CLOUD COMPUTING AND GRID SYSTEMS – (SEMESTER IV)

TOTAL MARKS: 50 | DURATION: 2 HOURS

PART A (7 x 2 = 14 Marks)

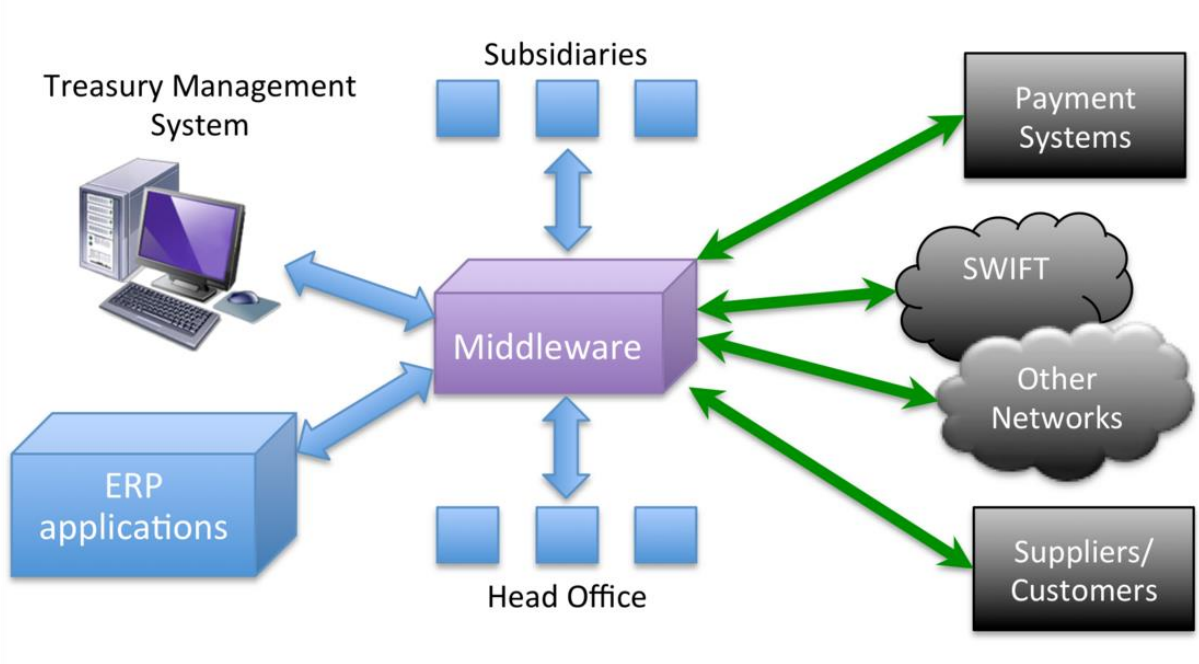
1. **List the applications of grid computing. (reference ya mwalimu**

Grid computing refer to a form of distributed computing where multiple computers, often geographically dispersed, are connected and work together to solve a single, large-scale problem.

- High-energy physics simulations (e.g., CERN)
- Climate/weather modeling
- Genome sequencing and biomedical research
- Financial market simulations
- Engineering design and analysis (e.g., fluid dynamics)

2. **Mention any four Middleware resource managers. (reference mwalimu page 15 unit 1)**

What is middleware?

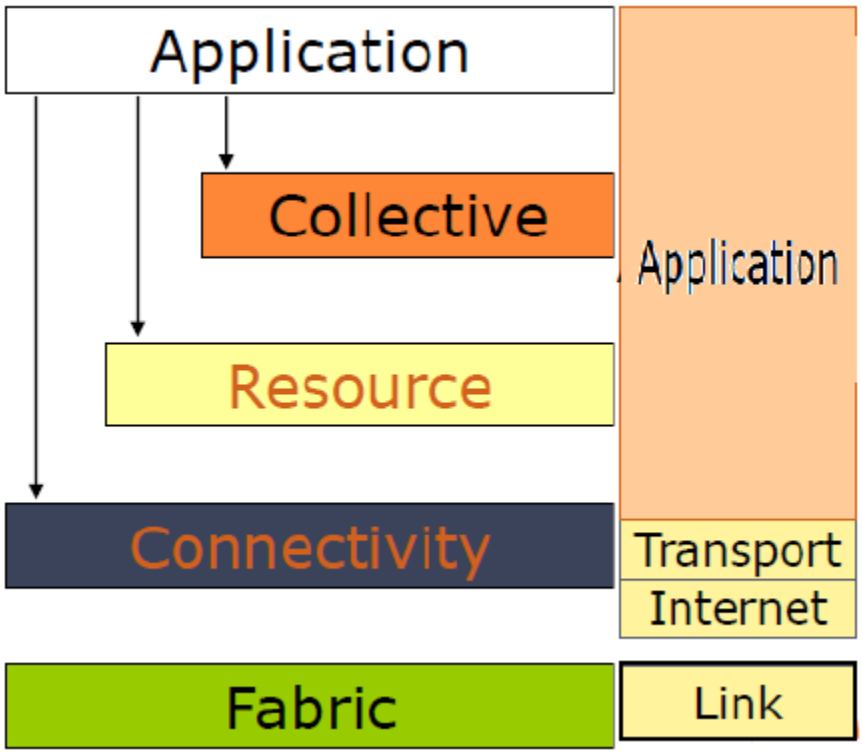


- Globus Toolkit
- UNICORE (Uniform Interface to Computing Resources)

- gLite
- ARC (Advanced Resource Connector)
-

3. **Explain the importance of layered grid architecture.**

   Layered grid architecture simplifies **design, integration, and management** by dividing responsibilities into logical layers:



1. **Fabric Layer:** Physical resources (CPU, memory, storage)
2. **Connectivity Layer:** Communication protocols
3. **Resource Layer:** Resource allocation & discovery
4. **Collective Layer:** Coordinates multiple resources
5. **Application Layer:** User-facing applications

   This structure improves **interoperability**, **scalability**, and **maintenance**.

4. Mention the application of Kubernetes? Kubernetes is used to **automate deployment, scaling, and management** of containerized applications.

- Manages clusters of containers (Docker, etc.)
- Ensures fault tolerance and load balancing
- Enables rolling updates and rollback
-

5. Name the categories of specific cloud provisioning.

- **User self-service provisioning**
- **Advanced provisioning**
- **Dynamic provisioning**
- **Policy-based provisioning**

6. List the actors and roles of a cloud ecosystem.

A cloud ecosystem refers to the interconnected network of cloud computing services, solutions, technologies, and providers that enable the delivery, management, and consumption of cloud resources.

- **Cloud Provider:** Supplies infrastructure/services
- **Cloud Consumer:** Uses cloud services
- **Cloud Broker:** Manages service use across providers
- **Cloud Auditor:** Evaluates compliance/security
- **Cloud Carrier:** Network connectivity provider

7. What are the major design goals of cloud architecture?

- Scalability
- Availability and Reliability
- Security and Compliance
- Flexibility and Modularity
- Cost Optimization
- Multi-tenancy Support

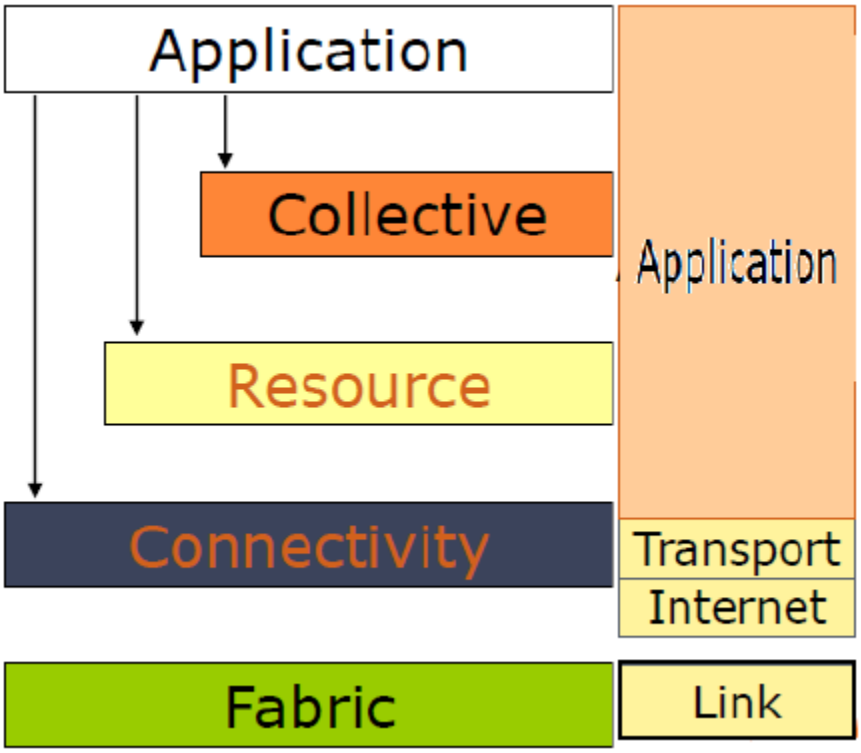
PART B (3 x 4 = 12 Marks)

8(a). Expound the Layered Grid Architecture. (reference mwalimu 47 unit 1)

A layered grid architecture breaks the system into modular components:

1. **Fabric Layer:** Raw hardware – computers, storage
2. **Connectivity Layer:** Ensures secure communication (SSL, GSI)
3. **Resource Layer:** Manages and allocates resources (CPU, I/O)
4. **Collective Layer:** Coordinates global resource use across grids

5. **Application Layer:** User programs interact with the grid



6.

Clear separation of concerns improves interoperability.

OR

8(b). List any four comparisons between computational and data grids with an example. (reference mwalimu page 20)

Types of Grids

Computational Grid: Focuses on sharing processing power.

Data Grid: Emphasizes sharing and managing large sets of distributed data.

Collaboration Grid: Enables scientists or researchers across different locations to collaborate on a project, pooling their resources and expertise.

Feature	Computational Grid	Data Grid
Purpose	High-performance computing	Distributed data access/storage
Example	Protein folding simulation	astronomical observations.
Data Priority	Temporary, task-specific	Persistent and reusable
Tools	MPI, Globus	SRB, GridFTP

9(a). Explain briefly about the NIST characteristics of cloud computing? According to NIST (National Institute of Standards and Technology), the five essential characteristics of cloud are:

1. **On-Demand Self-Service**
2. **Broad Network Access**
3. **Resource Pooling** (shared via multitenancy)
4. **Rapid Elasticity** (scale up/down quickly)
5. **Measured Service** (metered billing & pay as you go)

OR

9(b). Discuss the key technologies that are fundamental to network-based systems.

- **Virtualization:** Creation of virtual version of computing from a single physical machine
- **Networking Protocols** (TCP/IP)
- **Networking Devices (Routers**
- **Middleware:** Facilitates resource abstraction
- **Wireless Technologies**

10(a). Mention any four examples of SAAS & PAAS service models.

SaaS (Software as a Service):

- Gmail
- Google Docs
- Google drive
- OsIM

PaaS (Platform as a Service):

- Google App Engine
- Heroku
- Microsoft Azure App Services
- Red Hat OpenShift

OR

10(b). Write about the design challenges of cloud computing.

- **Security and Privacy**: Protect data in multitenant environments
- **Latency**: Real-time performance in distributed systems
- **Interoperability**: Vendor lock-in and system integration
- **Data Management**: Huge volume across regions

- **Resource Allocation**: Elastic scaling without overprovisioning

---

PART C (2 x 12 = 24 Marks)

11(a). Create a virtual organization as "Cloud Computing" and explain their concepts, working and advantages.

A **virtual organization** in cloud is a dynamic group of users/services collaborating across organizational boundaries using cloud infrastructure for shared common goal.

Concept:

- Users from different geographies collaborate on shared cloud services.

Working:

- Resources are provisioned via cloud APIs
- Identity & access managed using IAM tools
- Services are deployed in multi-region VMs or containers

Advantages:

- Fast deployment & scalability
- Cost-effective collaboration
- Platform independence

OR

11(b). Discuss the working of Grid Computing in detail. Grid computing connects geographically distributed resources to solve large-scale problems.

How it works:

- Breaks complex tasks into smaller chunks
- Distributes jobs to idle computers in the grid
- Middleware (like Globus) manages job scheduling, communication, and data

Applications:

- Scientific research (climate, physics)
- Data-intensive simulations (earthquake modeling)

Key Benefit: Harnesses **idle computing power** from many sources.

12(a). Select any one cloud entity/stakeholder you like to perform among the NIST reference architecture in future? Discuss and defend the scenario with examples.

Chosen Role: Cloud Auditor

Why:

- Ensures **security**, **privacy**, and **compliance** in cloud use
- Vital for financial, healthcare, and government sectors

Example:

- Auditing AWS/GCP infrastructure to ensure **HIPAA** compliance for a hospital
- Verifying GDPR compliance of European SaaS companies

Skills Required:

- Knowledge of cloud platforms (AWS, Azure)
- Familiarity with standards like ISO 27001, NIST 800-53

OR

12(b). Explain the concept of generic cloud architecture and cloud-enabling technologies in hardware, software, and networking.

Generic Cloud Architecture Includes:

- **Infrastructure Layer:** Hardware (servers, storage, networking)
- **Platform Layer:** OS, runtime, middleware
- **Application Layer:** SaaS, APIs, services
- **Collective layer**
- **Communication Layer**

Cloud-Enabling Technologies:

- **Hardware:** Multi-core processors, SSDs, network switches
- **Software:** Virtualization tools (VMware, KVM), Containers (Docker)
- **Networking:** SDN (Software-Defined Networking), VPNs, high-speed interconnects

ELCS 0003 – GRID & CLOUD COMPUTING (JUNE 2025)

DEGREE CONTINUOUS ASSESSMENT TEST – II | YEAR: III | TOTAL MARKS: 50

PART A (7 x 2 = 14 Marks)

1. Write about federation clouds.

Federated clouds are a **collaborative network of cloud providers** that interoperate to provide resource sharing, load balancing, and service integration. Users benefit from cross-provider data migration, SLA enforcement, and seamless service access.

2. Discuss the cloud that Netflix is utilizing?

Netflix utilizes **Amazon Web Services (AWS)** to stream millions of hours of video content daily. AWS provides Netflix with:

- Global scalability (via AWS regions and edge locations)
- Reliability with EC2(for computer), S3(storage), Lambda, DynamoDB
- Auto-scaling and performance monitoring (CloudWatch(observation)

3. **What are the Hadoop YARN and Hadoop common?(reference page 26)**

   The Hadoop ecosystem is a collection of open-source tools and frameworks built around the core Apache Hadoop project, designed for storing and processing vast amounts of data across distributed computer clusters.

- **Hadoop Common:** Set of shared utilities and libraries used by other Hadoop modules.
- **Hadoop YARN (Yet Another Resource Negotiator):** Responsible for resource management and job scheduling within Hadoop clusters.

4. Provide a description of the level of abstraction.
Levels of abstraction hide the complexity of lower-level operations. In cloud computing:

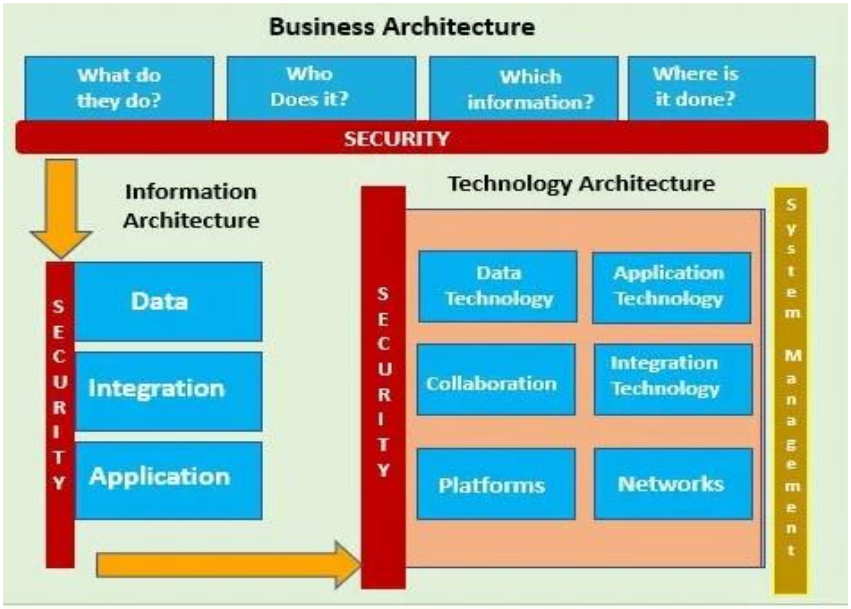
- **Hardware abstraction**: Virtualization (e.g., VMs, containers)
- **Platform abstraction**: PaaS hides OS/runtime from developers
- **Service abstraction**: Users interact with APIs, not raw infrastructure

5. Discuss about the CloudSim framework. (reference ya mwalimu page 64 unit 4)

CloudSim is a **simulation toolkit** for modeling and testing cloud environments. It allows researchers to:

- Simulate VM provisioning, task scheduling, and data center behavior
- Test energy efficiency, network latency, and SLA violations
- Prototype new cloud algorithms before real deployment

6. **Draw the structure of security architecture.**
   The structure typically includes:



- **Identity & Access Management (IAM)**
- **Data Protection & Encryption**
- **Network Security (firewalls, intrusion detection)**
- **Application Security (patching, code review)**
- **Monitoring & Auditing Tools**

7. Define least privilege principle. (reference ya mwalimu page 50)

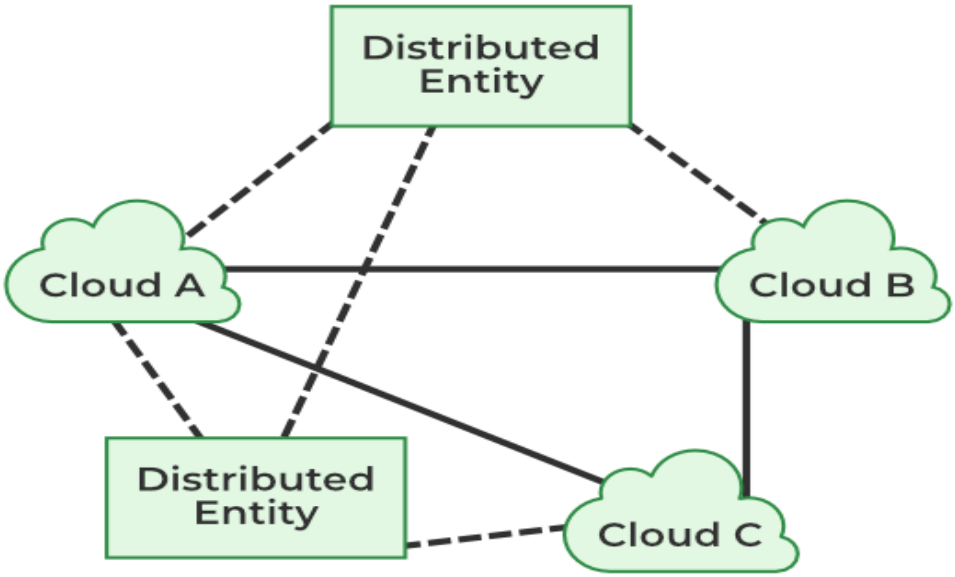
.

- Is the method of Providing users with only the minimum level of access necessary to perform their job functions, minimizing potential damage in case of a security breach.

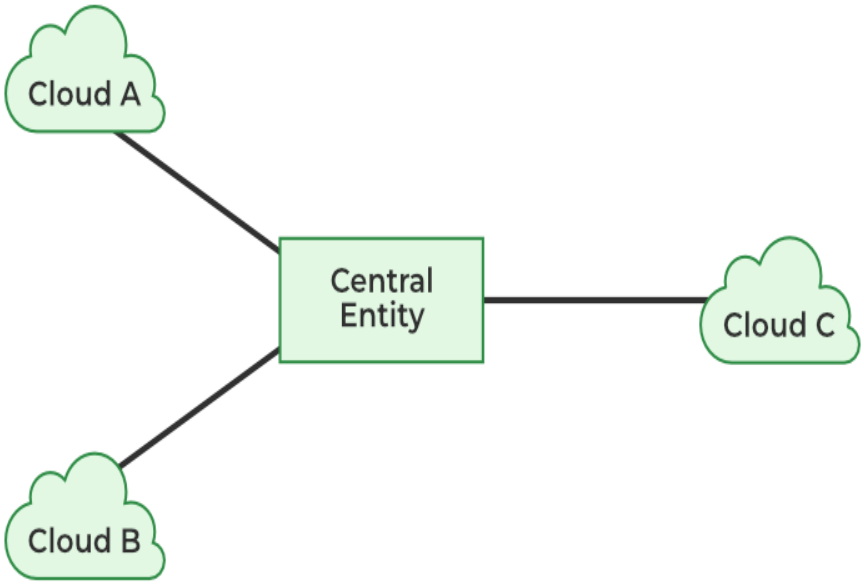
PART B (3 x 4 = 12 Marks)

8(a). Discuss the topologies used in inter-cloud architecture.
Topologies describe how different clouds interconnect:

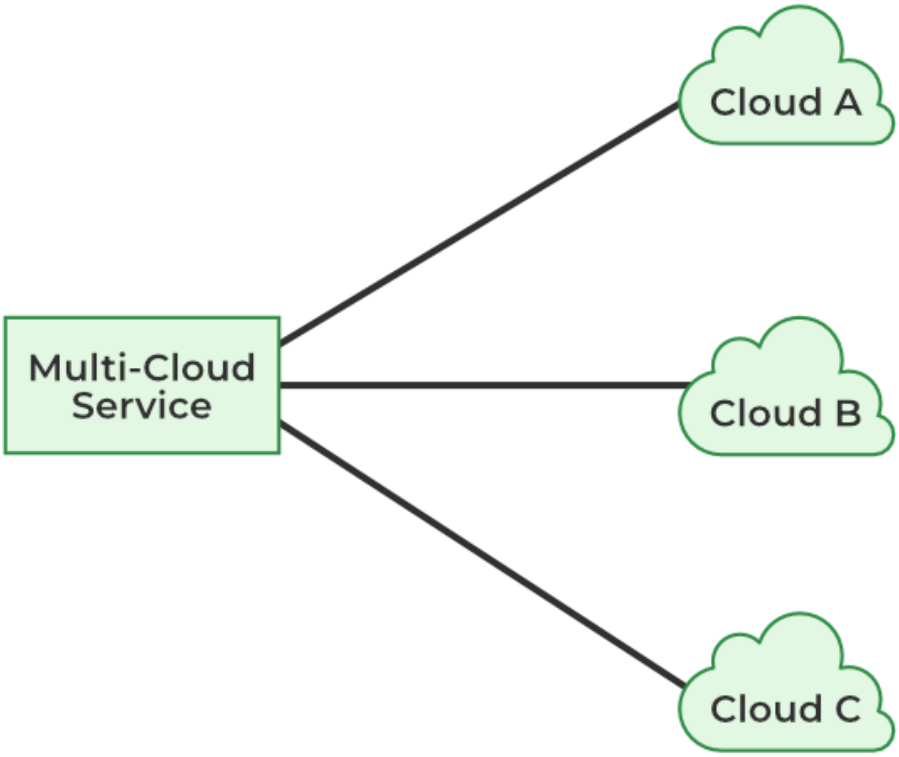
1. **Hybrid Topology:** Combination of private/public cloud with seamless integration (common in enterprises)
2. **Peer to Peer Federation:**



3. **Centralized**:



4.
5. **Mult-cloud**:



6.

OR

8(b). Differentiate CloudSim and OpenStack platforms.

Feature	CloudSim	OpenStack
Purpose	Simulation Toolkit	Real Cloud OS Platform
Deployment	Not deployed – simulated	Real infrastructure environment
Use Case	Research/algorithm testing	Actual service provisioning
Programming	Java-based toolkit	Python-based cloud suite

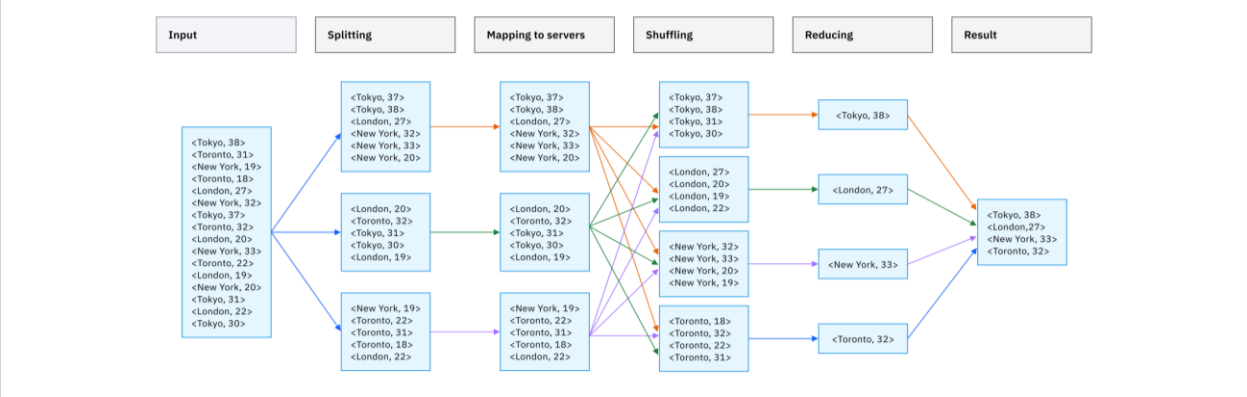
9(a). Describe the working process of MapReduce model with an example.

MapReduce is a programming model that uses parallel processing to speed large-scale data processing.
MapReduce processes large data sets by:

1. **Map Phase:** Divides tasks into key-value pairs (e.g., words in a doc)
2. **Shuffle & Sort Phase:** Groups values by keys
3. **Reduce Phase:** Aggregates or summarizes data

Example:

Tokyo Example:



OR

9(b). Explain GAE and AWS in detail.

- **Google App Engine (GAE):** PaaS that lets developers build and deploy scalable apps on Google infrastructure. Auto-scaling, supports multiple languages (Python, Go, Java).
- **AWS (Amazon Web Services):** IaaS and PaaS offering compute (EC2), storage (S3), databases (RDS, DynamoDB), and AI services. Highly flexible and globally distributed.

Comparison of Google App Engine and Amazon AWS

Feature	Google App Engine	Amazon AWS
Service Type	PaaS	IaaS + PaaS
Scalability	Automatic	Elastic (configurable)
Language Support	Limited	Extensive
Flexibility	Limited customization	Highly flexible
Ease of Use	Simplified	Requires more setup and management
Best For	Small to medium applications	Applications of all sizes

-

10(a). Draw the IAM architecture and explain their components.
IAM (Identity and Access Management) architecture includes:

1. **Users & Groups** – End-users, roles
2. **Permissions**– JSON-based access rules
3. **Authentication** – Login methods (MFA, SSO)
4. **Authorization** – Determines what a user can access
5. **Audit Logs** – Tracks all identity activity for compliance

OR

10(b). Discuss about VMware ESXi in detail.
VMware ESXi is a **type-1 hypervisor** used to run multiple virtual machines on a single server without a host OS.

- Supports VM provisioning, migration (vMotion), and clustering
- Manages CPU, memory, network for each VM
- Backbone for private cloud setups

PART C (2 x 12 = 24 Marks)

11(a). Discuss the key steps involved in resource provisioning and cloud exchange platforms. (REFERENCE PAGE 33 unIT 3)
Steps:

1. **Resource identification** – Identify available resources
2. **Resource Allocation** – Based on policy, pricing, QoS(Quality of Servic)

3. **Confirgutation management** – Provision VMs, containers, storage
4. **Deployment strategy** – Track resource usage
5. **Automatic deployment** – Auto-adjust resources (scale up/down)
6. Monitoring and o**p**timization – Free resources after use
7. Security measures

Cloud Exchange Platforms: Allow resource trading between providers and consumers with SLA, dynamic pricing.

OR

11(b). Compare the paradigms of parallel and distributed programming with suitable diagrams.

Feature	Parallel Programming	Distributed Programming
Memory	Shared	Distributed
Location	Single machine	Multiple machines
Speed	Faster (lower latency)	Slower (network delays)
Example Language	CUDA	RPC(remote procedure call)

Diagram:

- Parallel → CPUs in same machine
- Distributed → Nodes in a network

12(a). Discuss about the risk management structure and their importance in detail.

- **Risk Identification** – List possible threats (e.g., data loss)
- **Risk Assessment** – Probability × Impact analysis
- **Mitigation Planning (control)** – Encryption, backup, firewall
- **Monitoring & Review (review controls)** – Regular audits, incident response

Importance: Prevent service outages, data breaches, ensure compliance

OR

12(b). Compare the various types and aspects of security with an example.

Security Type	Description	Example
Physical Security	Protect hardware	Biometric locks, env monitors
Network Security	Protect data in transition	Firewalls, VPNs
Application Security	Prevent code vulnerabilities	Input validation
Data Security	Protect data at rest	Encryption, access control
Identity and access management (IAM) Security	Ensure user authenticity	IAM, MFA

Aspects involve implementing controls like encryption, firewalls, intrusion detection systems, and regular security assessments to mitigate risks and ensure business continuity.