**UNIT-5**

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| **Application services** |
| **Platform services** |
| **Infrastructure** |

**Q.1) Explain IaaS with Examples and Advantages?**

* **IaaS** (Infrastructure as a Service) is a type of cloud computing that provides virtualized computing resources over the internet.
* It is one of the three main categories of cloud computing services, along with SaaS (Software as a Service) and PaaS (Platform as a Service).
* With IaaS, customers can rent computing resources such as servers, storage, and networking, rather than having to purchase and maintain them on-premises.
* This allows organizations to more easily scale their resources as needed and only pay for what they use, rather than having to invest in expensive hardware up front.
* **Examples of IaaS providers include:**
* **Amazon Web Services (AWS),** which offers a wide range of services including Elastic Compute Cloud (EC2) for virtual servers, Simple Storage Service (S3) for storage, and Virtual Private Cloud (VPC) for networking.
* Microsoft Azure, which offers services such as Azure Virtual Machines for servers, Azure Storage for storage, and Azure Virtual Network for networking.
* Google Cloud Platform (GCP), which offers services such as Compute Engine for virtual servers, Cloud Storage for storage, and Cloud Virtual Network for networking.
* **The main advantages of using IaaS include:**
* **Flexibility:** IaaS allows organizations to easily scale their resources up or down as needed, without having to invest in expensive hardware up front.
* **Cost Savings:** By only paying for the resources they use, organizations can save money compared to purchasing and maintaining their own hardware.
* **Scalability:** IaaS resources can be quickly scaled to meet changing demands, making it ideal for organizations with fluctuating workloads.
* **Speed:** With IaaS, organizations can quickly provision new resources and get their applications and services up and running faster.
* **Access to the latest technologies:** IaaS providers are constantly updating their infrastructure and services, allowing customers to take advantage of new technologies without having to invest in them themselves. However, IaaS also has some disadvantages as well such as security, compliance, and vendor lock-in. It's important for organizations to carefully consider their needs and the risks involved before choosing to use IaaS.

**Q.2) Explain PaaS with Examples and Advantages?**

* **PaaS** (Platform as a Service) is a type of cloud computing that provides a platform for developing, running, and managing applications and services.
* It sits on top of IaaS (Infrastructure as a Service) and provides additional tools and services for building, deploying, and scaling applications.
* With PaaS, developers can focus on writing code, without having to worry about the underlying infrastructure or managing the platform.
* PaaS providers take care of the infrastructure and platform, and make it easy for developers to quickly deploy and scale their applications.
* **Examples of PaaS providers include:**
* **Heroku,** which is a platform for building, deploying, and scaling web applications.

Microsoft Azure App Service, which provides a platform for building, deploying, and scaling web and mobile apps.

* **Google App Engine,** which is a platform for building and deploying web applications and services on the Google Cloud Platform.
* **The main advantages of using PaaS include:**
* **Productivity:** PaaS makes it easy for developers to quickly deploy and scale their applications, allowing them to focus on writing code and not worry about managing the underlying infrastructure.
* **Cost Savings:** PaaS can save organizations money compared to building and maintaining their own platform.
* **Scalability:** PaaS providers can easily scale resources to meet the changing demands of applications, without requiring developers to manage the underlying infrastructure.

Access to the latest technologies: PaaS providers are constantly updating their platforms and services, allowing developers to take advantage of new technologies without having to invest in them themselves.

* **Reduced time-to-market:** PaaS providers offer a variety of ready-made services, features, and tools which help to speed up the development process, thus reducing the time-to-market for the applications.
* However, PaaS also has some disadvantages such as vendor lock-in, limited control over the infrastructure, and difficulty in migrating to other platforms. It's important for organizations to carefully consider their needs and the risks involved before choosing to use PaaS.

**Q.3) Explain SaaS with Examples and Advantages?**

* **SaaS** (Software as a Service) is a type of cloud computing that provides software applications over the internet, typically on a subscription basis. SaaS is the most popular and widely used category of cloud computing services.
* With SaaS, users can access and use software applications through a web browser or mobile app, without having to install or maintain the software on their own devices.
* The software and associated data are hosted and managed by the SaaS provider, who is responsible for maintaining the infrastructure, security, and updates.
* **Examples of SaaS providers include:**
* Salesforce, a customer relationship management (CRM) software.
* Microsoft Office 365, a suite of productivity and collaboration tools such as Word, Excel, and PowerPoint.
* Zoom, a video conferencing software.
* Netflix, an online streaming service for movies and TV shows.
* **The main advantages of using SaaS include:**
* **Accessibility:** SaaS applications can be accessed from anywhere with an internet connection, allowing users to work remotely or on-the-go.
* **Cost Savings**: SaaS is typically less expensive than traditional software, as users only pay for what they use and do not have to invest in expensive hardware or software licenses.
* **Scalability:** SaaS providers can easily scale resources to meet the changing demands of users, without requiring users to manage the underlying infrastructure.
* **Automatic updates:** SaaS providers are responsible for updating and maintaining the software, which means that users always have access to the latest features and security updates.
* **Flexibility:** SaaS can be easily integrated with other applications and services, allowing organizations to adapt their workflow and business processes as needed.
* However, SaaS also has some disadvantages such as limited control over the data, security concerns, and internet dependency. It's important for organizations to carefully consider their needs and the risks involved before choosing to use SaaS.

**Q.4) Explain CaaS with Examples and Advantages?**

* **CaaS (Container as a Service)** is a type of cloud computing that provides a platform for managing and deploying containerized applications. Containers are a lightweight and portable form of virtualization that allow applications to run consistently across different environments.

CaaS providers offer a platform and set of tools for deploying, scaling, and managing containerized applications. This allows developers to focus on writing code, without having to worry about the underlying infrastructure or managing the platform.

* **Examples of CaaS providers include:**
* **Docker Hub,** which is a platform for building, sharing, and running containerized applications.
* **Google Kubernetes Engine,** which is a platform for deploying, scaling, and managing containerized applications on the Google Cloud Platform.
* **Amazon Elastic Container Service (ECS**), which is a platform for deploying, scaling, and managing containerized applications on Amazon Web Services.
* **The main advantages of using CaaS include:**
* **Portability:** Containers allow applications to run consistently across different environments, making it easier to deploy and scale applications.
* **Isolation:** Containers provide a level of isolation between applications, which helps to ensure that they do not interfere with each other.
* **Flexibility:** CaaS providers offer a variety of tools and services for deploying, scaling, and managing containerized applications, allowing developers to easily adapt their workflow and processes as needed.
* **Cost Savings:** CaaS allows organizations to save money compared to building and maintaining their own platform for containerized applications.
* **Scalability:** CaaS providers can easily scale resources to meet the changing demands of applications, without requiring developers to manage the underlying infrastructure.

However, CaaS also has some disadvantages such as vendor lock-in, limited control over the infrastructure, and difficulty in migrating to other platforms. It's important for organizations to carefully consider their needs and the risks involved before choosing to use CaaS.

**Q.5) Explain MaaS with Examples and Advantages?**

* MaaS (Management as a Service) is a type of cloud computing that provides a management platform for IT infrastructure and services. It is a relatively new and emerging category of cloud services.
* MaaS providers offer a platform and set of tools for managing IT infrastructure, applications, and services. This includes monitoring, provisioning, scaling, and maintaining IT resources. The goal of MaaS is to provide a single point of control for IT management, regardless of the underlying infrastructure, whether it's on-premises, in the cloud, or in a hybrid environment.
* **Examples of MaaS providers include:**
* **ServiceNow,** which provides a platform for IT service management, including incident management, problem management, and change management.
* **Microsoft Azure Arc,** which is a platform for managing hybrid environments, including on-premises and multi-cloud resources.
* **AWS Control Tower,** which is a platform for setting up and governing multi-account environments on Amazon Web Services.
* **The main advantages of using MaaS include:**
* **Simplification:** MaaS provides a single point of control for managing IT resources, regardless of the underlying infrastructure, which simplifies IT management.
* **Scalability:** MaaS providers can easily scale resources to meet the changing demands of IT infrastructure and services, without requiring IT staff to manage the underlying infrastructure.
* **Cost Savings:** MaaS allows organizations to save money compared to building and maintaining their own IT management platform.
* **Automation:** MaaS providers offer a variety of tools and services for automating IT management tasks, which can help to reduce errors and improve efficiency.
* **Visibility:** MaaS provides a unified view of IT resources across different environments, which helps to improve visibility and understanding of IT infrastructure and services.
* However, as with other cloud services, MaaS also has some disadvantages such as vendor lock-in, limited control over the infrastructure, and difficulty in migrating to other platforms. It's important for organizations to carefully consider their needs and the risks involved before choosing to use MaaS.
* **Storage as a service**:
* Storage as a service is a business model in which a large company needs space in their infrastructure to a smaller company or individual.
* Storage as a service is generally seen as a good alternative for a small or midsized business that lacks the capital budget and or technical personnel to implement and maintain their own storage infrastructure.
* Storage as a service is also being promoted for business to mitigate risk in disaster recovery, provide long term retention for records and enhance both business continuity and availability.
* **Traditional storage versus cloud:**
* **Performance :** no SQL, low latency,
* **Maintenance:** focus on main application/ feature
* **Support:** quick, accurate and efficient
* Reliability is good
* Security is good

Q.6) **Explain Amazon EC2 with Examples and Advantages?**

* **Amazon Elastic Compute Cloud** (EC2) is a web service that provides resizable compute capacity in the cloud. It allows users to launch virtual machines (also known as instances) on demand, and pay only for the resources they use.
* **Examples of using EC2 include:**
* Setting up a web server to host a website or application.
* Running a batch processing job to process large amounts of data.
* Running a video rendering pipeline to create animations or special effects.
* **Advantages of using EC2 include:**
* **Flexibility:** EC2 allows users to choose from a variety of instance types, each optimized for different types of workloads. This allows users to select the best option for their specific needs.
* **Scalability:** EC2 allows users to easily scale their compute resources up or down, depending on their needs. This can help reduce costs by only paying for the resources that are actually being used.
* **Reliability:** EC2 instances are distributed across multiple availability zones, which can help protect against outages or failures in a specific location.
* **Security:** EC2 provides a number of security features, such as security groups and network ACLs, to help protect instances and data.
* **Cost-effective:** EC2 allows users to pay for resources on-demand, rather than having to make a large upfront investment in hardware. This can help reduce costs, especially for organizations that have variable or unpredictable compute needs.
* **Feature of Amazon EC2:**
* Virtual computing environment known as instances.
* Preconfigured template for your instances known as Amazon Machine images.
* Various configurations of CPU, memory, storage and networking capacity for your instances known as instance types.
* Secure login info for your instances using key pairs.
* Virtual networks you can create that are logically isolated from the rest of cloud, and that you can optionally connect to your own network known as virtual private clouds(VPC).

Q.7) **Explain Virtualization with Advantages?**

* **Virtualization introduction:** Refers to act of creating a virtual (rather than actual) version of something. Including virtual computer hardware platform, OS, storage devices and computer n/w resources.
* Virtualization is a framework or methodology of dividing the resources of computer into multiple execution environments, by applying one or more concepts or technologies such as H/W and S/W partitioning, time sharing, partial or complete machine simulation,gos,others In multitasking**:**

**AP3**

**AP2**

**AP1**

**OS**

**CPU**

**OS3**

**AP3**

**AP2**

**AP1**

**VIRTUAL CPU3**

**OS2**

**AP3**

**AP2**

**AP1**

**VIRTUAL CPU2**

**OS1**

**AP3**

**AP2**

**AP1**

**VIRTUAL CPU1**

**Fig: Virtualization**

* **Advantages:**
* **Flexibility** – More than one instance.
* **Availability** – temporary migration , if physical node is down.
* **Scalability**- very easy to insert a physical node with the basic cluster
* **Hardware utilization –** virtual machines utilize hardware resources that are left idle.
* **Security:** using multiple virtual machines, it is possible to separate services by running one service on each virtual machine . this approach is also called jailing of services.

**Q.8) Definitions?**

1. **Virtual machines:**

* A representation of real machine using S/W. that provides an O.S environment which can run or host a guest O.S, virtual machines are created and managed by V.M.M

1. **Guest O.S:**

* O.S which is running inside the created virtual machine.

1. **Hypervisor:**

* A thin layer of software that generally provides virtual partitioning capabilities which runs directly an hardware, referred to as “bare metal” approach.

1. **VMM:**

* S/W that runs in a layer between host O.S and one or more virtual machines that provides virtual machine abstraction to guest O.S.

**Q.9) Types of virtualization?**

* **Hosted:** when VMM runs in O.S.
* Bare metal approach runs on VMM on top of n/w directly.

1. **Full virtualization:**

* Native virtualization
* It is designed to simulate the underlying network which is physically available.
* It gives flexibility to more user virtual machines from one host to another host very easily. But at the cost of performance due to overhead.
* **Ex**: VMWare.

1. **Para virtualization:**

* The hypervisor exports a modified version of the underlying physical network.
* It provides better performance than full virtualization.
* **Ex :** Xen.

1. **OS level virtualization:**

* No requirement of virtual machine monitor software
* Single OS image handles all the guest images in different isolated containers.
* **Ex :** linux Vserver.

1. **Application virtualization:**

* Referred as process virtualization
* It is the approach of running applications inside a virtual execution environment.
* The virtual execution environment provides standard API for cross platform execution and manages consumption of applications local resources.
* **Ex:** environment variables, objects.

1. **Pros and cons of virtualization:**
2. **Pros:**

* Lower overall capital expenditures by hosting multiple virtual servers on a single physical machine, you can reduce cost.
* Automated tasks: virtualization lets you automate a number of significant roujtine IT tasks
* Greater redundancy: provides greater safety and security.
* Faster deployment: deploying a virtual machine is simpler than deploying a physical machine.

1. **Cons:**

* High upfront expenditures
* Not all applications are ready for virtualization.
* The danger of server sprawl.
* Virtualization application inenterprises.

1. **Server virtualization:**

* It is a masking of server resources
* Divide one physical server into multiple isolated virtual environments.
* The virtual environments are sometimes called virtual private servers , also called as guests instaces , containers, emulations.
* Virtual machine model.
* Para virtual machine model
* Virtualization at OS layer.
* **VMM** 🡪users hypervisor to coordinate instructions to CPU.
* **PVM**🡪modifies guest O.S code is called porting.
* Virtualization at OS level, the hosts runs a single OS kernel as its core and exports O.S functionality to each of the guests.
* **Advantages:**
* Disaster recovery
* Reduces CPU overhead
* Reduces S/w calls.

1. **Desktop virtualization:**

* It is the concept of isolating a logical O.S instance from the client. That is used to access it.
* Needs remote display protocol.
* Uses both a machine virtualization
* Layer for hosting PC VM’s on a server and presentation virtualization for remote access of those virtual machines from the desktop.
* A full instance of desktop O.S runs as an virtual machine that is hosted on a server and remote accessed from a client device.
* For the end user, the experience of virtual desktop should be same as using local PC.
* Access is managed through connection broker software.
* **Ex :** VMware view, Citrix Xen desktop.

1. **Application virtualization:**

* Application virtualization is software technology that encapsulates application software from the underlying system in which it is executed.
* **Benefits:** Allows applications to run an environments that do not suit the native application.

1. **Storage virtualization:**

* Storage virtualization is the process of grouping the physical storage from multiple network storage devices so that it looks like a single storage device.
* Storage virtualization is also known as cloud storage.
* Storage virtualization aggregates the function and hides the actual complexity of SAN.
* **Advantages:**
* Improved storage management in a heterogeneous IT environment.
* Better availability and estimation of down time with automated management.
* Better storage utilization.

1. **Network virtualization:**

* Network virtualization is the process of combining hardware and software network resources and network functionality into a single , software based administrative entity , a virtual network.
* **Advantages:**
* Flexibility
* Manageability
* Scalability
* Security
* Privacy and isolation
* Heterogeneity and Programmability.
* **SECURITY IN THE CLOUD:**
* Cloud security is an evolving sub domain of information security, it refers to a broad set of policies, technologies, controls deployed to protect data, applications and associated infrastructure of cloud computing.
* **Dimensions of cloud security:**
* **Identity management** – to control access to information and computing resources.
* **Physical security** – secure the IT hardware (servers, routers,cable etc)
* **Personnel security** – service level agreement , code of conduct , policies etc.
* **Availability** – cloud providers help ensure that customers can rely on access to their data and applications
* **Privacy** – providers ensure that all critical data are masked or encrypted.
* **Cloud security challenges:**
* Data protection
* User authentication
* Disaster and data breach
* **Data protection:** Here placing critical data in the hands of third party, data needs to be encrypted at all times.
* **User authentication** – companies need to be able to view data access logs and audit trails to verify that only authorized users are accessing the data.
* **Disaster and data breach refered as contingency planning** – a comprehensive security assessment from a neutral third part is strongly recommended as well.
* **Other challenges:**
* Loss of control
* Lack of trust
* Multi-tenancy
* **Network security:** Network components are shared by different tenants due to resource pooling. Sharing resources allows attackers to launch cross-tenant attacks.
* Virtual networks increases virtual machines inter connectivity , an important security challenge in cloud computing.
* The most secure way is to look each virtual machine with its host by dedicated physical channels.
* Most hypervisors use virtual networks to link virtual machines to communicate more directly and efficiently.
* Most virtualization platforms such as Xen provide two ways to configure virtual networks bridged and routed.
* But these techniques increase the possibility to perform some attacks such as sniffing and spoofing.
* **Host and application level security:** The applications such as SaaS are typically delivered via the internet through a web browser.
* Flaws in web applications may create vulnerabilities for SaaS applications .
* Attackers having been using the web to compromise user’s computer and perform malicious activities such as steal sensitive data .
* Multi-tenancy
* Data security
* Accessibility
* **Storage security:**
* Traditional security problems
* Law issue
* Third party issue
* Authentication
* Encryption
* Segmentation
* Metadata based storage model
* Multi-cloud architecture model
* **Security management in cloud:**
* Ensure effective governance , risk.
* Audit operational and business processes.
* Manage people , roles and identities.
* Ensure proper protection of data and information.
* Ensure privacy policies
* Assess the security provisions for cloud application
* Ensure cloud network and connections are secure
* Evaluate security controls on physical infrastructure and facilities
* Manage security terms in cloud SLA
* Understand the security requirements of the exit process
* **Data privacy:**
* Data privacy questions about how safe is your data in the cloud ?
* **Issues:**
* Data segregation and ownership
* Location of data
* Security procedures/ standards
* Access protocols.
* Audit rights
* Notifications of security breaches
* **Life cycle of data in cloud**

**Create**

**Store**

**Use**

**Share**

**Archive**

**Destroy**

* **In create phase:**
* Data classification
* Assignments of rights to create
* Integer creation
* **In store phase:**
* Access management
* Data integrity and confidentiality
* Encryption in REST
* Data recovery.