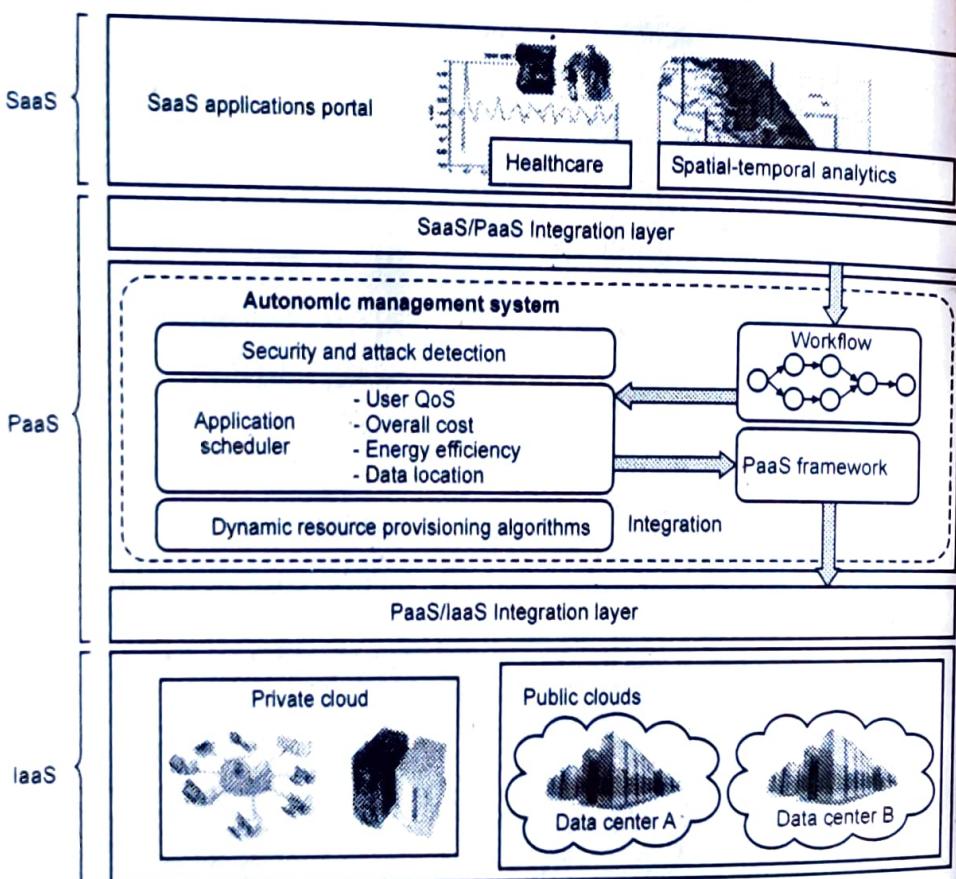


Fig. Q.9.1 : System architecture for autonomic Cloud management

- Autonomic monitoring are mostly implemented on specific layers of the cloud computing architecture. (See Fig. on next page)

Fig. Q.9.1 shows the high-level architecture enabling autonomic management of SaaS applications on Clouds.

SaaS Application Portal : This component hosts the SaaS application using a Web Service-enabled portal system.

Autonomic Management System and PaaS Framework : This layer serves as a Platform as a Service. Its architecture comprises of autonomic management components to be integrated in the PaaS level, along with modules enforcing security and energy efficiency.

Infrastructure as a Service : This layer comprises distributed resources provided by private (enterprise networks) and public Clouds.

SaaS is described as a software application deployed as a hosted service and accessed over the Internet.

In order to manage the SaaS applications in large scale, the PaaS layer has to coordinate the Cloud resources according to the SaaS requirements, which is ultimately the user QoS.

Application Scheduler : The scheduler is responsible for assigning each task in an application to resources for execution based on user QoS parameters and the overall cost for the service provider.

Q.10 Write short note on CometCloud

Ans. : • CometCloud is based on a decentralized coordination substrate, and supports highly heterogeneous and dynamic cloud/Grid infrastructures, integration of public/private clouds and cloudbursts.

• CometCloud is an autonomic computing engine for cloud and grid environments.

• CometCloud is composed of a programming layer, a service layer, and an infrastructure layer. Fig. Q.10.1 shows CometCloud architecture for autonomic cloudbursts.

- The infrastructure layer uses the Chord self-organizing overlay, and the Squid information discovery and content-based routing substrate built on top of Chord.
- The routing engine supports flexible content-based routing and complex querying using partial keywords, wildcards, or ranges.

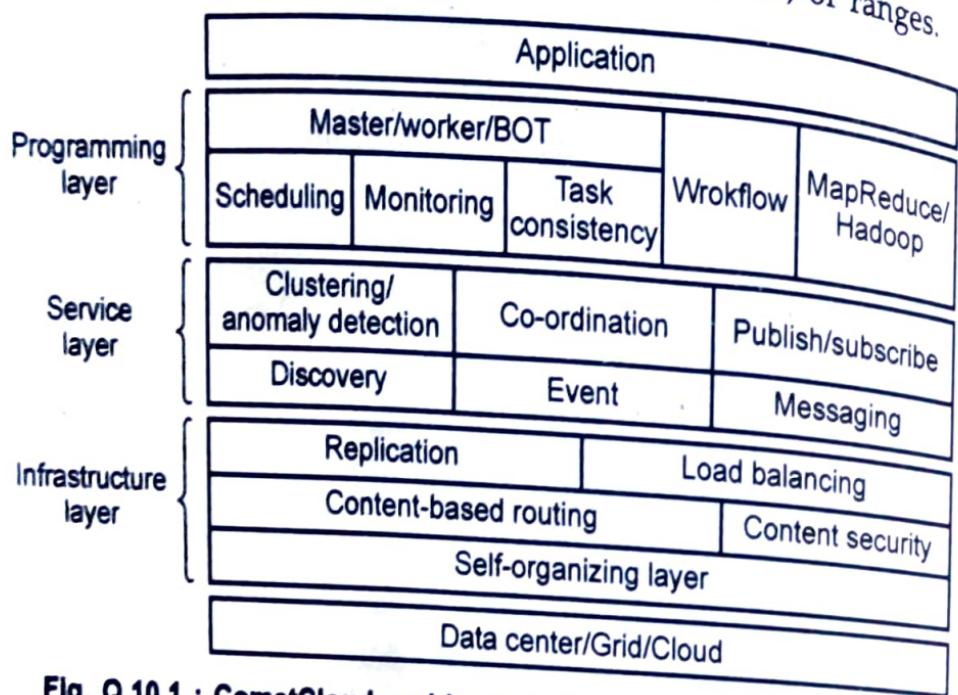


Fig. Q.10.1 : CometCloud architecture for autonomic cloudbursts

- This layer also provides replication and load balancing services, and it handles dynamic joins and leaves of nodes as well as node failures.
- The service layer provides a range of services to support autonomies at the programming and application level. An application can switch between spaces at runtime and can simultaneously use multiple spaces.
- This layer also provides asynchronous (publish/subscribe) messaging and eventing services.
- The programming layer provides the basic framework for application development and management. It supports a range of paradigms including the master/worker/BOT. Masters generate tasks and workers consume them.

6.7 Multimedia Cloud

Q.11 Write short note on Multimedia Cloud Computing.

Ans. : • Due to the invention of cloud computing, nowadays users can easily access the multimedia content over the internet at any time. User can efficiently store the multimedia content of any type and of any size in the cloud after subscribing it with no difficulties.

• Not only storing the media content like Audio, Video and Image, but can process them within the cloud since the computation time for processing media data is more in complex hardware.

• After processing the processed data can be easily received from the cloud through a client without any need of installing complex hardware.

• Fig. Q.11.1 shows fundamental concept of multimedia cloud.

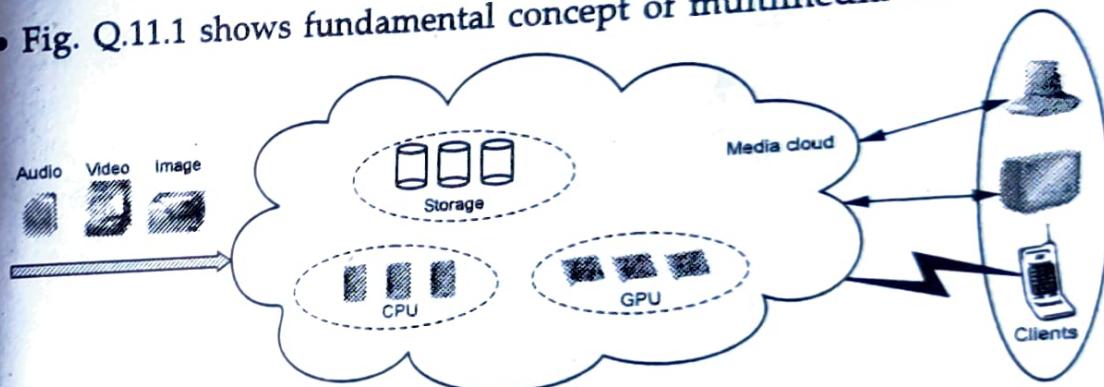


Fig. Q.11.1

• Thus Multimedia cloud computing is the processing, accessing and sharing of multimedia contents like audio, video and image services and applications available in the cloud without acquiring them.

many company's clouds like AmazonEC2, Google opBox, SkyDrive provides content management system cloud work.

of he ing s can access the multimedia content for he view a video anywhere in the world at uters, tablets or smart phones.

- Cloud media is, a cloud which has the multimedia content of the owner of that particular cloud. The media content can be accessed through the multimedia signaling protocols in the cloud and can be streamed to clients present in computers, tablets, cars and smart phones.
- Fig. Q.11.2 shows relation between cloud media and media cloud.

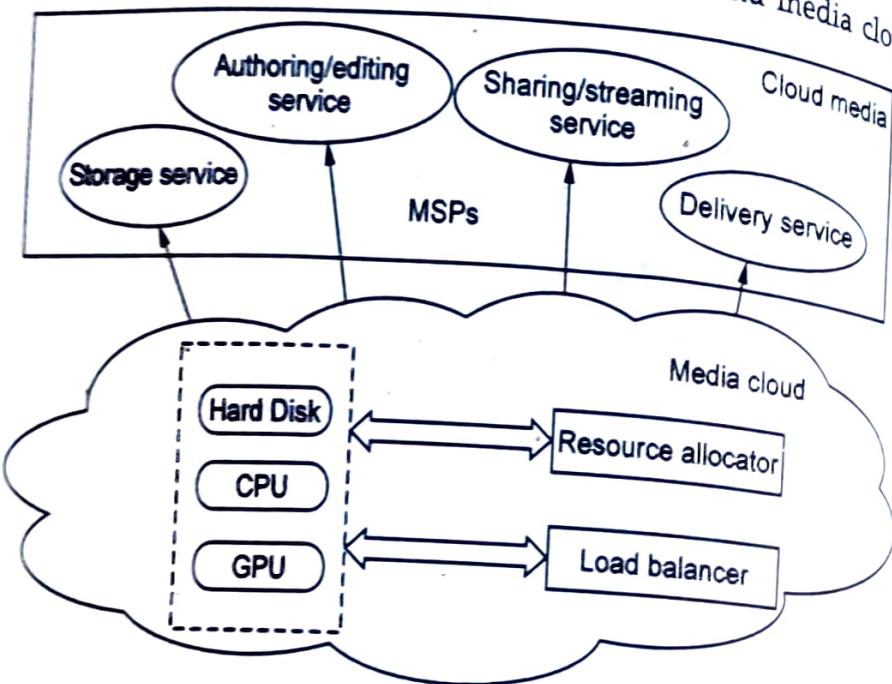


Fig. Q.11.2 : relation between cloud media and media cloud

- Not only processing, but the media content can be shared between clouds using the streaming protocols like TCP/IP, UDP, RTP, HTTP etc.
- Streaming of media content involves, loading or buffering media data, coding, mixing, rating and rendering over the service providers.
- Other profiling, packetizing, tokenizing of media contents will be done by the cloud based on the streaming protocols used and it will be streamed to the client system.
- Cloud media technology offers number of key benefits to its service providers as well as the users through increased

implementation time, efficient data storage capacity, less computation and cost.

It created a striking impact in the multimedia content processing like editing, storing, encrypting and decrypting, gaming, streaming, compressing etc

6.8 Energy Aware Cloud Computing, Jungle Computing

Q.12 What is Green computing ? What are the benefits of Green computing ?

Ans. : • Computers today are an integral part of individuals' lives all around the world; but unfortunately these devices are toxic to the environment given the materials used, their limited battery life and technological obsolescence.

- Green IT refers to the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems such as monitors, printers, storage devices, and networking and communications systems efficiently and effectively with minimal or no impact on the environment.
- Green computing refers to the practice and procedures of using computing resources in an environment friendly way while maintaining overall computing performance.
- Green computing is the environmentally responsible and eco-friendly use of computers and their resources.
- Computers and other IT infrastructure consume significant amounts of electricity, which is increasing day by day, placing a heavy burden on our electric grids and contributing to greenhouse gas (GHG) emissions.
- Green IT, also known as green computing.
- To promote green computing concepts at all possible levels, the following four complementary approaches are employed :
 - 1 Green use : Minimizing the electricity consumption of computers and their peripheral devices and using them in an eco-friendly manner

- 2 Green disposal : Re-purposing an existing computer or appropriately disposing of, or recycling, unwanted electronic equipment
- 3 Green design : Designing energy-efficient computers, servers, printers, projectors and other digital devices
- 4 Green manufacturing : Minimizing waste during the manufacturing of computers and other subsystems to reduce the environmental impact of these activities.
- "Electronic waste" may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets, and refrigerators. This includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal.
- Green computing represents a responsible way to address the issue of global warming. By adopting green computing practices, business leaders can contribute positively to environmental stewardship and protect the environment while also reducing energy and paper costs.

Benefit of Green IT

- Green IT benefits the environment by improving energy efficiency, lowering GHG emissions, using less harmful materials and encouraging reuse and recycling.
 - 1. Reduced in power and resource consumption
 - 2. Green technology helps manage and recycle waste material
 - 3. Reduced environmental impact and carbon footprint.
 - 4. Improved operational efficiency

Q.13 Write short note on Green Cloud.

Ans. : • Cloud computing is a highly scalable and cost-effective infrastructure for running HPC, enterprise and Web applications. However, the growing demand of Cloud infrastructure has drastically increased the energy consumption of data centers, which has become a critical issue. Energy-efficient solutions are required to minimize the impact of Cloud computing on the environment.

- Data centres are not only expensive to maintain, but also unfriendly to the environment.
- Cloud service providers need to adopt measures to ensure that their profit margin is not dramatically reduced due to high energy costs.
- Amazon.com's estimate the energy-related costs of its data centers amount to 42 % of the total budget that include both direct power consumption and the cooling infrastructure amortized over a 15-year period.
- Google, Microsoft, and Yahoo are building large data centers in barren desert land surrounding the Columbia River, USA to exploit cheap hydroelectric power.
- There is also increasing pressure from Governments worldwide to reduce carbon footprints, which have a significant impact on climate change.
- As **energy costs** are increasing while **availability** dwindle, there is a need to shift focus from optimising data centre resource management for pure performance alone to optimising for **energy efficiency** while maintaining high service level performance.
- **Green Cloud computing** model that achieves not only efficient processing and utilisation of computing infrastructure, but also minimise energy consumption.
- Exponential data growth leads to greater storage needs. The traditional approach of adding more disks and storage systems satisfies demand, but also increases power, cooling, and space requirements.
- Green storage is the practice of using a variety of "clean energy" storage methods and products to cut down on a data center's carbon footprint, as well as cost.

- There are a number of systems that can be used for green storage, and by analyzing your data center and specific needs, you can choose a combination of solutions that work for your environment :
 1. Tape is a popular method of green storage that is widely used. Tape has no moving parts that use up energy, is portable and has a longer shelf-life than other storage technology.
 2. Virtualized servers can host up to 20 virtualized servers on one physical server. This improves efficiency and cuts down on the need for expensive hardware.
 3. Not as widely used, but growing in popularity, are Solid-State Drives (SSDs), which are energy efficient and faster than mechanical hard disk drives. However, SSDs come at a higher cost than other methods.
 4. A massive array of idle disks (MAID) system only spins active drives, cutting down on energy use and prolonging shelf-life. This architecture has been around for a while but hasn't widely caught on largely

Q.14 Explain Energy-saving software techniques.

Ans. : • Reducing power consumption is a challenge to system designers. Portable systems, such as laptop computers and Personal Digital Assistants (PDAs) draw power from batteries; so reducing power consumption extends their operating times.

- For desktop computers or servers, high power consumption raises temperature and deteriorates performance and reliability. Power consumed by the CPU is significant.
- The total energy consumed by the system per cycle is the sum of energies consumed by the processor and L1 cache, interconnects and pins, memory, L2 cache, the DC-DC converter and the efficiency losses in the battery.
- Energy-saving software techniques are as follows :

Techniques	Sub-types
Computational Efficiency	1. Algorithm 2. Multithreading 3. uArch tuning 4. vectorization
Data Efficiency	1. Caching 2. Asynchronous I/O
Context Awareness	1. AC/DC 2. Policy for power 3. thresholds
Idle Efficiency	1. timer resolution 2. background activity 3. C-states

6.9 Jungle Computing

Q.15 What is Jungle Computing ? What are the reasons for using Jungle Computing ?

- Ans. :**
- Jungle computing is distributed computing system.
 - A Jungle Computing System consists of all compute resources available to end-users, which includes clusters, clouds, grids, desktop grids, supercomputers, as well as stand-alone machines and even mobile devices.
 - Reasons for using Jungle Computing Systems :
 1. An application may require more compute power than available in any one system a user has access to.
 2. Different parts of an application may have different computational requirements, with no single system that meets all requirements.

- From a high-level view, all resources in a Jungle Computing System are in some way equal, all consisting of some amount of processing power, memory and possibly storage.
- End-users perceive these resources as just that : a compute resource to run their application on

Q.16 What are Jungle computing systems ?

Ans. : • When grid computing was introduced over a decade ago, its foremost visionary aim was to provide efficient and transparent socket computing over a distributed set of resources.

- Many other distributed computing paradigms have been introduced, including peer-to-peer computing, volunteer computing and more recently cloud computing.
- These paradigms all share many of the goals of grid computing, eventually aiming to provide end-users with access to distributed resources with as little effort as possible.
- These new distributed computing paradigms have led to a diverse collection of resources available to research scientists, which include stand-alone machines, cluster systems, grids, clouds, desktop grids, etc.
- With clusters, grids and clouds thus being equipped with multi-core processors and many-core 'add-ons', systems available to scientists are becoming increasingly hard to program and use.
- Despite the fact that the programming and efficient use of many-cores is known to be hard, this is not the only problem. With the increasing heterogeneity of the underlying hardware, the efficient mapping of computational problems onto the 'bare metal' has become vastly more complex. Now more than ever, programmers must be aware of the potential for parallelism at all levels of granularity.

6.10 Docker at a Glance

Q.17 What is Docker ? List the benefits of the Docker Workflow

Ans. : • Docker is quickly changing the way that organizations are deploying software at scale.

- Docker is a tool that promises to easily encapsulate the process of creating a distributable artifact for any application, deploying it at scale into any environment, and streamlining the workflow and responsiveness of agile software organizations.

• Benefits :

1. Packaging software in a way that leverages the skills developers already have.
2. Bundling application software and required OS file systems together in a single standardized image format
3. Abstracting software applications from the hardware without sacrificing resources

Q.18 What is Process Simplification? Explain workflow with and without docker.

Ans. : • Docker can simplify both workflows and communication, and that usually starts with the deployment story. Fig. Q.18.1 shows workflow with and without docker.

1. Application developers request resources from operations engineers.
2. Resources are provisioned and handed over to developers.
3. Developers script and tool their deployment.
4. Operations engineers and developers tweak the deployment repeatedly.
5. Additional application dependencies are discovered by developers.
6. Operations engineers work to install the additional requirements.
7. Go to step 5 and 6
8. The application is deployed.

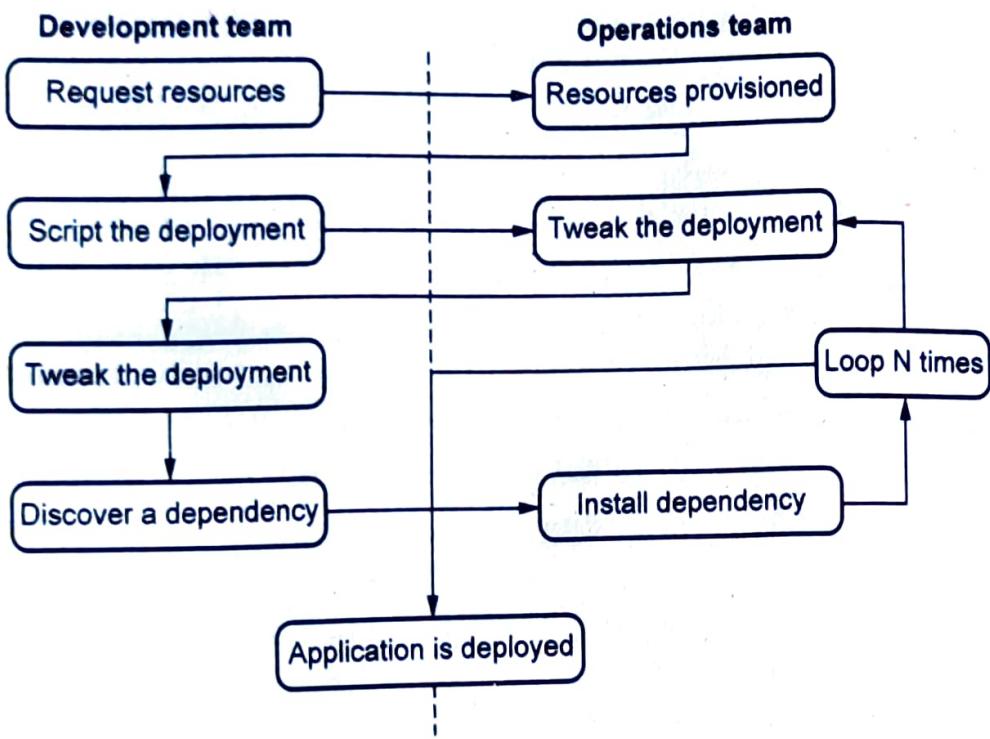


Fig. Q.18.1(a) : Traditional deployment workflow (without Docker)

1. Application developers request resources from operations engineers.
 2. Resources are provisioned and handed over to developers.
 3. Developers script and tool their deployment.
 4. Operations engineers and developers tweak the deployment repeatedly.
 5. Additional application dependencies are discovered by developers.
 6. Operations engineers work to install the additional requirements.
 7. Loop over steps 5 and 6 N more times.
 8. The application is deployed.
- Fig. Q.18.1(b) shows Docker deployment workflow

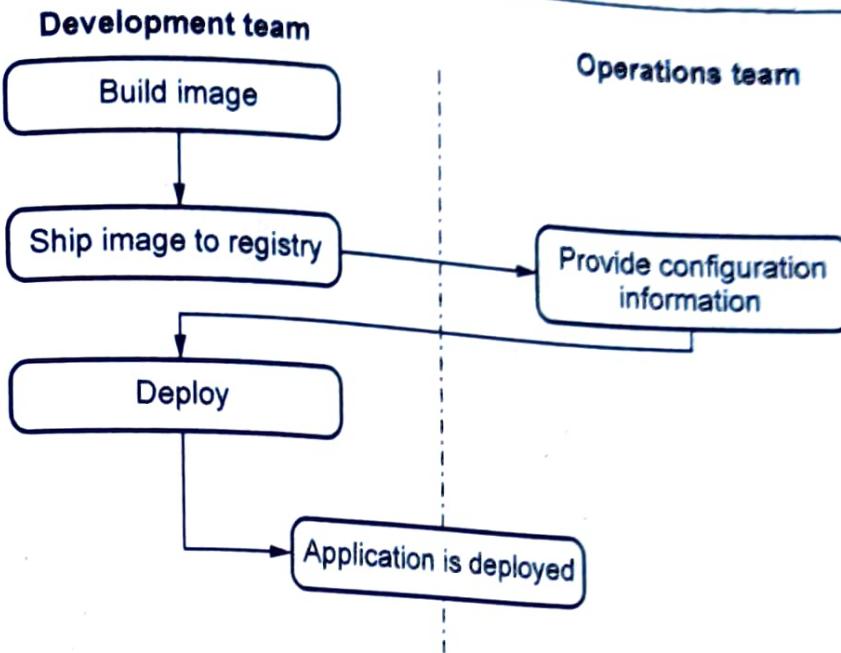


Fig. Q.18.1(b) : Docker deployment workflow

1. Developers build the Docker image and ship it to the registry.
2. Operations engineers provide configuration details to the container and provision resources.
3. Developers trigger deployment

Q.19 Explain briefly Docker client/server model.

Ans. : Fig. Q.19.1 shows Docker client- server model. It consists of two parts : the client and the server. Registry is one more components which stores Docker images and metadata about those images.

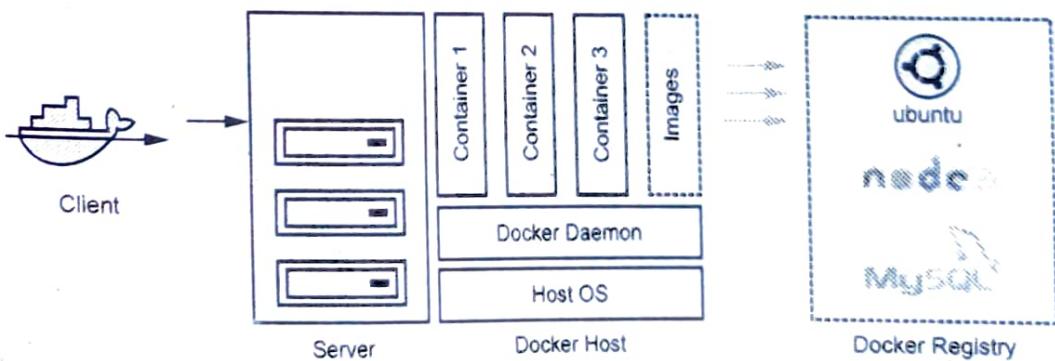


Fig. Q.19.1 : Client-server model

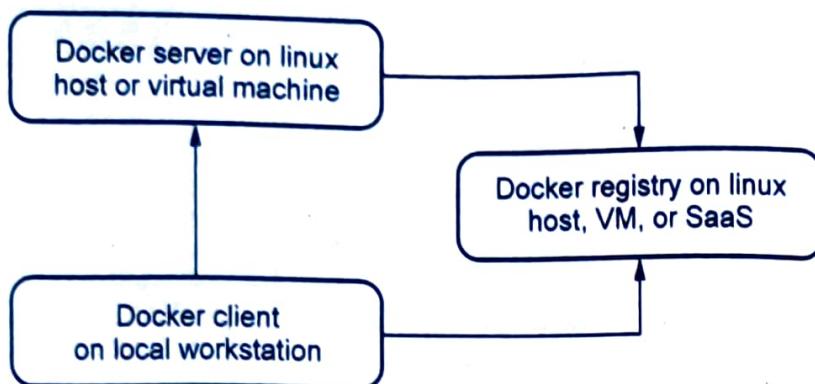


Fig. Q.19.2 : Data flow

- Docker Engine is a client-server based application with following components -
 1. A server which is a continuously running service called a daemon process.
 2. A REST API which interfaces the programs to use talk with the daemon and give instruct it what to do.
 3. A command line interface client.
- Docker client is the primary service using which Docker users communicate with the Docker. When we use commands "docker run" the client sends these commands to dockerd, which execute them out.
- The command used by docker depend on Docker API. In Docker client can interact more than one daemon process.
- The Docker images are building the block of docker or docker image is a read-only template with instructions to create a Docker container. Docker images are the most build part of docker life cycle
- The server does the ongoing work of running and managing your containers, and you use the client to tell the server what to do.
- The Docker daemon can run on any number of servers in the infrastructure, and a single client can address any number of servers.

- Clients drive all of the communication, but Docker servers can talk directly to image registries when told to do so by the client.
- Clients are responsible for directing servers what to do, and servers focus on hosting containerized applications.
- Docker registry keeps Docker images. We can run our private registry.
- When we run the docker pull and docker run commands, the required images are pulled from our configured registry directory.
- Using Docker push command, the image can be uploaded to our configured registry directory.

END... ↗

Time : 1 Hour]

[Maximum Marks : 30]

Instructions to the candidates :

- 1) Solve Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6.
- 2) Figures to the right indicate full marks.
- 3) Assume suitable data, whenever necessary.

Q.1 a) What is cloud computing ? What are the components of cloud computing ? Explain with neat diagram.

(Refer Q.4 and Q.5 of Chapter 1)

[5]

b) What are the advantages and disadvantages of cloud computing ? (Refer Q.8 of Chapter 1)

[5]

OR

Q.2 a) Explain cloud deployment models as per the NIST guidelines.

(Refer Q.19 of Chapter 2)

[6]

b) Explain benefits of SaaS in detail.

(Refer Q.12 of Chapter 1)

[4]

Q.3 a) Draw and explain cloud file system GFS/HDFS.

(Refer Q.4 of Chapter 2)

[5]

b) Explain the working of Google Data Store.

(Refer Q.18 (b) of Chapter 2)

[5]

OR

Q.4 a) How do you Store Big Table tables on GFS/HDFS.

(Refer Q.13 of Chapter 2)

[5]

b) Draw and explain architecture of Amazon Dynamo.

(Refer Q.17 of Chapter 2)

[5]

Q.5 a) Explain different levels of virtualization implementation with neat diagram Also give example of each.

(Refer Q.2 and Q.5 of Chapter 3)

[5]

b) Discuss the disadvantages of hardware level virtualization along with the solutions to overcome.
(Refer Q.17 and Q.18 of Chapter 3)

OR

[5]

Q.6 a) What is hypervisor ? Write a short note on Xen architecture.
(Refer Q.9 of Chapter 3)

[5]

b) Explain full and para virtualization with examples.
(Refer Q.11 of Chapter 3)

[5]

END... ↗

Course 2015

Time : 2 $\frac{1}{2}$ Hours]

[Maximum Marks : 70]

Instructions to the candidates :

- 1) Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8, Q.9 or Q.10.
- 2) Draw neat diagram wherever necessary.
- 3) Assume suitable data, if necessary.
- 4) Figures to the right indicate full marks.

Q.1 a) Explain in detail the benefits and limitations that are offered by the cloud to organizations when they hire cloud services. Also, explain about the security concerns for the organisations while using cloud services.

[5]

Ans. : Refer Q.8 of Chapter - 1

- Cloud computing is a basic technology for sharing of resources on the internet. Virtualization is a central innovation for empowering cloud resource sharing. Confidentiality of data storage is the essential alarm for assurance of data security so cloud computing does not provide robust data privacy.
- All details of data migration to cloud remain hidden from the customers. The problem in cloud computing environments are security of cloud computing.
- Cloud computing involves using internet hosting rather than local servers, to make data and services easily accessible across locations and devices. It is a system where most businesses and people work from more than one computing device.
- Cloud computing can refer to either the applications or services delivered through the internet as well as to the software and hardware that facilitate these services.
- Clouds typically have single security architecture but have many customers with different demands. Cloud security issues may

drive and define how we adopt and deploy cloud computing solutions.

- Highly sensitive data is likely to be on private clouds where organizations have complete control over their security model. Cloud computing is about gracefully losing control while maintaining accountability even if the operational responsibility falls upon one or more third parties.
- In cloud computing environments, it will be necessary to be able to prove the security state of a system, regardless of its location or proximity to other, potentially insecure virtual machines.
- Virtual machines are dynamic. They can quickly be reverted to previous instances, paused and restarted, relatively easily. They can also be readily cloned and seamlessly moved between physical servers.
- Cloud computing servers use the same operating systems, enterprise and web applications as localized virtual machines and physical servers. The ability for an attacker or malware to remotely exploit vulnerabilities in these systems and applications is a significant threat to virtualized cloud computing environments.

b) Write a note on cloud file systems with architecture.

(Refer Q.1 and Q.4 of Chapter - 2)

[5]

OR

Q.2 a) Write a note on multitenant nature of SaaS Solutions. [5]

Ans. : • In order to achieve cost efficiencies in delivering same applications to various sets of users it is a vital and obvious choice that an increasing number of applications are Multi-tenant instead of single tenant.

- Multi-tenant application should be able to satisfy the needs of multiple sub-organizations or sections within the organization (multiple tenants), using the single, shared stake of software and hardware.
- Fig. 1 shows multi-tenant organization.

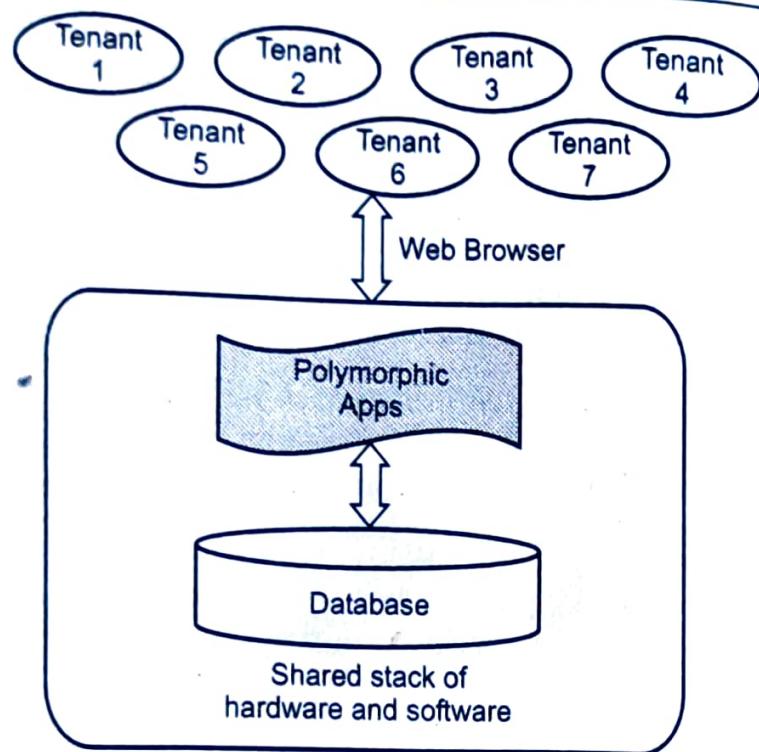


Fig. 1 Multi-tenant organization

- A traditional static application is not capable of addressing unique challenges of multi-tenancy.
- A Multi-tenant application should be dynamic in nature, or polymorphic, to fulfill the specific expectations of various tenants and their users.
- Application components need to be generated at runtime from meta-data-i.e. data about the application itself.
- When tenants create custom application entities (i.e., custom tables), programmatically need to track of Meta-data concerning the entities, their Attribute, relationships, and other entity definition characteristics.
- A few large database tables store the structured and unstructured data separately for all virtual tables, and a set of related, specialized pivot tables in order to maintain data that makes the combined data set fully functional.
- A multi-tenant cloud is a cloud computing architecture that allows customers to share computing resources in a public or

private cloud. Each tenant's data is isolated and remains invisible to other tenants.

- It allows multiple users to work in a software environment at the same time, each with their own separate user interface, resources and services.
- The multitenant application design was created to enable multiple users (tenants) to access the same application logic simultaneously.
- Tenants can individually customize features of the application, such as :
 - User interface** : Tenants can define a specialized look for their application interface.
 - Business process** : Tenants can customize the rules, logic, and workflows of the business processes that are implemented in the application.
 - Data model** : Tenants can extend the data schema of the application to include, exclude, or rename fields in the application data structures.
 - Access control** : Tenants can independently control the access rights for users and groups.
- Benefits of a Multitenancy technology :

- Costs savings** : It yields tremendous economy of scale for the provider so he can offer the service at a lower cost to customers.
- Improved quality, user satisfaction and customer retention** : A multitenant application is one large community hosted by the provider which can gather operational information from the collective user population and make frequent, incremental

Open shared application
and one shared database

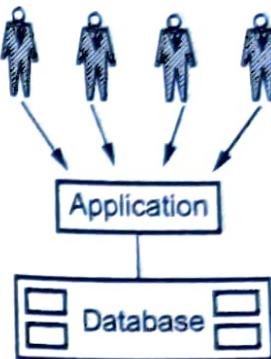


Fig. 2 Multi-tenant technology

improvements to the service that benefit the entire user community at once.

3. **Improved security** : most current enterprise security models are perimeter-based, making them vulnerable to inside attacks.
- Common characteristics of multitenant applications are as follows:
 1. **Usage isolation** - The usage behavior of one tenant does not affect the application availability and performance of other tenants.
 2. **Data security** - Tenants cannot access data that belongs to other tenants.
 3. **Recovery** - Backup and restore procedures are separately executed for the data of each tenant.
 4. **Application upgrade** - Tenants are not negatively affected by the synchronous upgrading of shared software artifacts.
 5. **Scalability** - The application can scale to accommodate increases in usage by existing tenants and/or increases in the number of tenants.
 6. **Metered usage** - Tenants are charged only for the application processing and features that are actually consumed.
 7. **Data tier isolation** - Tenants can have individual databases, tables and schemas isolated from other tenants.
 - b) *Explain open cloud consortium.*

(Refer Q.31 of Chapter - 3)

[5]

- Q.3 a) *Explain the following threats related to cloud computing.* [5]
- i) Disk failure ii) Disgruntled employees iii) Network failure.

Ans. : i) **Disk failure** : Disk drives are mechanical device and they will eventually wear out and fail. All mechanical device have an associated Mean Time Between Failure (MTBF) rating.

ii) **Disgruntled employees** : Disgruntled employees can harm a company by launching a computer virus, changing or deleting files or exposing system password. In some cases, they can cause

significant damage to the company's reputation or to its intellectual property.

iii) **Network failure** : For simple network, the network will remain down until the faulty device or cable is identified and replaced.

b) Explain the solution stack : LAMP. Also, explain how LAPP is considered as more powerful alternative to the more popular LAMP stack.

[5]

Ans. : • Solution stack is a set of different programs or application software that are bundled together in order to produce a desired result or solution.

• This may refer to any collection of unrelated applications taken from various subcomponents working in sequence to present a reliable and fully functioning software solution. Many computer companies like Microsoft and Linux provide different solution stacks to clients.

a) LAMP

• LAMP is an archetypal model of web service stacks, named as an acronym of the names of its original four open-source components : The Linux operating system, the Apache HTTP Server, the MySQL relational database management system (RDBMS), and the PHP programming language.

• The common software components that make up a traditional LAMP stack are :

1. **Linux** : The operating system (OS) makes up our first layer. Linux sets the foundation for the stack model. All other layers run on top of this layer.
2. **Apache** : The second layer consists of web server software, typically Apache Web Server. This layer resides on top of the Linux layer. Web servers are responsible for translating from web browsers to their correct website.
3. **MySQL** : Our third layer is where databases live. MySQL stores details that can be queried by scripting to construct a website. MySQL usually sits on top of the Linux layer alongside Apache/layer 2. In high end configurations, MySQL can be off loaded to a separate host server.

4. **PHP** : Sitting on top of them all is our fourth and final layer. The scripting layer consists of PHP and/or other similar web programming languages. Websites and Web Applications run within this layer.

b) LAPP

- The LAPP stack is an open source web platform that can be used to run dynamic web sites and servers. It is considered by many to be a powerful alternative to the more popular LAMP stack and includes Linux, Apache, PostgreSQL (instead of MySQL) and PHP, Python and Perl.
- LAPP uses Linux as the operating system, Apache as the Web server, PostgreSQL as the RDBMS, and PHP as the object-oriented scripting language. Perl or Python may be substituted for PHP.

OR

Q.4 a) Explain the following

[5]

- i) **CPU virtualization (Refer Q.18 of Chapter - 3)**
- ii) **Memory virtualization (Refer Q.19 of Chapter - 3)**

b) How to improve performance through load balancing ? Explain how load balancing takes help of a server to route traffic to other servers which share the workload.

[5]

Ans. : • Across the web, sites experience a wide range of network traffic requirements. For simple web page, client web browser request an HTML page and then related graphics, CSS from the web server.

- Fig. 3 shows load balancing uses a server to route the traffic to multiple servers.
- Typically, a load balancer sits between the client and the server accepting incoming network and application traffic and distributing the traffic across multiple backend servers using various algorithms.
- By balancing application requests across multiple servers, a load balancer reduces individual server load and prevents any one

application server from becoming a single point of failure, thus improving overall application availability and responsiveness.

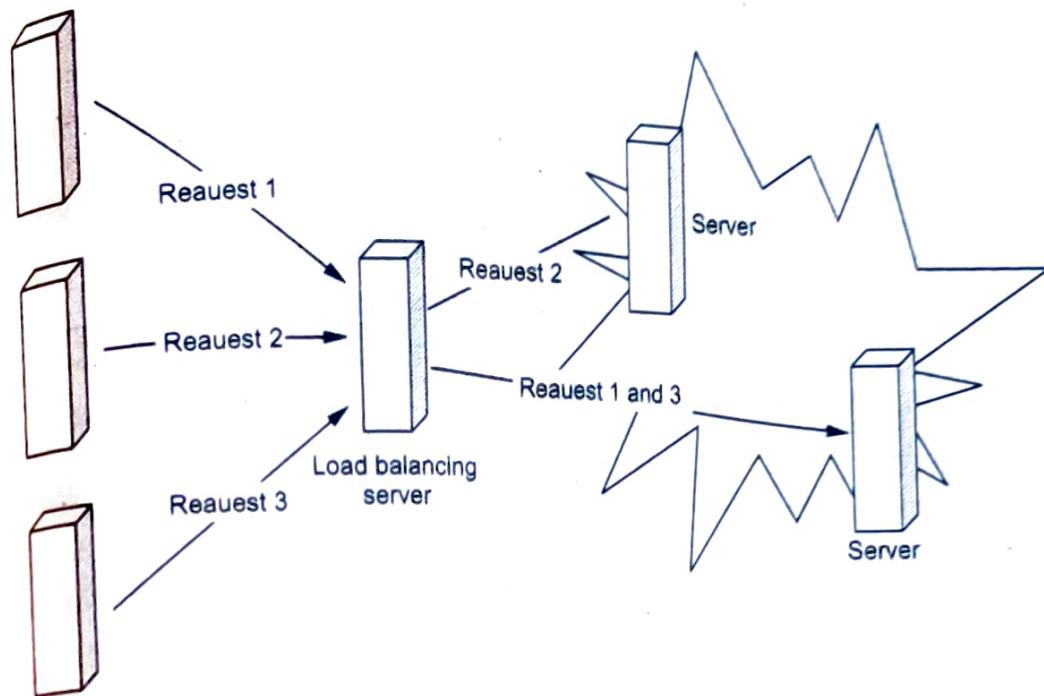


Fig. 3

- Load balancers consider two factors before forwarding a request to a backend server. They will first ensure that the server they choose is actually responding appropriately to requests and then use a pre-configured algorithm to select one from the set of healthy servers.
- Cloud load balancing is the process of distributing workloads and computing resources across one or more servers. This kind of distribution ensures maximum throughput in minimum response time.
- The workload is segregated among two or more servers, hard drives, network interfaces or other computing resources, enabling better resource utilization and system response time. Thus, for a high traffic website, effective use of cloud load balancing can ensure business continuity.
- There is a variety of load balancing methods, which use different algorithms for different needs.

1. Least Connection Method - This method directs traffic to the server with the fewest active connections. This approach is quite useful when there are a large number of persistent client connections which are unevenly distributed between the servers.
2. Least Response Time Method - This algorithm directs traffic to the server with the fewest active connections and the lowest average response time.
3. Least Bandwidth Method - This method selects the server that is currently serving the least amount of traffic measured in megabits per second (Mbps).
4. Round Robin Method - This method cycles through a list of servers and sends each new request to the next server. When it reaches the end of the list, it starts over at the beginning.
5. Weighted Round Robin Method - The weighted round-robin scheduling is designed to better handle servers with different processing capacities. Each server is assigned a weight. Servers with higher weights receive new connections before those with less weights and servers with higher weights get more connections than those with less weights.

Q.5 a) Explain the steps for configuring a server for EC2.

[9]

Ans. : • Let's get started with Amazon Elastic Compute Cloud (Amazon EC2) by launching, connecting to and using a Linux instance. An instance is a virtual server in the AWS cloud. With Amazon EC2, you can setup and configure the operating system and applications that run on your instance.

- When you sign up for AWS, you can get started with Amazon EC2 using the AWS Free Tier.
- The instance is an Amazon EBS-backed instance (meaning that the root volume is an EBS volume). You can either specify the availability zone in which your instance runs or let Amazon EC2 select an availability zone for you. When you launch your instance, you secure it by specifying a key pair and security group. When you connect to your instance, you must specify the private key of the key pair that you specified when launching your instance.

- Various steps to configure Amazon EC2 Linux instance is shown in Fig. 4.

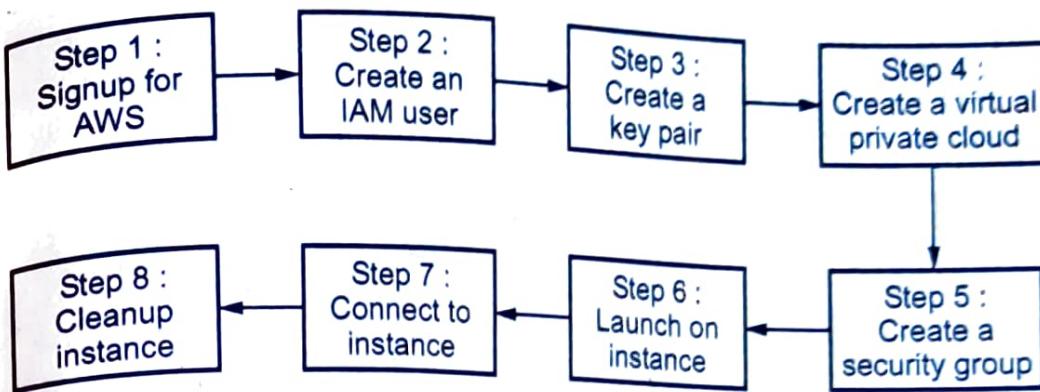


Fig. 4 Steps to signup for EC2

Step 1 : SignUp for AWS

- When you signup for Amazon Web Services (AWS), your AWS account is automatically signed up for all services in AWS, including Amazon EC2. You are charged only for the services that you use.
- With Amazon EC2, you pay only for what you use. If you are a new AWS customer, you can get started with Amazon EC2 for free.

Step 2 : Create an IAM user

- Services in AWS, such as Amazon EC2, require that you provide credentials when you access them, so that the service can determine whether you have permission to access its resources. The console requires your password.
- You can create access keys for your AWS account to access the command line interface or API. However, we don't recommend that you access AWS using the credentials for your AWS account; we recommend that you use AWS Identity and Access Management (IAM) instead.
- Create an IAM user and then add the user to an IAM group with administrative permissions or grant this user administrative permissions. You can then access AWS using a special URL and the credentials for the IAM user. If you signed up for AWS but

have not created an IAM user for yourself, you can create one using the IAM console.

Step 3 : Create a key pair

- AWS uses public-key cryptography to secure the login information for your instance. A Linux instance has no password; you use a key pair to log in to your instance securely. You specify the name of the key pair when you launch your instance, then provide the private key when you log in using SSH.
- If you haven't created a key pair already, you can create one using the Amazon EC2 console. Note that if you plan to launch instances in multiple regions, you'll need to create a key pair in each region.

Step 4 : Create a Virtual Private Cloud (VPC)

- Amazon VPC enables you to launch AWS resources into a virtual network that you've defined, known as a Virtual Private Cloud (VPC). The newer EC2 instance types require that you launch your instances in a VPC. If you have a default VPC, you can skip this section and move to the next task, create a security group. To determine whether you have a default VPC, open the Amazon EC2 console and look for default VPC under account attributes on the dashboard.

Step 5 : Create a security group

- Security groups act as a firewall for associated instances, controlling both inbound and outbound traffic at the instance level. You must add rules to a security group that enable you to connect to your instance from your IP address using SSH. You can also add rules that allow inbound and outbound HTTP and HTTPS access from anywhere. Note that if you plan to launch instances in multiple regions, you'll need to create a security group in each region.

Step 6 : Launch an instance

- You can launch a Linux instance using the AWS management console as described in the following procedure.

1. Open the Amazon EC2 console at <https://console.aws.amazon.com/ec2/>.
2. From the console dashboard, choose Launch Instance.
3. The Choose an Amazon Machine Image (AMI) page displays a list of basic configurations, called Amazon Machine Images (AMIs), that serve as templates for your instance. Select an HVM version of Amazon Linux 2. Notice that these AMIs are marked "Free tier eligible."
4. On the Choose an Instance Type page, you can select the hardware configuration of your instance. Select the t2.micro type, which is selected by default. Notice that this instance type is eligible for the free tier.
5. Choose Review and Launch to let the wizard complete the other configuration settings for you.
6. On the Review Instance Launch page, under security groups, you'll see that the wizard created and selected a security group for you. You can use this security group or alternatively you can select the security group that you created when getting setup using the following steps.
 - a) Choose Edit security groups.
 - b) On the Configure Security Group page, ensure that Select an existing security group is selected.
 - c) Select your security group from the list of existing security groups and then choose Review and Launch.
7. On the Review Instance Launch page, choose Launch.
8. When prompted for a key pair, select Choose an existing key pair, then select the key pair that you created when getting setup. When you are ready, select the acknowledgement check box and then choose launch instances.
9. A confirmation page lets you know that your instance is launching. Choose View Instances to close the confirmation page and return to the console.
10. On the Instances screen, you can view the status of the launch. It takes a short time for an instance to launch. When you launch an instance, its initial state is pending. After the instance starts, its state changes to running and it receives a public DNS name.

11. It can take a few minutes for the instance to be ready so that you can connect to it. Check that your instance has passed its status checks; you can view this information in the status checks column.

Step 7 : Connect to your Instance

Several ways to connect to your Linux instance is shown in Table 1.

Your computer OS	Topic
Linux	Connecting to your Linux instance using SSH.
Windows	Connecting to your Linux instance from Windows using PuTTY.
	Connecting to your Linux instance from Windows using Windows Subsystem for Linux.
Other	Connecting to your Linux instance using MindTerm

Table 1 Ways to connect to Linux Instance

Step 8 : Cleanup your instance

- After you've finished with the instance, you should cleanup by terminating the instance.
- Terminating an instance effectively deletes it; you can't reconnect to an instance after you've terminated it.
- If you launched an instance that is not within the AWS free tier, you'll stop incurring charges for that instance as soon as the instance status changes to shutting down or terminated. If you'd like to keep your instance for later, but not incur charges, you can stop the instance now and then start it again later.
- To terminate your instance following steps can be used :
 - 1) In the navigation pane, choose instances. In the list of instances, select the instance.
 - 2) Choose actions, instance state, terminate.
 - 3) Choose yes, terminate when prompted for confirmation.

- Amazon EC2 shuts down and terminates your instance. After your instance is terminated, it remains visible on the console for a short while and then the entry is deleted.

b) What are AWS load balancing services ? Explain the elastic load balancer and its types with its advantages.
(Refer Q.16 and Q.17 of Chapter - 4)

[8]

OR

Q.6 a) Explain the steps to create an Amazon S3 bucket and managing associated object.

[8]

Ans. : • You can use Amazon S3 to store and retrieve any amount of data at any time, from anywhere on the web. By completing the steps in this quick start guide, you will successfully create a new S3 bucket, add a file to it, retrieve this file, and finally delete it, all within the AWS Free Tier.

- When you sign up for AWS, your AWS account is automatically signed up for all services in AWS, including Amazon S3. If you don't have an AWS account, use the following procedure to create one.

To sign up for AWS

1. Open <https://aws.amazon.com/>, and then choose Create an AWS Account.

Note : If you previously signed in to the AWS Management Console using AWS account root user credentials, choose Sign in to a different account. If you previously signed in to the console using IAM credentials, choose Sign-in using root account credentials. Then choose Create a new AWS account.

2. Follow the online instructions. Part of the sign-up procedure involves receiving a phone call and entering a verification code using the phone keypad.

Step 1 : Create an Amazon S3 Bucket

- First, you need to create an Amazon S3 bucket where you will store your objects.
1. Sign in to the preview version of the AWS Management Console

2. Under Storage & Content Delivery, choose S3 to open the Amazon S3 console.
 3. From the Amazon S3 console dashboard, choose Create Bucket.
 4. In Create a Bucket, type a bucket name in Bucket Name. The bucket name you choose must be globally unique across all existing bucket names in Amazon S3 (that is, across all AWS customers).
 5. In Region, choose Oregon.
 6. Choose Create.
- When Amazon S3 successfully creates your bucket, the console displays your empty bucket in the Buckets pane.

Step 2 : Upload a File to Your Amazon S3 Bucket

- Now that you have created a bucket, you're ready to add an object to it. An object can be any kind of file, a document, a photo, a video, a music file, or other file type.

 1. In the Amazon S3 console, choose the bucket where you want to upload an object, choose Upload, and then choose Add Files.
 2. In the file selection dialog box, find the file that you want to upload, choose it, choose Open and then choose Start Upload.

 - You can watch the progress of the upload in the Transfer pane.

Step 3 : Retrieve a File from Your Amazon S3 Bucket

- Now that you have added an object to a bucket, you can open and view it in a browser. You can also download the object to your local computer.

 1. In the Amazon S3 console, choose your S3 bucket, choose the file that you want to open or download, choose Actions, and then choose Open or Download.
 2. If you are downloading an object, specify where you want to save it.

 - The procedure for saving the object depends on the browser and operating system that you are using.

Step 4 : Delete a File From Your Amazon S3 Bucket

- If you no longer need to store the file you've uploaded to your Amazon S3 bucket, you can delete it.
- Within your S3 bucket, select the file that you want to delete, choose Actions and then choose Delete.
- In the confirmation message, choose OK.

b) What is an amazon EBS snapshot ? Give steps to create EBS snapshot. (Refer Q.13 of Chapter - 4) [9]

Q.7 a) Describe cloudlets for mobile cloud computing with neat diagram and differentiate between cloudlets and clouds.

(Refer Q.10 and Q.11 of Chapter - 5) [8]

b) Write a note on innovative application of IoT.

(Refer Q.28 of Chapter - 5) [9]

OR

Q.8 a) Explain performance metrics for HPC / HTC systems.

(Refer Q.15 of Chapter - 5) [9]

b) Explain the Cyber Physical System (CPS). Explain CPS components. (Refer Q.29 of Chapter - 5) [8]

Q.9 a) Explain the client server architecture of docker ? What are network ports and unix sockets ? (Refer Q.19 of Chapter - 6) [8]

b) What is energy aware cloud computing ? Explain in detail. (Refer Q.13 of Chapter - 6) [8]

OR

Q.10 a) What is impact of cloud on operating systems in future ?

(Refer Q.1 of Chapter - 6) [8]

b) Explain docker with respect to process simplification, Board support and adoption, architecture. (Refer Q.18 of Chapter - 6) [8]

DECEMBER-2019 [END SEM] [5670] - 717

Solved Paper**Course 2015****Time : 2 $\frac{1}{2}$ Hours]****[Maximum Marks : 70]****Q.1 a) Write note on identity management as a service (IDaaS).****(Refer Q.20 of Chapter - 1)****[7]****b) Write a note on different cloud storage providers.****(Refer Q.18 of Chapter - 2)****[7]****c) Write a note on solution stacks : LAMP and LAPP.****(Refer Q.3 (b) of May - 2019)****[6]****OR****Q.2 a) Explain the term "Limited Portability between Cloud Providers".****[7]****Ans. :** • Portability is a measure used to determine the impact of moving cloud consumer IT resources and data between clouds.**• Cloud portability is the ability to move applications and data from one cloud computing environment to another with minimal disruption.****• Cloud portability enables the migration of cloud services from one cloud provider to another or between a public cloud and a private cloud.****• A cloud consumer's application has a decreased level of portability when assessing a potential migration from cloud A to cloud B, because the cloud provider of cloud B does not support the same security technologies as cloud A.****• Cloud data portability is the ability to easily transfer data from one cloud service to another cloud service or between a cloud service customer's system and a cloud's service.****• It is achieved by the source service supplying the data in exactly the format that is accepted by the target service. But, even if the formats do not match, the transformation between them may be simple and straightforward to achieve with commonly available tools.****• Cloud application portability is the ability to easily transfer an application or application components from one cloud service to a**

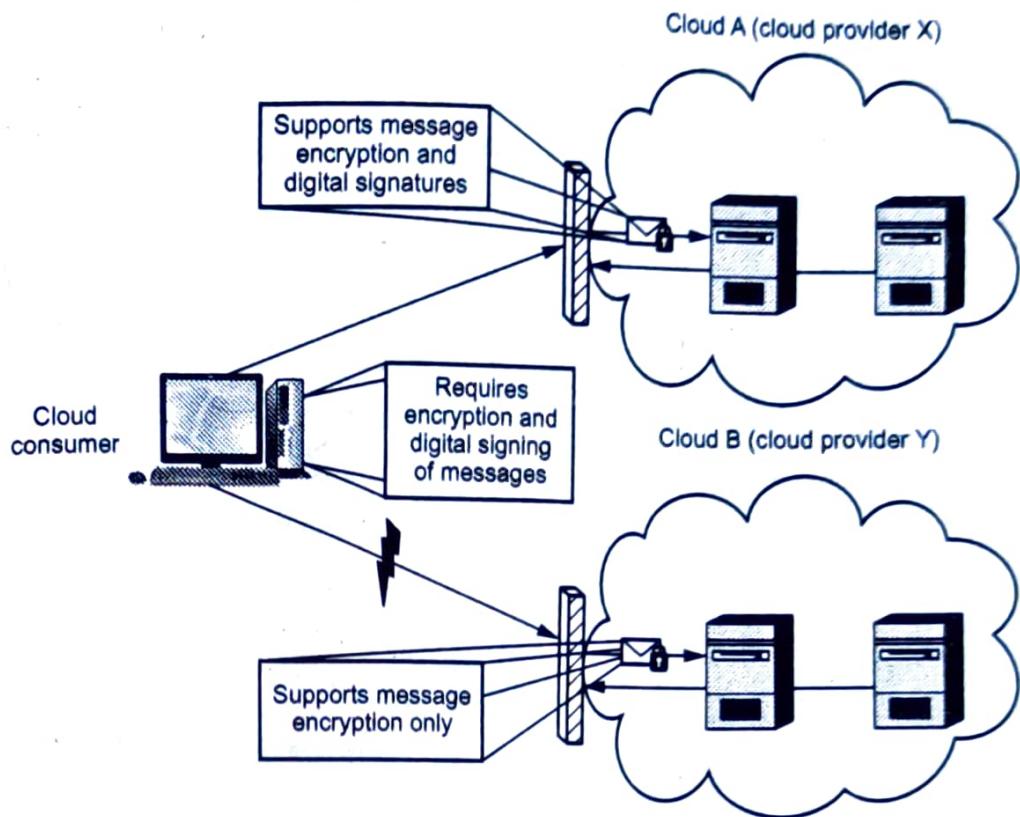


Fig. 1 Cloud portability

comparable cloud service or from a cloud service customer's system to a cloud service.

- The key is the ease of moving the application or application components. The application may require recompiling or relinking for the target cloud service, but it should not be necessary to make significant changes to the application code.

b) Explain the storage model of bigtable.

(Refer Q.11 of Chapter - 2)

[7]

c) Explain open virtualization format ?

(Refer Q.32 of Chapter - 3)

[6]

Q.3 a) Explain "Snap Shotting an EBS Volume and Increasing Performance" ? (Refer Q.9 of Chapter - 4) [9]

b) Write a note on services offered by amazon ?

(Refer Q.1 of Chapter - 4)

[8]

OR

Q.4 a) Explain the steps to create an amazon S3 bucket and managing associated objects ? (Refer Q.6 (a) of May-2019) [9]

b) Explain steps to configure server for EC2 ?
 (Refer Q.5 (a) of May-2019) [8]

Q.5 a) Explain graph theoretic analysis of social network ?
 (Refer Q.34, Chapter - 5) [9]

b) Write a note on supply chain management, retailing ?
 (Refer Q.26, Chapter - 5) [8]

OR

Q.6 a) Explain RFID tags and device components ?
 (Refer Q.18 of Chapter - 5) [9]

b) Write a note on performance metrics for HPC/HTC systems ?
 (Refer Q.15 of Chapter - 5) [8]

Q.7 a) Explain immutable infrastructure, workflow, building application in docker ? (Refer Q.18 of Chapter - 6) [8]

Ans. : • Immutable infrastructure is an approach to managing services and software deployments on IT resources wherein components are replaced rather than changed. An application or services is effectively redeployed each time any change occurs.

- Docker containers were designed to be immutable.
- Another benefit to using docker containers to implement your immutable infrastructure, is that it helps manage data persistence or stateful components, like an application's database. Stateful components cannot simply be destroyed and redeployed using a server image.

b) Explain traditional as well as docker deployment workflow, client server architecture of docker ?
 (Refer Q.18 and Q.19 of Chapter - 6) [8]

OR

Q.8 a) Write a notes on energy aware cloud computing, energy efficiency in cloud computing ?
 (Refer Q.13 and Q.14 of Chapter - 6) [8]

b) Explain the comet cloud architecture with diagram.
 (Refer Q.10 of Chapter - 6) [8]

END... ↗

