Shree Rahul Education Society's (Regd.)
SHREE L. R. TIWARI COLLEGE OF ENGINEERING
Kanakia Park, Near Commissioner's Bungalow, Mira Road (East), Thane 401107, Maharashtra
(Approved by AICTE, Govt. of Maharashtra & Affiliated to University of Mumbai)
Tel. No.: 022-65295732 / 022-65142376 | Email: slrtce@rahuleducation.com | Website: www.slrtce.in

DEPARTMENT OF COMPUTER ENGINEERING

CSL605 Cloud Computing

Sixth Semester, 2024-2025 (Even Semester)

Name of Student :

Roll No. :

Division :

Assignment No. 1

Outcome : CSL605.5- Explore various commercially available cloud services and recommend the appropriate one for the given application.

Task :

Date of Assignment :

Date of Submission :

Particulars	Max. Marks	Marks Obtained
Timely Submission (TS)	**3**	
Originality of material (OM)	**3**	
Neatness (NT)	**3**	
Innovative Solution (IS)	**3**	
Total	**12**	

Grades – Meet Expectations (3 Marks), Moderate Expectations (2 Marks), Below Expectations (1 Mark)

Checked and Verified by

Name of Faculty : Pravin Jangid

Signature :

Date :

Assignment No. 1

Sub: **Cloud Computing** Sem: **VI**

Branch: **CS**

1. Comparative study of different computing

technologies [Parallel, Distributed, Cluster, Grid, Quantum)

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1. Parallel Computing

Definition

Parallel computing involves the simultaneous use of multiple compute resources to solve a computational problem. The problem is divided into smaller sub-problems, which are solved concurrently using multiple processors within a single system.

Architecture

- Shared memory (e.g., multi-core processors)
- Distributed memory using message passing (e.g., MPI)

Advantages

- Faster execution for tasks that can be parallelized
- Efficient utilization of hardware resources
- Suitable for real-time and compute-intensive applications

Disadvantages

- Difficult to design parallel algorithms
- Overhead due to synchronization and communication between tasks
- Not all problems can be parallelized

Applications

- Scientific simulations
- Image and video processing
- Real-time systems

2. Distributed Computing

Definition

Distributed computing refers to a model where computational tasks are divided among multiple independent systems connected via a network. These systems work collaboratively to achieve a common goal.

Architecture

- Client-server architecture
- Peer-to-peer networks
- Middleware-based systems for communication and coordination

Advantages

- Scalability across geographic regions
- Cost-effective due to the use of commodity hardware
- Improved fault tolerance through redundancy

Disadvantages

- Complex synchronization and coordination
- Vulnerability to network latency and failures
- Difficult to ensure consistency across systems

Applications

- Distributed databases
- Cloud services
- Search engines and large-scale web applications

3. Cluster Computing

Definition

Cluster computing involves a group of interconnected computers (nodes), typically in the same location, working together as a single system. These systems are often homogeneous and connected via a high-speed local area network (LAN).

Architecture

- Homogeneous nodes
- Centralized or decentralized coordination
- Load balancing mechanisms

Advantages

- High performance and availability
- Easier maintenance compared to supercomputers
- Better utilization of local computing resources

Disadvantages

- Requires consistent configuration across nodes
- Limited by network bandwidth and local infrastructure
- Less flexible than grid computing

Applications

- High-performance computing (HPC)
- Scientific research
- Financial modeling

4. Grid Computing

Definition

Grid computing aggregates resources from multiple geographically distributed systems to form a virtual supercomputer. It enables the sharing of processing power, storage, and data across a

network of heterogeneous systems.

Architecture

- Distributed and heterogeneous systems
- Middleware for resource management and job scheduling
- Security and authentication mechanisms

Advantages

- Large-scale resource utilization
- Flexibility and scalability
- Cost-effective use of idle resources

Disadvantages

- Complex infrastructure setup and management
- Security and privacy concerns
- Variable performance due to resource diversity

Applications

- Scientific research (e.g., CERN)
- Climate modeling
- Bioinformatics and genome analysis

5. Quantum Computing

Definition

Quantum computing leverages principles of quantum mechanics, such as superposition and entanglement, to perform computations. Unlike classical bits, quantum bits (qubits) can represent multiple states simultaneously.

Architecture

- Qubits and quantum gates
- Quantum entanglement and superposition

- Requires specialized hardware (e.g., superconducting circuits)

Advantages

- Potential for exponential speedup in specific problems
- Suitable for cryptography, optimization, and quantum simulations
- Offers new computational paradigms

Disadvantages

- Still in experimental stages
- Requires extreme conditions (e.g., very low temperatures)
- Difficult to program and maintain stability

Applications

- Cryptographic algorithms
- Drug discovery and material science
- Machine learning and AI

2. How does containerization differ from hypervisor-based virtualization, and what are the specific use cases where each technique excels?"

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Containerization and **hypervisor-based virtualization** are both technologies used to deploy and manage applications efficiently, but they differ significantly in **architecture, performance, and use cases**. Here's a detailed comparison and explanation of where each excels:

1. Core Concept & Architecture

Containerization

- **Definition**: Containers are lightweight, standalone executable packages that include everything needed to run a piece of software—code, runtime, system tools, libraries, and settings.
- **Architecture**: Containers share the **host OS kernel**. Each container runs as an isolated user-space instance.

- **Example Technologies**: Docker, Podman, Kubernetes (for orchestration)

Hypervisor-based Virtualization

- **Definition**: Virtual machines (VMs) emulate entire hardware systems, including their own OS, on top of a host system.
- **Architecture**:
    - **Type 1 (Bare-metal)**: Hypervisor runs directly on hardware (e.g., VMware ESXi, Microsoft Hyper-V)
    - **Type 2 (Hosted)**: Hypervisor runs on top of an existing OS (e.g., VirtualBox, VMware Workstation)
- **Example Technologies**: VMware, KVM, Xen, VirtualBox

2. Key Differences

Feature	Containerization	Hypervisor-based Virtualization
Isolation Level	Process-level (shares OS kernel)	Hardware-level (separate OS per VM)
Overhead	Minimal	Higher (each VM has full OS)
Boot Time	Seconds	Minutes
Resource Efficiency	High (small footprint)	Lower (more overhead)
Security Isolation	Moderate (depends on kernel security)	Strong (full OS isolation)
Portability	Very high (works across OSs)	Lower (OS and hardware dependent)
Use of Host Kernel	Shared	Not shared

3. Use Cases Where Each Excels

Containerization – Best Suited For:

1. **Microservices Architecture**
    a. Fast startup and shutdown for deploying small, independent services.
2. **DevOps & CI/CD Pipelines**
    a. Easy to integrate, deploy, and roll back applications.
3. **Cloud-native Applications**

a. Optimized for Kubernetes and cloud platforms (AWS, GCP, Azure).

4. **Application Isolation**

    a. Run multiple versions of apps or dependencies without OS overhead.

5. **Scalability**

    a. Spin up hundreds/thousands of container instances efficiently.

Example: Deploying a stateless Node.js app with its dependencies in a container, orchestrated via Kubernetes.

3. "Compare and contrast the three primary service models in cloud computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Provide examples of each model and discuss their respective benefits, limitations, and suitable use cases."

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1. Overview of Cloud Service Models

Service Model	Description	Control Level
IaaS	Provides virtualized computing resources over the internet	Highest
PaaS	Offers a development platform and environment in the cloud	Moderate
SaaS	Delivers software applications over the internet on-demand	Lowest

2. Infrastructure as a Service (IaaS)

Definition

IaaS provides **virtualized hardware resources** such as compute, storage, and networking over the internet. Users are responsible for managing the OS, middleware, and applications.

Examples

- **Amazon Web Services (AWS EC2)**
- **Microsoft Azure Virtual Machines**
- **Google Compute Engine**

Benefits

- High flexibility and scalability
- Cost-effective (pay-as-you-go model)
- Full control over the infrastructure
- Ideal for temporary or unpredictable workloads

Limitations

- Requires technical expertise to manage
- Users are responsible for patching and system maintenance
- Security and compliance are user responsibilities

Suitable Use Cases

- Hosting websites and applications with custom configurations
- Development and testing environments
- Disaster recovery solutions
- Large-scale data processing

3. Platform as a Service (PaaS)

Definition

PaaS offers a **platform and environment** for developers to build, test, and deploy applications without worrying about the underlying infrastructure.

Examples

- **Google App Engine**
- **Microsoft Azure App Service**
- **Heroku**

Benefits

- Simplified development and deployment
- No infrastructure management required

- Automatic scaling and updates
- Integrated development tools and services

Limitations

- Limited control over the underlying hardware and OS
- Vendor lock-in due to proprietary services and APIs
- Less flexibility in custom configurations

Suitable Use Cases

- Rapid application development
- Web and mobile app development
- API integrations and backend services
- Startups and small teams focusing on coding, not infrastructure

4. Software as a Service (SaaS)

Definition

SaaS delivers **fully functional software applications** over the internet. Users access the service via a web browser without needing to install or manage the software.

Examples

- **Google Workspace (Gmail, Docs)**
- **Microsoft 365 (Word, Excel Online)**
- **Salesforce CRM**
- **Zoom**

Benefits

- No installation or maintenance required
- Accessible from any device with internet access
- Subscription-based pricing
- Automatic updates and patches

Limitations

- Minimal customization options
- Data security and privacy depend on the provider
- Dependent on internet connectivity

Suitable Use Cases

- Email and collaboration tools
- Customer relationship management (CRM)
- Video conferencing and project management
- Enterprise applications for HR, accounting, etc