CC UNIT 2 - CLOUD ENABLING TECHNOLOGY AND VIRTUALIZATION

CLOUD ENABLING TECHNOLOGY :-

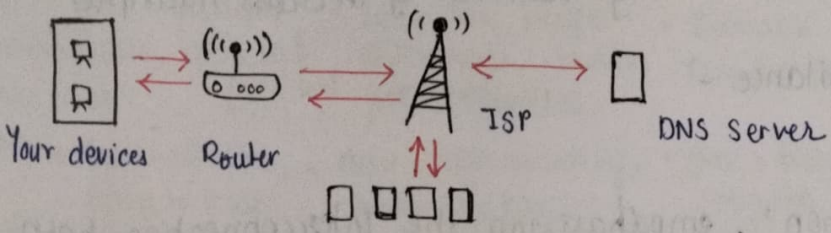
1. BROADBAND NETWORKS AND INTERNET ARCHITECTURE

Broadband n/w :- high-speed Internet access (always on & faster)

- The broadband connection providers are also known as Internet Service Providers (ISPs)
- Types - 1) fibre optic : fastest speed via glass fibres.
2) Cable : uses coaxial cables.
3) DSL : Transmits over copper phone lines.
4) Satellite : Uses communication satellites.
5) Wireless : Connects via radio signals (Wi-Fi, mobile).

Internet Architecture :- Structure & protocols for internet communication.

- Key Components - 1) TCP/IP Protocol Stack : standardizes communication
2) Router - Based Interconnectivity : Connects n/w & manages traffic
3) Internet Protocol (IP) : Assigns unique addresses for device communication.



Internet Architecture

2. DATACENTRE TECHNOLOGY

- Data Center is a facility that houses a large number of computers, networking equipment, & storage systems to store, process & manage data.
- It serves as the backbone of cloud computing by ensuring data availability, security & efficient processing.
- Components of Data Center -

1) Servers : These are high-performance computers that handle data processing & application execution. Eg. Web servers, db servers, etc
2) Storage Systems : Used to store large volumes of data securely. eg. HDD, SSD, cloud storage, etc.
3) Networking Equipments : Includes routers, switches & firewalls that enables secure & fast data transfer.
4) Power & Cooling Systems : UPS (Uninterruptible Power Supply) ensures continuous operation during power failures.
Cooling systems prevent servers from overheating, maintaining efficiency.

- 4 main building blocks of data center are :-

1) Facility (Physical Infrastructure) : Here all data center operation takes place. → Space & location → Physical security.
→ Cooling Infastructure → Power Infrastructure.

2) Operational Infrastructure : supports continuous operation of IT resource
→ Power supply & Backups → Security systems
→ Router, switches & firewalls → cooling systems (Air & Liquid cooling)
• Ensures reliability, security & efficiency of data center operations.

3) IT Resources : the core technological components that process & stores data
→ Servers → Network equipments.
→ Storage systems → Virtualization & cloud Integration.
• Provides computing power & storage capacity for cloud services.

4) Administrative & Operational staff : manage & maintaining data center
→ IT Administrators & Engineers → facility management Team
→ Security Personnel → compilance & Risk Management Team
• Ensures smooth operations, security and regulatory compilance.

3. VIRTUALIZATION TECHNOLOGY

• Virtualization is a technology that creates a virtual version of physical resources such as servers, OS, storage devices & networks.
• It allows multiple virtual environments to run on a single physical machine, improving efficiency, scalability & cost-effectiveness.

Types of virtulization :-

1) Server Virtulization : Divides physical server into multiple VMs using hypervisor. Each VM runs its own OS & applications.
Eg: VMware, Hyper-V, AWS, Microsoft Azure.

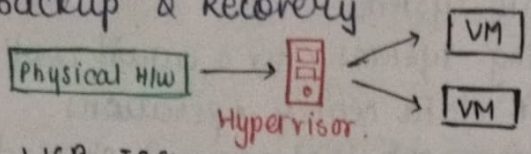
2) Storage Virtualization : combines physical storage from multiple devices into virtual storage unit.
Eg: Google Drive, AWS S3 - users see a single storage interface, but data is distributed accross multiple devices.

3) Network Virtualization : creates virtual networks that function independently of physical network hardware.
Eg: VLANs (Virtual LANs) allow multiple isolated n/w within a single physical n/w. VPN's

4) Desktop Virtualization : Separates desktop environment from physical device, allowing remote acces.
Eg: Virtual Desktop Infrastructure (VDI) - employees access company desktop from home.

5) Application virtualization : Enables application to run on devices without local installation.
Eg: Google Docs, Microsoft Office 365 - Application run on a cloud server, not your PC.

Advantages: Reduce hardware costs.
More scalable
Better Resource Utilization
Isolation & security
Backup & Recovery



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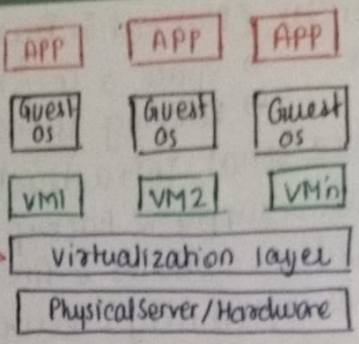

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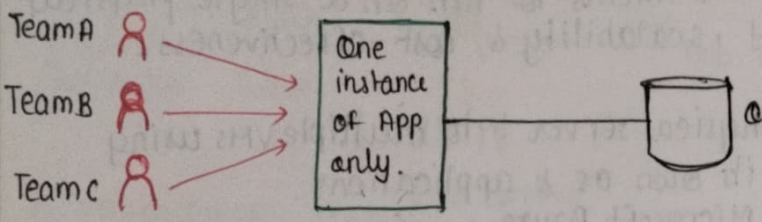
4. WEB TECHNOLOGY.

It encompasses the tools, languages and protocols used to build & manage websites, web applications, and web services.

→ Browsers : allows to access & interact with websites Eg. Google Chrome.
→ HTML → Frameworks → Database → server → API's
→ CSS → Libraries → Client Device → Protocols → Data formats

5. MULTI-TENANT TECHNOLOGY.

- A software architecture where a single instance of an application or system server multiple customers (tenants).
- Each tenants data is isolated, but they share resources like db, server and computing power; also ensures data privacy & security.



- Key features : Shared Infrastructure - multiple tenanants, same application.
Logical Isolation - each tenants data is isolated from other, ensure privacy & security.
Customization - tenants can customize certain aspects without affecting core appln code.
- Types : Single Application, Single DB (one-one)
Single Application, Multiple DB (one-many)
Multiple Application, Multiple DB (many-many)
- Advantages : 1) Cost efficiency - shared resource reduce cost.
2) Scalability - easily supports more users without additional infra.
3) Easy maintainance & updates - one update applies to all tenants.
4) Better Resource Utilization - servers & storage are optimized.
- Disadvantages : 1) Security Risks - sharing resource can make it easier for hackers to access data if security isn't strong.
2) Performance Issues - if one user uses lots of resources, it can slow down the system for others.
3) System failures - failures can affect all users at once.
4) Customization Needs - hard to make changes just for 1 user because everyone uses same system.
- Eg: Google Workspace, MS 365, AWS, Azure, Google cloud, Amazon, Shopify, etc

6. SERVICE TECHNOLOGY / SERVICE ORIENTED ARCHITECTURE (SOA)

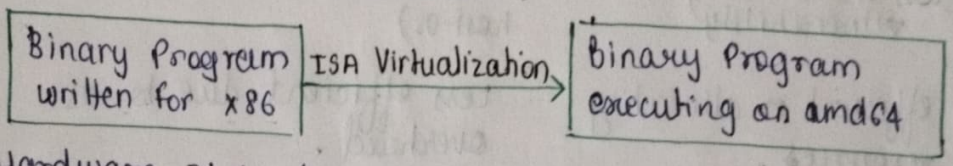
- Refers to use of services in software development, where a service is an autonomous, platform-agnostic software component
- Advantages: Scalability, cost Efficient, faster Development, Security
- Eg: Netflix, Youtube, Uber, Zomato, Banking Apps.

VIRTULIZATION :-

IMPLEMENTATION LEVELS OF VIRTULIZATION

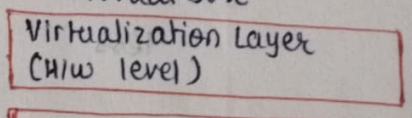
1. Instruction set Architecture level (ISA):

- Virtualization emulates the instruction set of a processor, allowing slw written for one architecture to run on another.
- Translator betn different computer languages
- Eg: QEMU (Quick Emulator) - Emulates different CPU architecture like ARM, x86.
  Bochs - Provides x86 emulation.



2. Hardware Abstraction Layer (HAL) level:

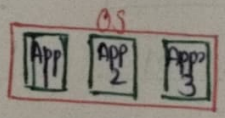
- This creates multiple VM's on a single physical server using a hypervisor, allowing multiple VM's to share physical h/w.
- ie virtualization of h/w resources like CPU, memory, Disk & n/w.
- Eg: VMware, Hyper-V, Virtual Box



} CPU, Memory, Disk, Network

3. OS (Operating system) level:

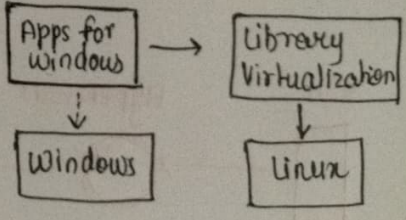
- Provides isolated execution environments within the OS itself.
- ie instead of making separate VM computers, this method splits one OS into multiple mini-systems. Each system can run separately without affecting others.
- Eg: Docker, Kubernetes, Open VZ



} Virtualized & isolated execution environments on OS level.

4. Library level:

- Enables running applications across multiple platforms.
- This level modifies system library calls to make application believe they are running in their native environment.
- Eg Wine, Wabi



5. Application level:

- runs appln via an appln VM instead of directly running on OS.
- Eg: JVM, .Net-CLR, MS App-V

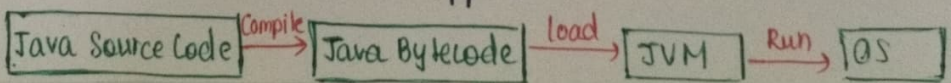


fig. Block diagram of JVM

TYPES OF HYPERVISOR

Hypervisor :- Also called as Virtual Machine Monitor (VMM), is software that enables creation & management of VM's on a physical machine.

	Type 1 Hypervisor (Bare-Metal)	Type 2 Hypervisor (Hosted)
Defn	Runs directly on the physical h/w without an underlying os.	Runs on top of an existing os.
Architecture	Installed directly on the server or machine.	Installed as an application within an os.
Performance	High Performance.	Lower Performance.
Security	More (less risk of os vulnerability)	less (depends on security of host-os)
Resource utilization	Highly efficient in allocating system resources.	less efficient due to os overhead.
Ease of use	Requires advanced knowledge to configure & manage	Easier to install & use.
Complexity	More complex	Simple.
Scalability	High	less
eg	VMware ESXi, MS Hyper-V, Xen, KVM	VirtualBox, VMware Workstation, Parallel Desktop, QEMU