UNIT - II

1. **Explain briefly the Cloud Computing architecture with relevant diagram.**

The architecture of cloud computing is structured into a layered reference model that covers the entire computing stack, from the physical hardware up to the application software systems. Cloud computing supports any IT service consumed as a utility and delivered through a network, typically the Internet.

A broad definition characterizes cloud computing as a **utility-oriented and Internet-centric way of delivering IT services on demand**. These services are categorized into three primary layers, often referenced in the NIST working definition:

1. **Software-as-a-Service (SaaS):** This is the **top layer** of the reference model. SaaS provides access to applications via the Internet as a Web-based service. These are application-level services, allowing customers to use the application instantly without needing to install or manage complex hardware or software.
2. **Platform-as-a-Service (PaaS):** This layer offers a **development and deployment platform** for running applications in the cloud, constituting the middleware on which applications are built. PaaS exposes a development platform rather than just infrastructure, often bundling the underlying infrastructure as part of the service. PaaS automates the deployment and scaling of applications, abstracting the user from concerns about physical or virtual hardware and operating systems.
3. **Infrastructure-as-a-Service (IaaS):** This forms the foundational solution, providing customizable infrastructure (such as virtual hardware, network devices, and storage) on demand. IaaS solutions combine cloud hosting platforms and resources. The main technology used to implement these solutions is **hardware virtualization**. This virtualization is managed by core middleware and hypervisors, which expose the distributed physical infrastructure (often a datacenter with hundreds or thousands of nodes) as a collection of virtual machines (VMs).

**Cloud Computing Architecture (Reference Model)**

The conceptual layered view of the cloud computing stack, as referenced in the sources (e.g., Figure 4.1), follows a structure where each higher layer builds upon the functionality of the layers below it:

|  |  |
| --- | --- |
| **Layer** | **Description** |
| **Software-as-a-Service (SaaS)** | Application-level services delivered to end-users (e.g., Web-based applications) |
| **Platform-as-a-Service (PaaS)** | Development and deployment platform/middleware for building and hosting applications |
| **Infrastructure-as-a-Service (IaaS)** | Virtualized computing resources (VMs, storage, network) provided on demand |
| **Virtual Infrastructure** | Hypervisors and virtualization technologies managing resource pools and providing VM isolation |
| **Physical Infrastructure** | Hardware appliances, Datacenters, Clusters, Servers, Storage Systems |

1. **Explain the Infrastructure and hardware-as-a-service with a relevant diagram.**

The Infrastructure-as-a-Service (IaaS) and Hardware-as-a-Service (HaaS) solutions constitute the **most popular and developed market segment of cloud computing**. IaaS/HaaS is fundamentally responsible for **delivering customizable infrastructure on demand**.

IaaS solutions are the combination of cloud hosting platforms and resources, delivering resources that cover the entire computing stack, starting from the physical hardware.

**Characteristics and Offering**

The main technology used to deliver and implement IaaS/HaaS solutions is **hardware virtualization**. IaaS offers customizable computing horsepower and resources, which range from single servers to entire infrastructures. These offerings commonly include network devices, load balancers, and database and Web servers.

Virtual machines (VMs) constitute the **atomic components** that are deployed and priced according to the specific features of the virtual hardware, such as memory, number of processors, and disk storage.

IaaS/HaaS brings significant benefits, including:

* **Workload partitioning**.
* **Application isolation** and **sandboxing**.
* **Hardware tuning**.
* **Reduced administration and maintenance cost** for customers, as well as reduced capital costs allocated to purchasing hardware.
* The ability for users to take advantage of the **full customization offered by virtualization** to deploy their infrastructure in the cloud.

**IaaS Solution Architecture**

An Infrastructure-as-a-Service solution is typically organized into three principal layers (as illustrated conceptually in Figure 4.2 in the sources):

**1. The Physical Infrastructure (Bottom Layer)**

This layer is the foundation upon which the management layer operates. The physical infrastructure is often implemented using a datacenter with hundreds and thousands of stacked nodes, and it may also include virtual resources rented from external IaaS providers.

The physical infrastructure uses **virtualization technologies** (managed by hypervisors) to expose the distributed physical infrastructure as a collection of virtual machines (VMs). This allows for fine partitioning of hardware resources, such as CPU and memory, and virtualization of specific devices to meet user requirements.

**2. The Software Management Infrastructure (Core Layer)**

This layer implements the core features of the IaaS solution. Management of the virtual machines is the most important function performed here. A central component is the **scheduler**, which is in charge of allocating the execution of virtual machine instances.

The scheduler interacts with several other specialized components that perform management tasks:

|  |  |
| --- | --- |
| **Component** | **Function** |
| **Monitoring component** | Tracks the execution of each VM instance and maintains data for reporting system performance. |
| **Pricing and billing component** | Takes care of the cost of VM execution and maintains data used to charge the user. |
| **VM repository component** | Provides a catalog of VM images that users can utilize to create virtual instances. |
| **VM pool manager component** | Keeps track of all the live VM instances. |
| **QoS/SLA management component** | Maintains a repository of SLAs and, with the monitoring component, ensures the desired quality of service. |
| **Provisioning component** | Integrates additional resources belonging to third-party IaaS providers. |

**3. The User Interface (Top Layer)**

This layer provides access to the services exposed by the software management infrastructure. This interface is generally based on **Web 2.0 technologies**, enabling either applications or final users to access the underlying services.

**Conceptual Diagram of IaaS Solution (Based on Figure 4.2)**

graph TD

A[User Interface (Web 2.0 Technologies)] --> B;

B[Software Management Infrastructure] --> C;

C[Physical Infrastructure]

subgraph Management Components

B1[Scheduler]

B2[Monitoring]

B3[Pricing & Billing]

B4[VM Repository]

B5[Provisioning (Third-Party Integration)]

B1 & B2 & B3 & B4 & B5

end

B -->|Manages and Allocates| C;

C -->|Provided via Hypervisors| C1[Virtual Machines/VEEs];

C --> C2[Hardware Appliances/Datacenters];

**3. Define PaaS. Explain the essential characteristics that identify a PaaS solution.**

4. SaaS applications are naturally multitenant, Justify with its characteristics and benefits.

5. Discuss the few challenges faced by Cloud computing at the initial stages.

6. Explain the Workload Distribution Architecture with a neat diagram.

7. Explain how Resource Pooling Architecture is beneficial with different Resource pools.

8. Explain the role of Automated Scaling Listener with its working in the Dynamic Scalability architecture.

9. Explain how Service Load Balancing Architecture is differs from Work load balance architecture.

10. The redundant storage architecture introduces a secondary duplicate cloud storage device as part of a failover system. Justify with its advantages.

11. Explain any five fundamental security terms relevant to cloud computing.

12. Explain the role of a threat agent in context of Cloud security with relevant diagram.

13. Define Threat Agent. Explain the different types of Threat Agents.

14. Explain briefly: a. Traffic Eavesdropping b. Malicious Intermediary

15. Explain briefly: a. Denial of Service b. Virtualization Attack

UNIT – III

1. Explain the architecture for supporting energy-efficient and green cloud computing infrastructure.

2. Explain the need and role of Market Oriented Cloud Computing (MOOC) with its reference model.

3. Explain the categories of schedulers based on classification according to the market model.

4. Explain the levels constitute a reference model for a cloud federation.

5. Explain the RESERVOIR technology used for Cloud Federation with its relevant diagram.

6. Explain the internal architecture of a RESERVOIR site with its main components.

7. InterCloud is a service-oriented architectural framework for cloud federation, justify the same with its elements.

8. Explain the role of Meta CDN with its architecture.

9. Explain the benefit of Cloud computing in context of remote ECG monitoring.

10. Discuss how Cloud computing is beneficial in context of CRM and ERP as applications.