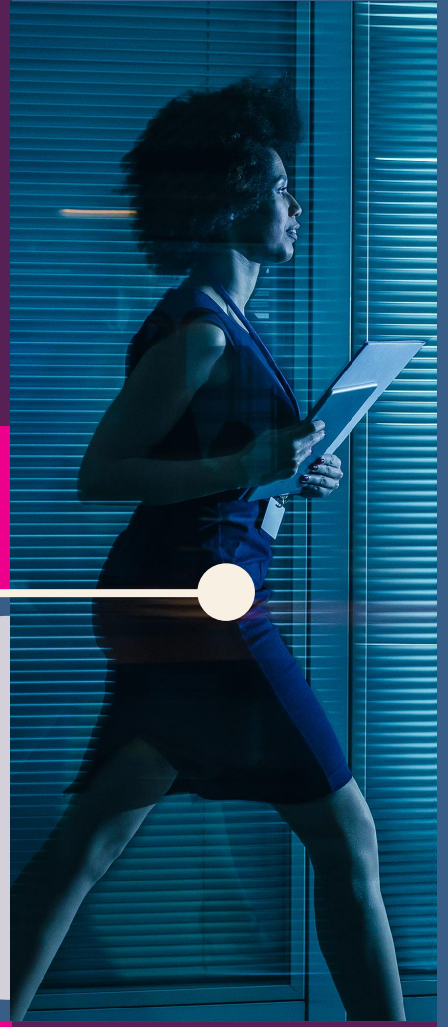
CLOUD COMPUTING

AGENDA

1. Historical Perspective:
   - A short history of client-server computing
   - Peer-to-peer computing
   - Distributed computing
2. Fundamentals of CC :
   - Cloud computing
   - Functioning of cloud computing
   - Cloud architecture
   - Cloud storage
   - Cloud services
3. Practical Applications:
   - Collaborative computing
   - Industrial applications



WHAT IS CLOUD COMPUTING?

- Cloud computing delivers computing services over the internet, allowing on-demand access to shared resources like networks, servers, and storage.
- It's like renting resources online instead of owning them locally.
- Servers at the remote station
- Types:
  - **Public, Private, Hybrid, Community**

TYPES OF CLOUDS:

- **Public Cloud:**
  - Services are provided over the public internet and accessible to anyone.
  - Examples include Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP).

TYPES OF CLOUDS:

- **Private Cloud:**
  - Cloud infrastructure is dedicated to a single organization
  - Hosted either on-premises or by a third-party provider.

TYPES OF CLOUDS:

- **Hybrid Cloud:**
  - Combines public and private cloud environments,
  - Allows data and applications to be shared between them.

TYPES OF CLOUDS:

- **Community Cloud:**
  - ???

KEY CHARACTERISTICS

- **On-demand self-service:**
  - Users can provision and manage computing resources as needed
  - Without human interaction with the service provider.

KEY CHARACTERISTICS

- **Resource pooling:**
  - Any kind of resources
  - E.g. storage, bandwidth etc.

KEY CHARACTERISTICS

- **Rapid elasticity:**
  - Computing resources can be rapidly scaled up or down to meet changing demand.
  - Something like channel allocation

KEY CHARACTERISTICS

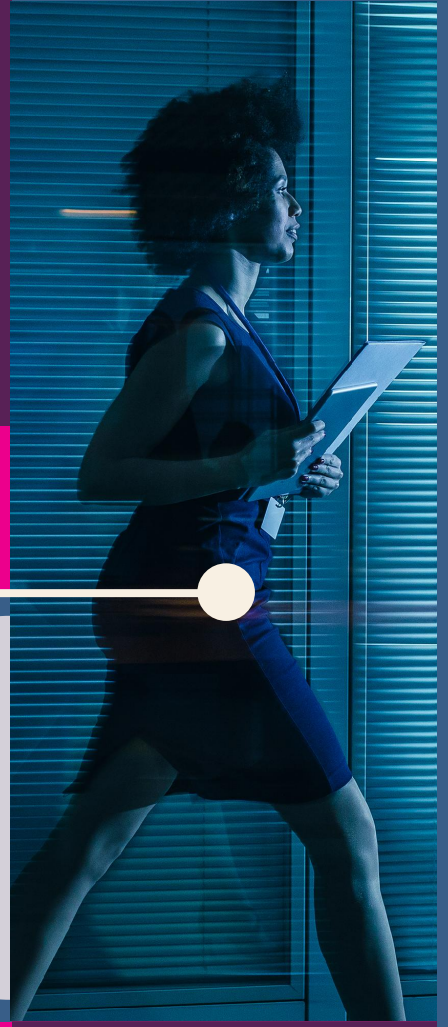
- **Measured service:**
  - Use and pay,
  - use as much as you wish to, pay-per-use billing models.

KEY CHARACTERISTICS

- **No maintenance:**
  - Why?

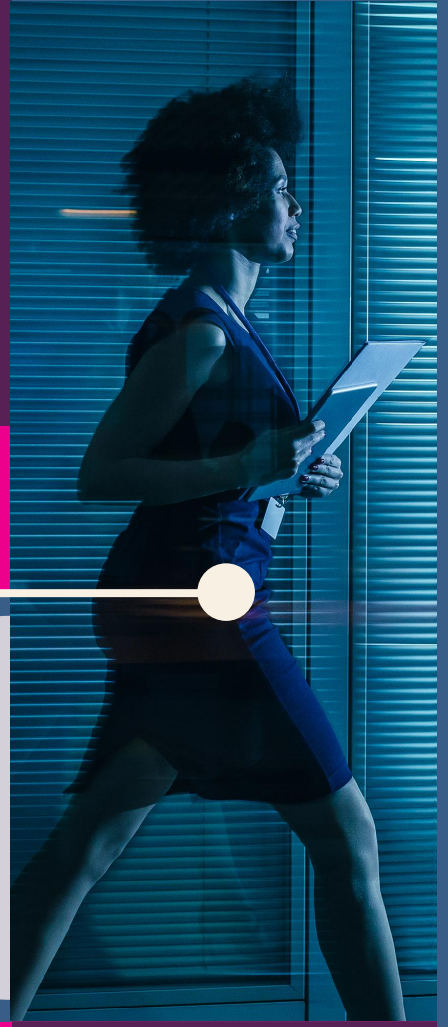
KEY CHARACTERISTICS

- **Security:**
  - All applications secured at the cloud
  - Data secured at the cloud



ADVANTAGES

- **“Key characteristics”** +++++++++
- **Cost-effectiveness:** Pay only for the resources you use, avoiding upfront infrastructure costs.
- **Scalability:** Easily scale resources up or down based on demand, ensuring optimal performance.
- **Flexibility and agility (break down):** Quickly deploy and adapt applications and services to changing business needs.
- **Accessibility** Access cloud services from anywhere with an internet connection, facilitating remote work and collaboration.
- **Collaboration: Dropbox, WeTransfer, etc.**



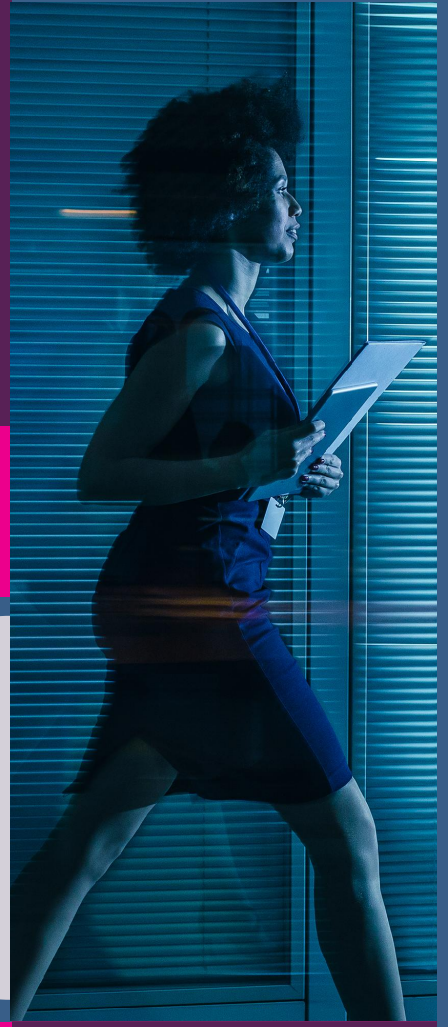
CHALLENGES AND CONSIDERATIONS:

- **Network connection:** If the network is poor, the accessibility will be down.
- **Security and privacy:** Concerns about data protection, compliance, and unauthorized access.
- **Data management:** Addressing data residency, migration, and interoperability issues.
- **Performance and latency:** Ensuring optimal performance and responsiveness, especially for latency-sensitive applications.
- **Vendor lock-in:** Potential challenges associated with switching between cloud providers due to proprietary technologies and data formats.

VENDOR “LOCK-IN” IN CLOUD COMPUTING

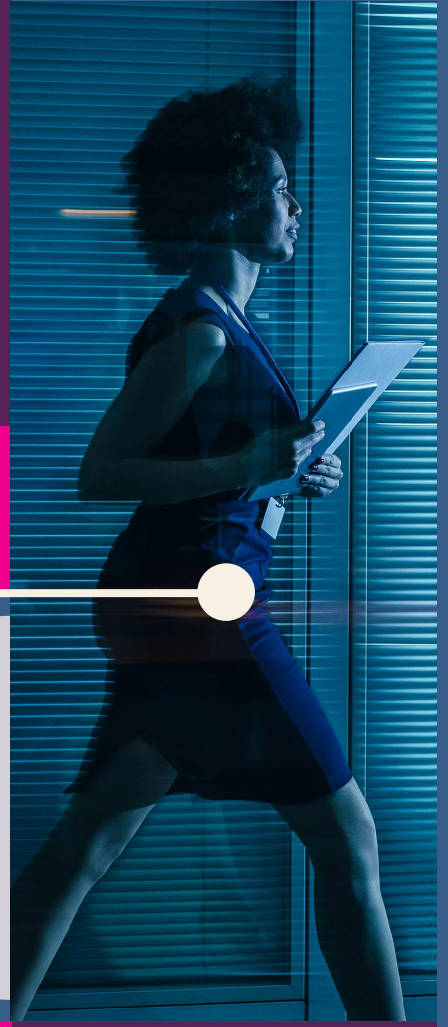
- Getting Stuck with One Provider
- Vendor lock-in refers to a situation where you become dependent on a specific cloud provider's technology and services.
- It's like listening to the music files in one platorm, you will get a compatibility issue when trying to listen in other platforms.

- **Type of “vendor lock-in” *risks:***
  - Data Transfer Risks
  - Application transfer Risks
  - Human resource knowledge risk



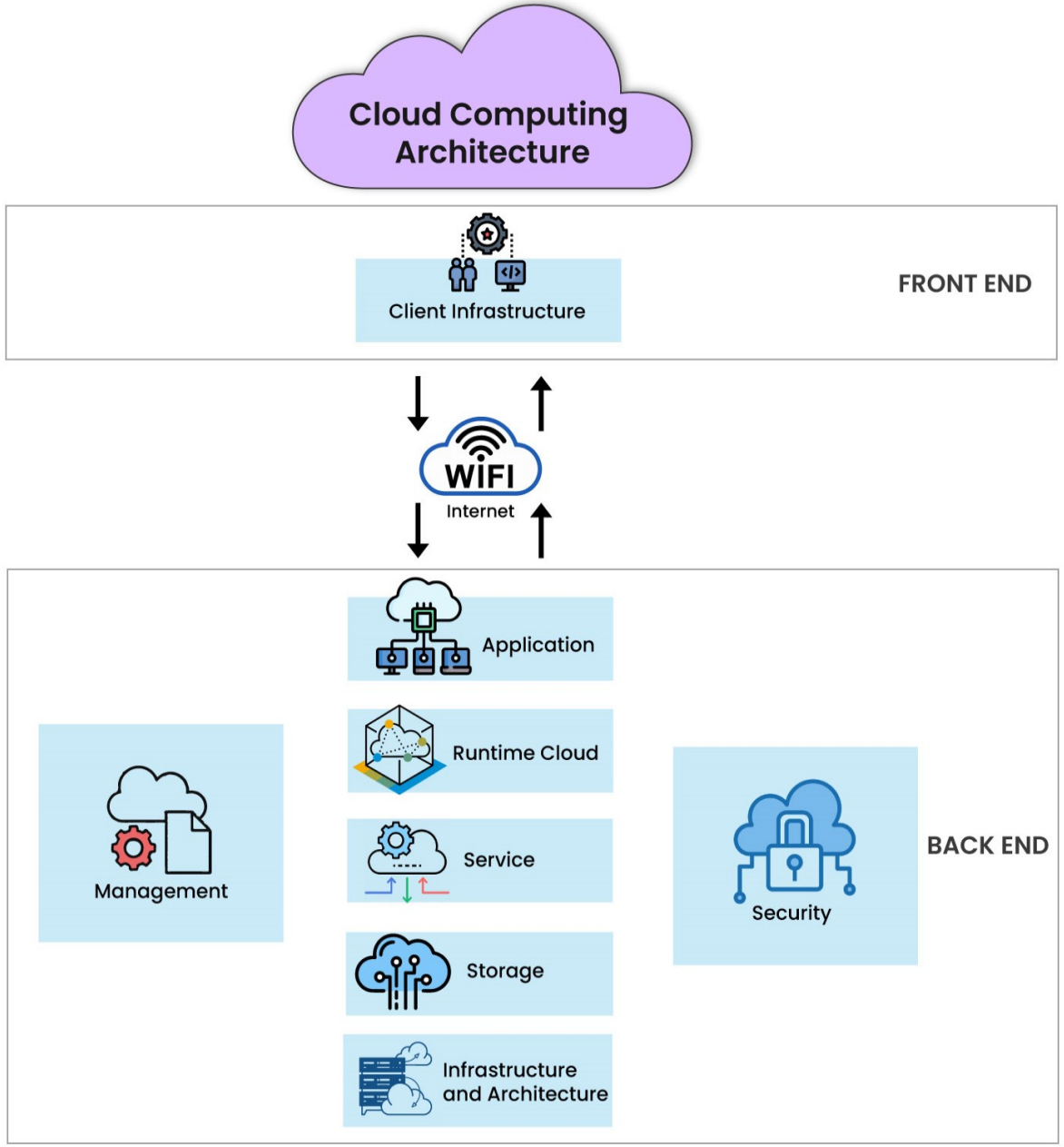
HERE'S HOW TO AVOID VENDOR LOCK-IN:

- Choose cloud services that use **open standards** whenever possible. This makes it easier to move your data and applications to another provider if needed.
- Don't heavily customize your cloud environment. The more unique your setup becomes, the harder it will be to switch providers.
- Be aware of **the exit strategy** offered by the cloud provider. How easy and affordable is it to move your data out if you decide to leave?
- **In short**: Customers get dependent on single cloud service providers. (locked-in)



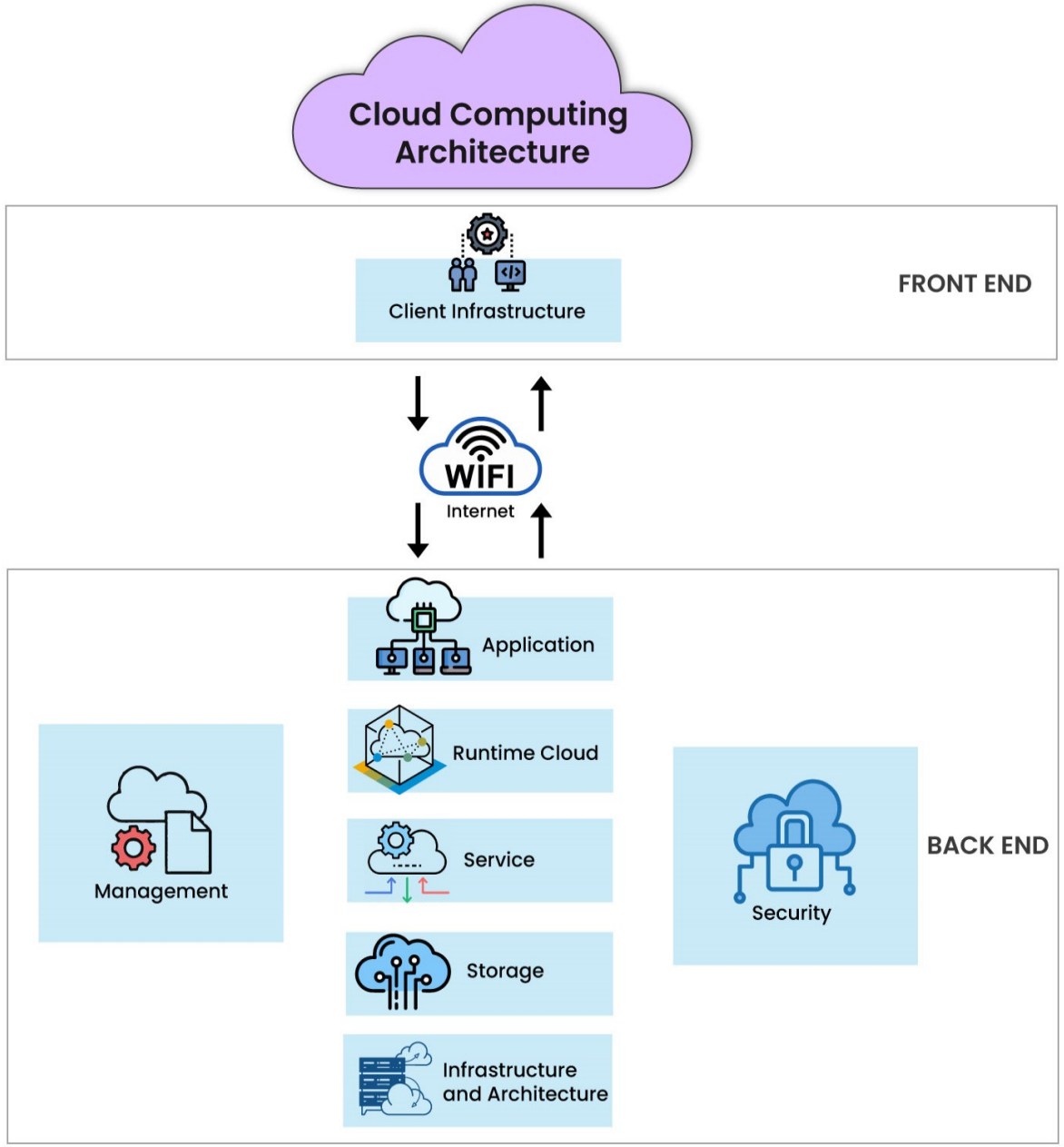
USE CASES AND APPLICATIONS:

- Web hosting and e-commerce
- Big data analytics and machine learning
- Software development and testing
- Disaster recovery and business continuity
- IoT (Internet of Things) and edge computing



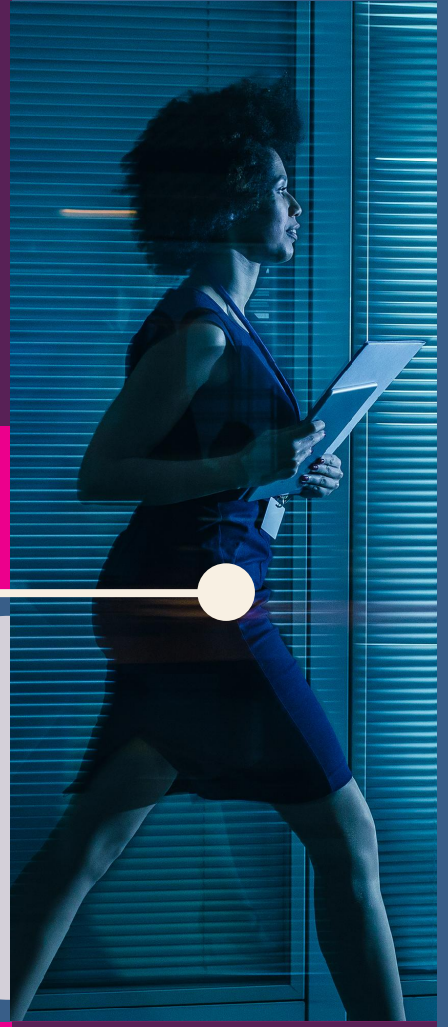
ARCHITECTURE

- **Client Infrastructure:** This is your device, like your laptop or phone, that you use to access the cloud.
- **Internet:** Information highway that connects your device to the cloud service.
- **Application:** Software used in the cloud, like a web app for editing documents.
- **Service Runtime:** It is the behind-the-scenes engine in the cloud that makes your application run smoothly.
- **Cloud Storage Infrastructure:** This is the giant warehouse in the cloud where your data (documents, photos) is securely stored.
- **Security:** Cloud providers implement robust security measures like firewalls, encryption, and access controls to safeguard your data and applications within the cloud environment.



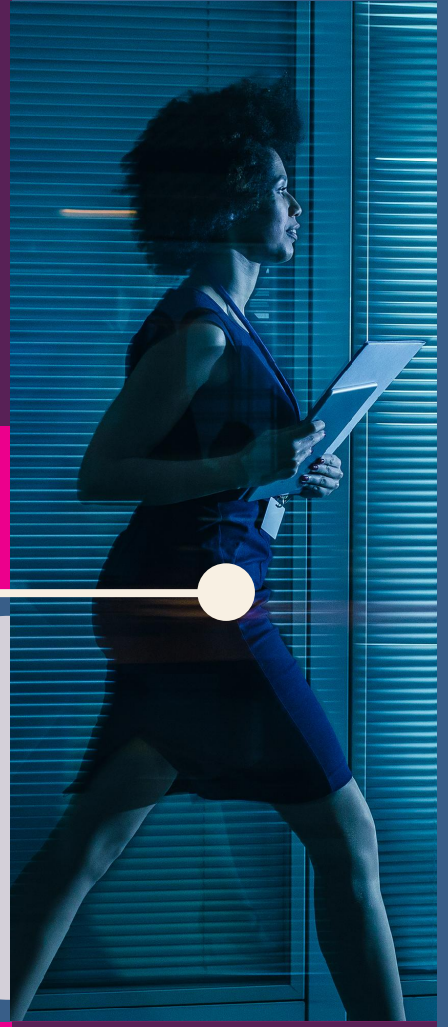
HOW IT WORKS?

- You use your device (client infrastructure) and the internet to connect to a cloud application.
- The application interacts with the service runtime in the cloud, which allocates resources and ensures the application functions properly.
- The cloud storage infrastructure securely stores the data associated with the application.
- Information travels back and forth between your device, the application, and the storage infrastructure through the internet.



CONCLUSION

- In conclusion, cloud computing offers a wide range of benefits and opportunities for organizations to innovate, scale, and optimize their IT infrastructure and operations.
- However, it's essential to understand the deployment models, service models, challenges, and best practices to maximize the value and mitigate risks associated with cloud adoption.



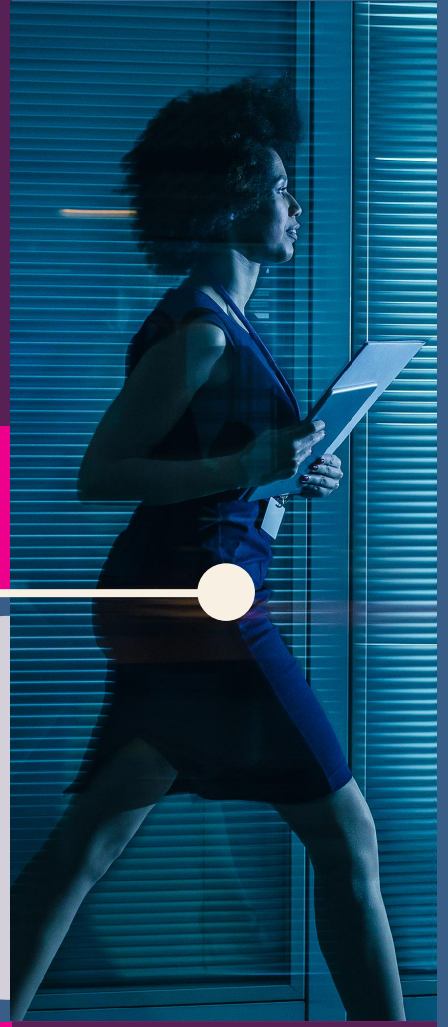
HISTORY OF CLIENT-SERVER COMPUTING -1

Time-Sharing Systems (1960s):

- Time-sharing systems emerged, allowing multiple users to access a computer simultaneously via remote terminals.
- This early form of decentralized computing laid the groundwork for future client-server architectures.

Decentralized Computing (1970s-1980s):

- Minicomputers and local area networks (LANs) became prevalent, enabling decentralized computing within organizations.
- Smaller computers served specific functions, but lacked the centralized management of later client-server systems.



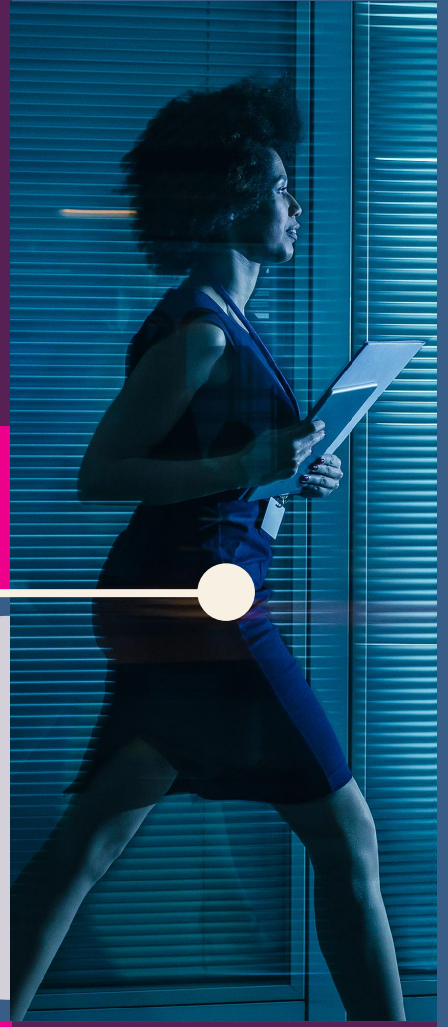
HISTORY OF CLIENT-SERVER COMPUTING-2

Rise of Personal Computers (1980s-1990s):

- Personal computers (PCs) gained popularity, leading to the development of networking technologies to connect them.
- Client-server architecture began to take shape as organizations sought efficient ways to distribute computing tasks.

Client-Server Model (Late 1980s-Early 1990s):

- Client-server computing became prominent, with clients (PCs or workstations) requesting services or resources from centralized servers.
- Servers handled tasks such as data storage, processing, and managing access to shared resources.



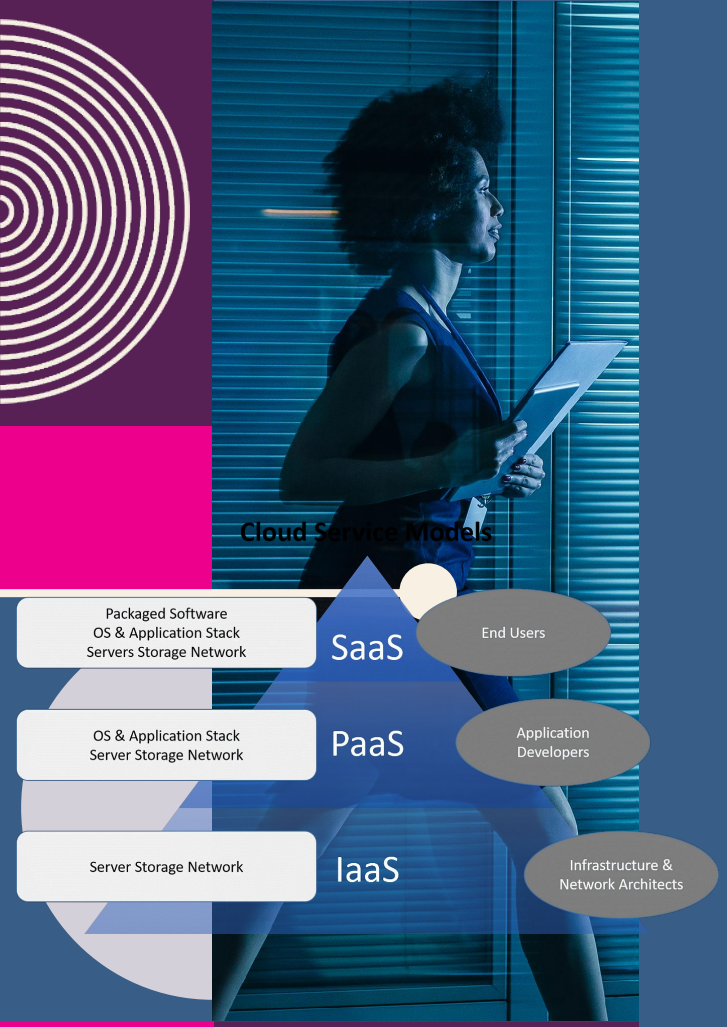
HISTORY OF CLIENT-SERVER COMPUTING - 3

Advancements in Networking (1990s-2000s):

- Networking technologies continued to advance, facilitating the growth of client-server architectures.
- The proliferation of web-based applications further solidified the client-server model's importance in IT infrastructure.

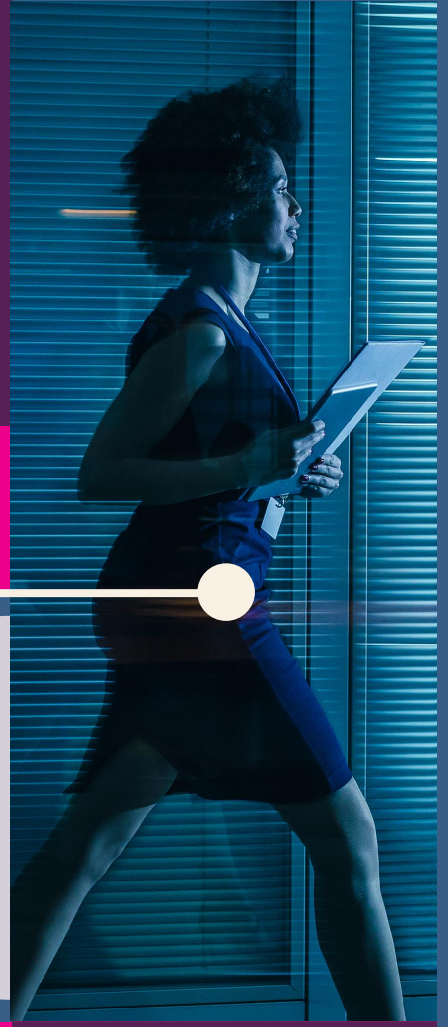
Continued Evolution (Present):

- Client-server computing remains a fundamental paradigm in IT infrastructure.
- It has evolved alongside newer computing models like cloud computing and edge computing but continues to play a crucial role in distributed computing environments.



TYPES OF CLOUD COMPUTING SERVICES:

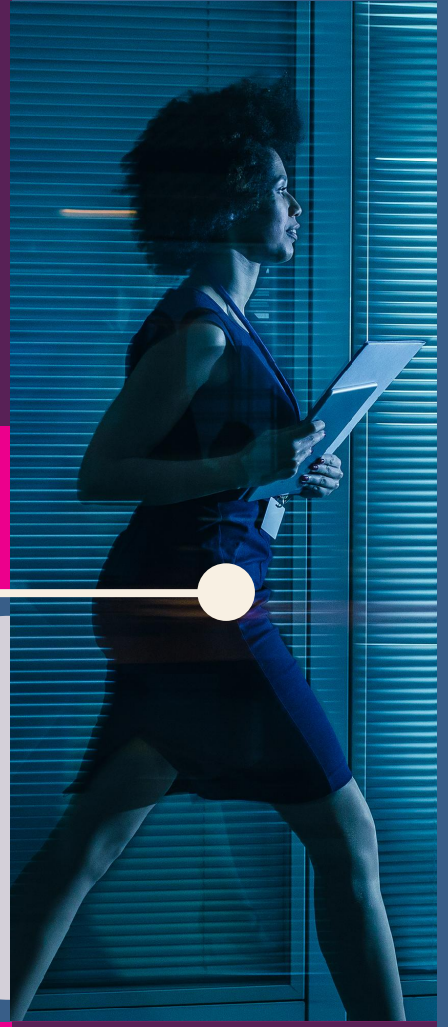
- **Infrastructure as a Service (IaaS):** Provides the core building blocks – servers, storage, network – as on-demand services. Users have complete control over the underlying infrastructure.
- **Platform as a Service (PaaS):** This platform allows customers to develop, run, and manage applications without dealing with underlying infrastructure complexities.
- **Software as a Service (SaaS):** Delivers software applications over the Internet on a subscription basis, eliminating the need for installation and maintenance.
    - Dropbox – Directly using the services.



SOFTWARE AS A SERVICE

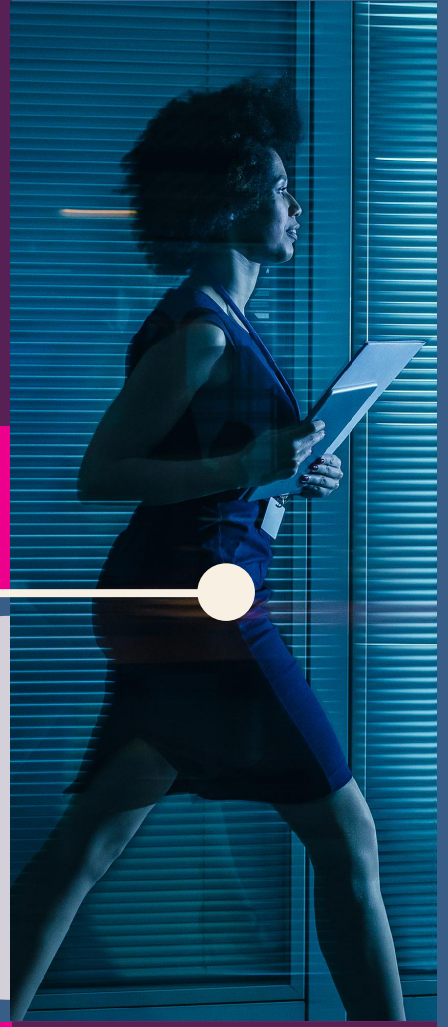
Referred as SaaS:

- Type of cloud computing services
- It is a way of delivering services and applications over the Internet.
- Maintenance of s/w & hardware done by the vendor.
- We needn't install the s/w on our machine.
- So, it removes the cost of hardware and software maintenance.
- Generally used by end users



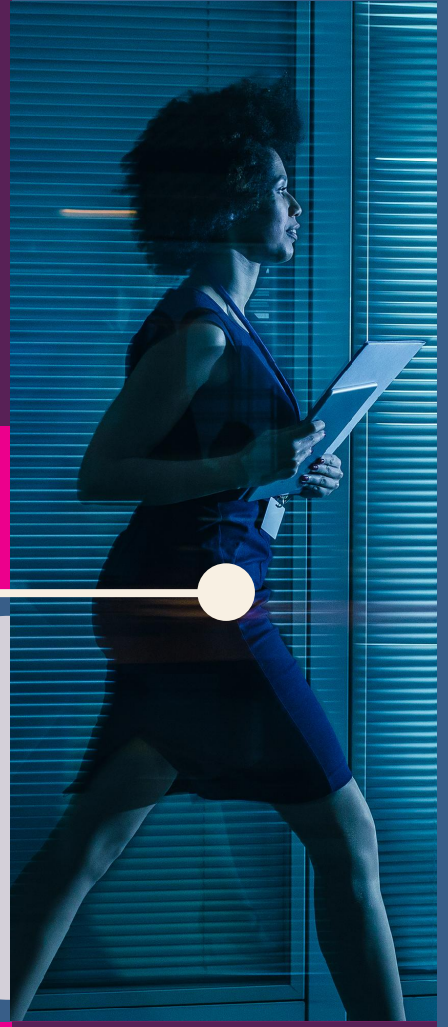
CHARACTERISTICS OF SOFTWARE AS A SERVICE:

- It makes the software available over the Internet.
- Cost-effective – pay as we use.
- Available on demand
- Can be scaled up or scaled down any time as per our needs.
- Works on a shared model. (One s/w is used by multiple clients)
- Software is automatically upgraded
- Platform independent to the user (We can use any platforms like android, ios, mac, etc.)
- Reduced time (We can use applications directly from the browser)
- Example: Gmail, DropBox, Google Drive



BENEFITS OF SOFTWARE AS A SERVICE:

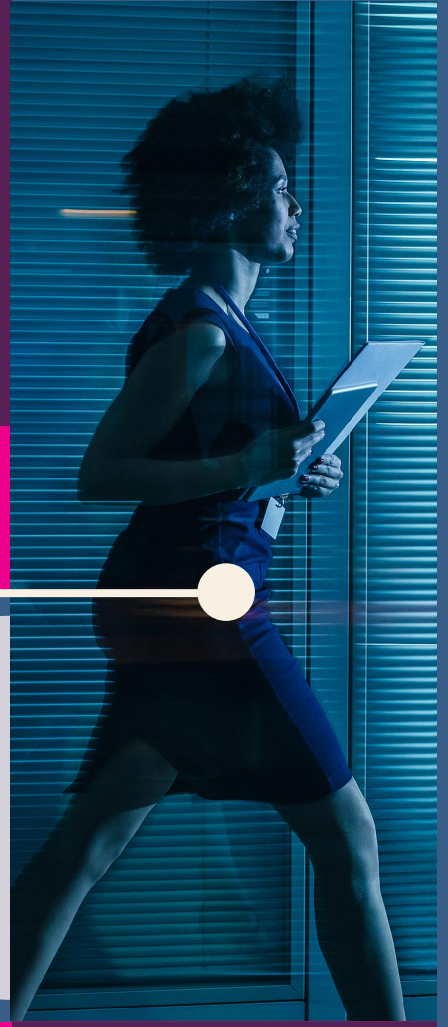
- **Same as characteristics**



PLATFORM AS A SERVICE

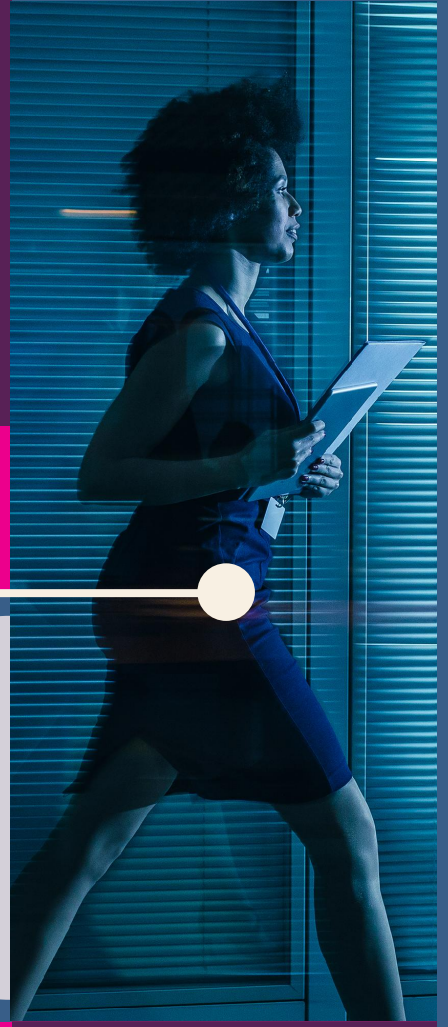
Referred as PaaS

- Used by the developers
- It provides a platform & environment (i.e. runtime environment) to allow developers to build applications and services over the internet.
- Offers development and deployment tools required to develop algorithms
- PaaS services are hosted on the cloud and accessed by the users via web browsers.
- We don’t have any control over the infrastructure (We will interact with the UI only and the O.S. will be provided by the vendor)
- Infrastructures like operating systems, where the data will be stored., etc.
- But we have the control over deployed applications .



BENEFITS OF PAAS

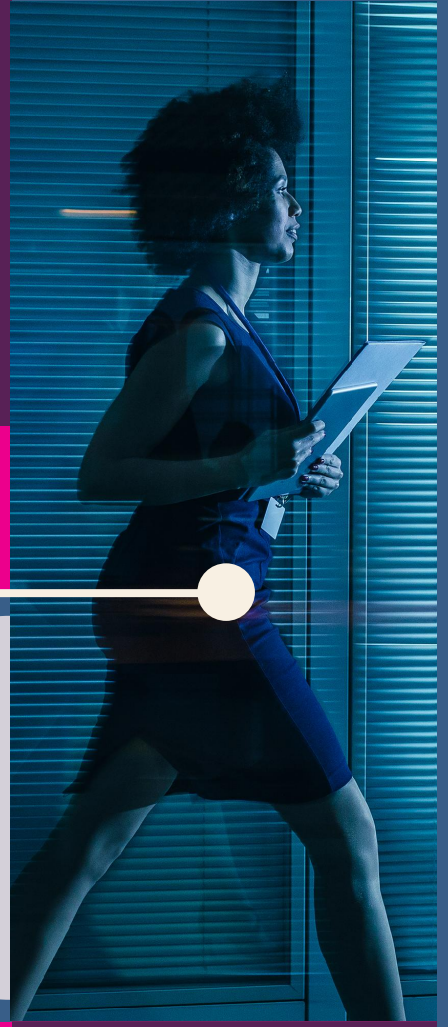
- It makes the software available over the Internet.
- Cost-effective – pay as we use.
- Can be scaled up (resources) or scaled down any time as per our needs.
- Software is automatically upgraded.
- We can use any platforms like android, ios, mac, etc.
- Reduced time (We can use applications directly from the browser)
- Example: **Google App Engine**, **Microsoft Azure**, **force.com**, **AWS**, **HeroKu**, etc.



INFRASTRUCTURE AS A SERVICE

Provides an Infrastructure

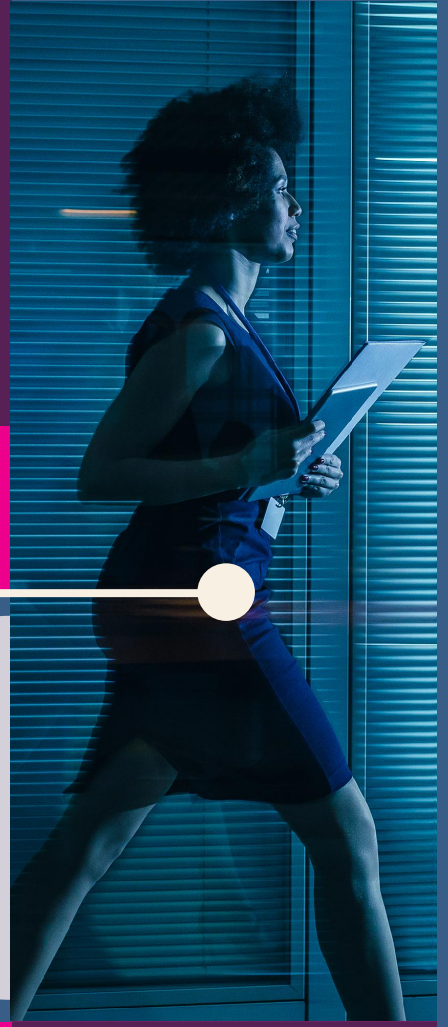
- It is a type of Cloud Computing Service used by system administrators and network architects.
- It simply provides the underlying operating systems, security, and servers for developing the applications.
- It provides access to fundamental resources such as physical machines, virtual machines, virtual storage, etc.
- It is a form of cloud computing that delivers the fundamental computes, n/w and storage resources to the consumer on demand, over the internet and on a pay as you go basis.



INFRASTRUCTURE AS A SERVICE

- Computing Resources: IaaS provides access to virtual servers, processing power, and memory. You can scale these resources up or down on-demand, paying only for what you use.
- Storage: IaaS offers secure and scalable storage solutions for data of all types. You can store anything from application data to backups and archives.
- Networking: IaaS manages the underlying network infrastructure, including firewalls, routers, and load balancers. This ensures reliable and secure communication between your applications and data.
- Virtualization: IaaS utilizes virtualization technology to create multiple virtual machines (VMs) on a single physical server. This allows you to run multiple applications on the same hardware, maximizing resource utilization and efficiency.

Essentially, IaaS offers a way to rent essential IT infrastructure without the burden of managing and maintaining physical hardware.



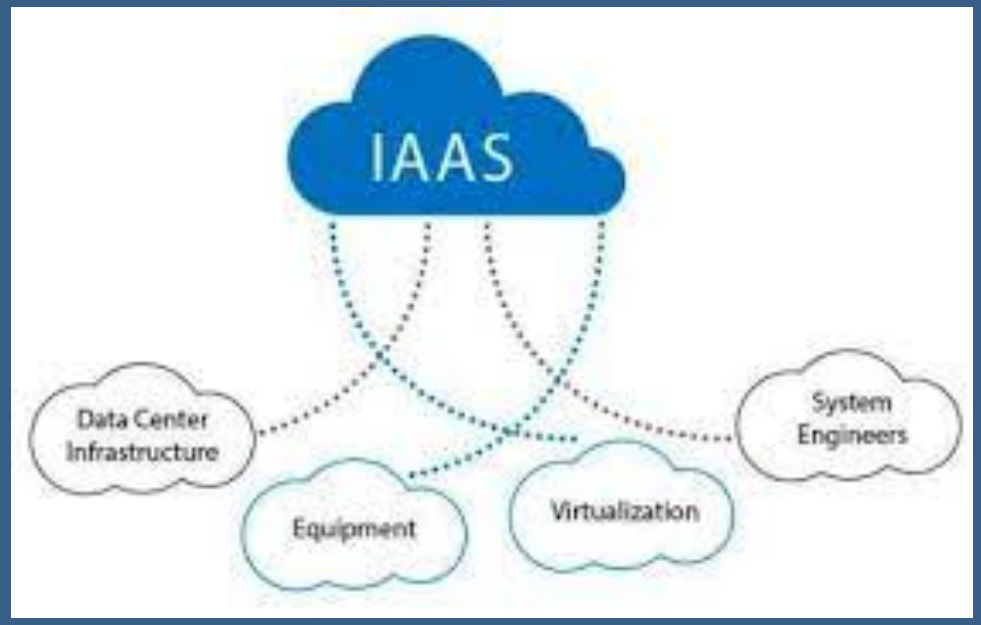
ADDITIONAL BENEFITS:

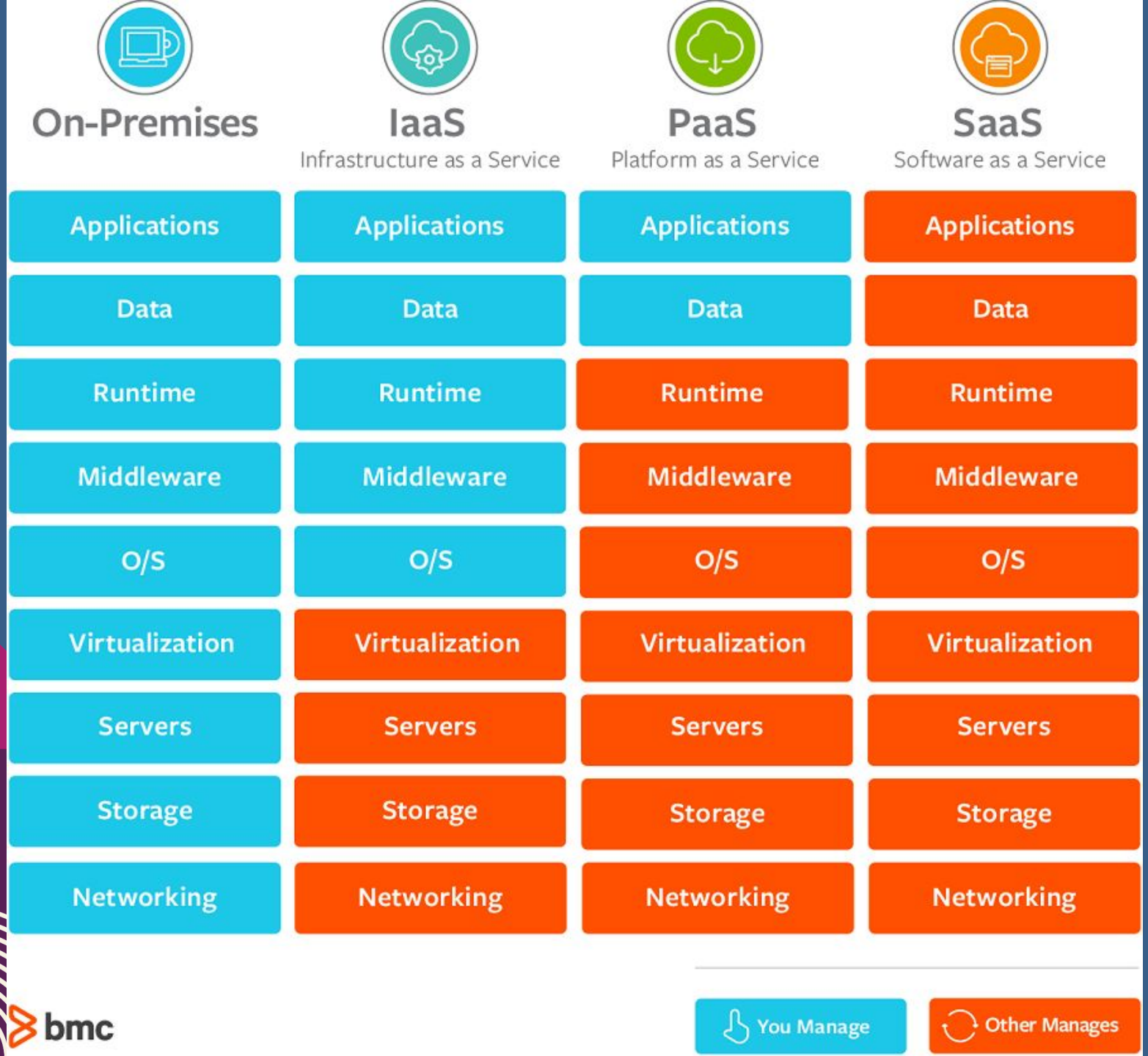
- Cost-Effectiveness:
- Scalability:
- Flexibility:
- Reduced Complexity: Offload hardware management to the IaaS provider, freeing your IT team to focus on core tasks.
- **IaaS is a popular choice for businesses of all sizes looking to:**
- Move to the cloud and avoid upfront hardware investments.
- Gain agility and scalability to meet changing business demands.
- Reduce IT infrastructure management overhead.

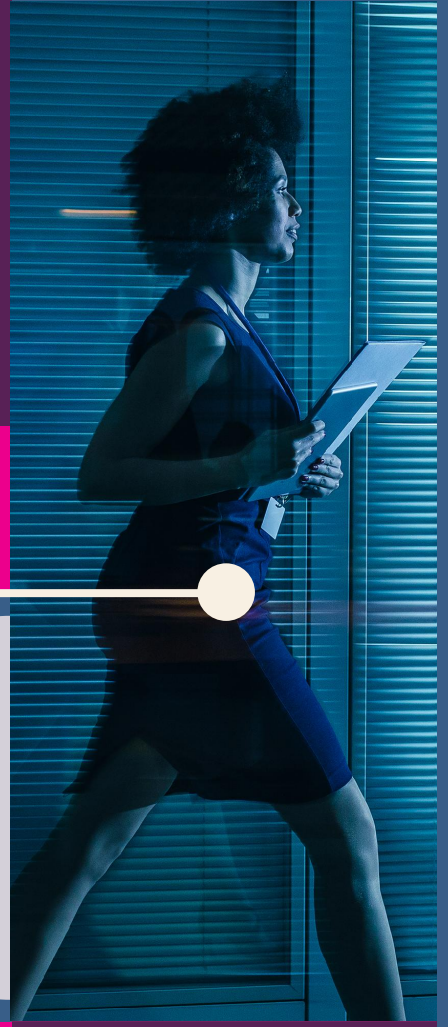
While IaaS provides the core infrastructure, it's important to note that it doesn't include the software applications themselves. Those would typically be deployed on top of the IaaS platform.


App Server
Mobiles
SaaS
Networks
Database
PCs
Codes

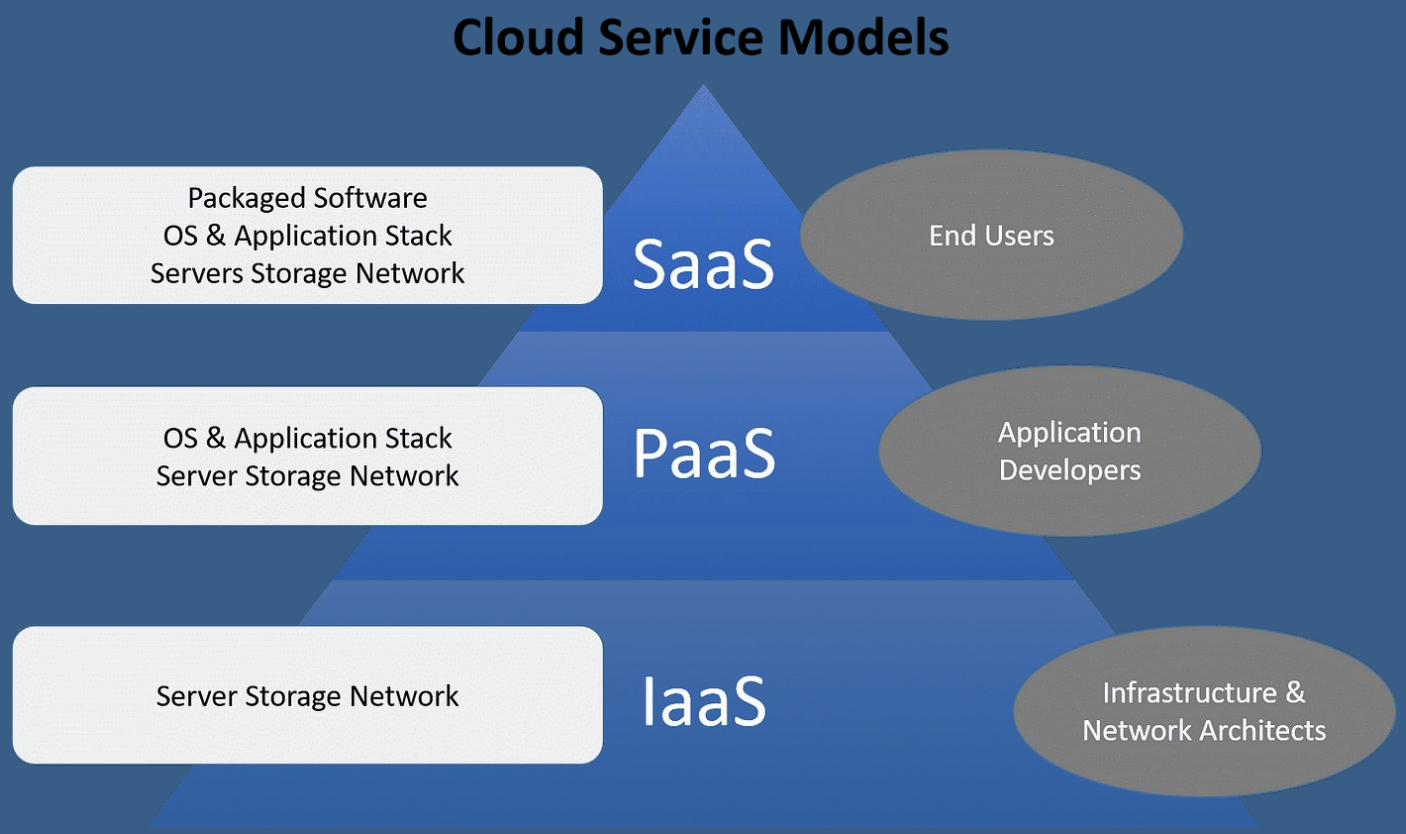

PaaS
Platform as a Service

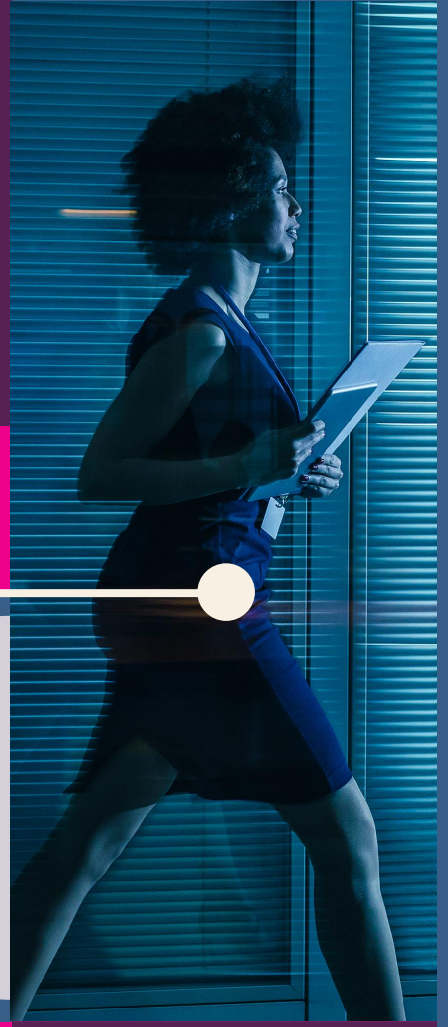

IAAS
Data Center Infrastructure
Equipment
Virtualization
System Engineers


On-Premises
IaaS
Infrastructure as a Service
PaaS
Platform as a Service
SaaS
Software as a Service
Applications
Data
Runtime
Middleware
O/S
Virtualization
Servers
Storage
Networking
bmc
You Manage
Other Manages



CLOUD SERVICE MODELS:

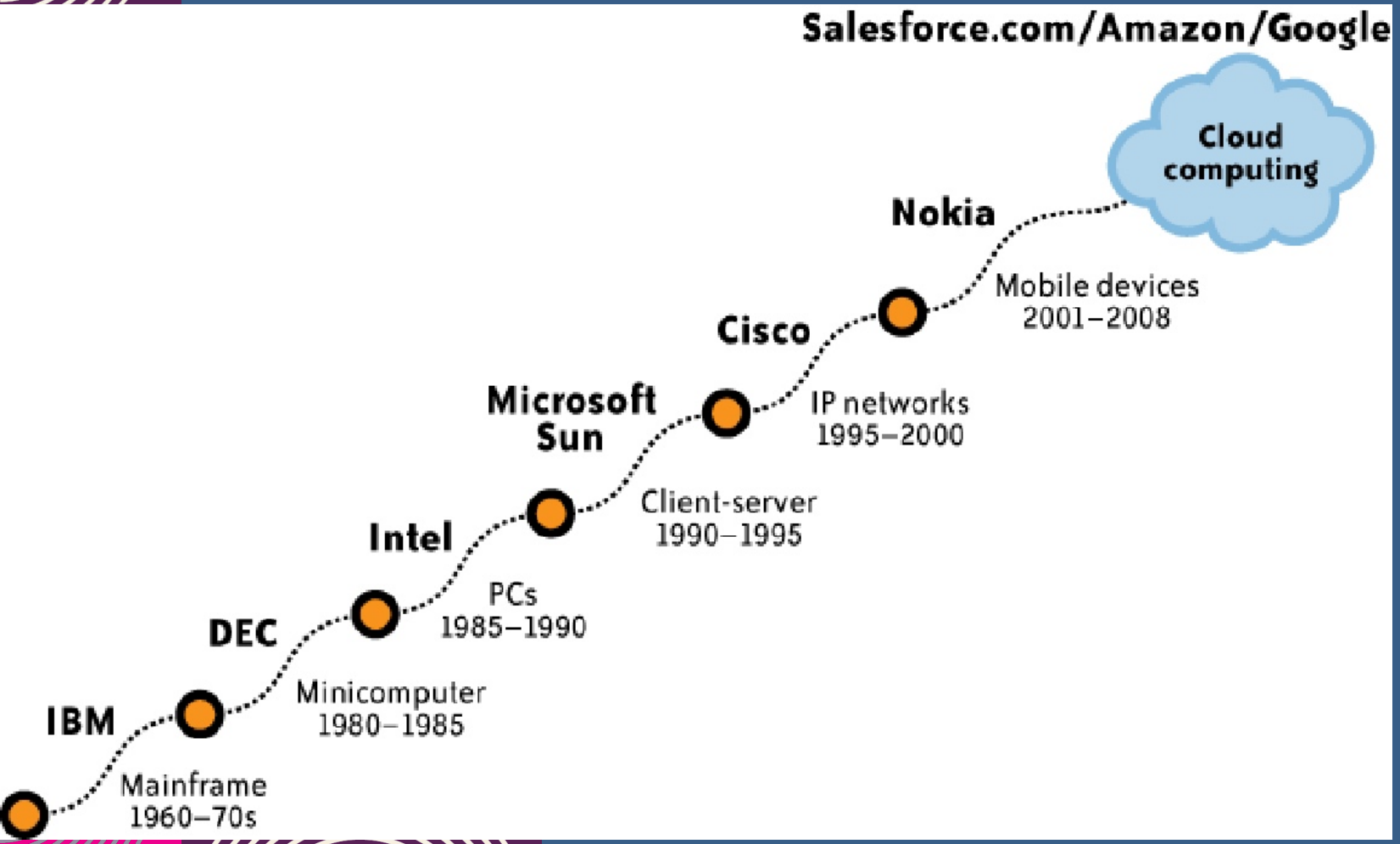




APPLICATIONS OF CC:

- **Business applications**: Every organization requires the cloud business application to grow their business
- Example: These are a few business applications of cloud computing
  - Salesforce provides tools for e-commerce, sales, etc.
  - PayPal: safe payments.
- **Data Storage & backup applications:** We can store files, data, images, audios, videos (eg. google drive).
- **Educational applications:** ailable over by Google, Chromebook for education,
- **Entertainment applications:** E.g. online games, video conferencing apps.

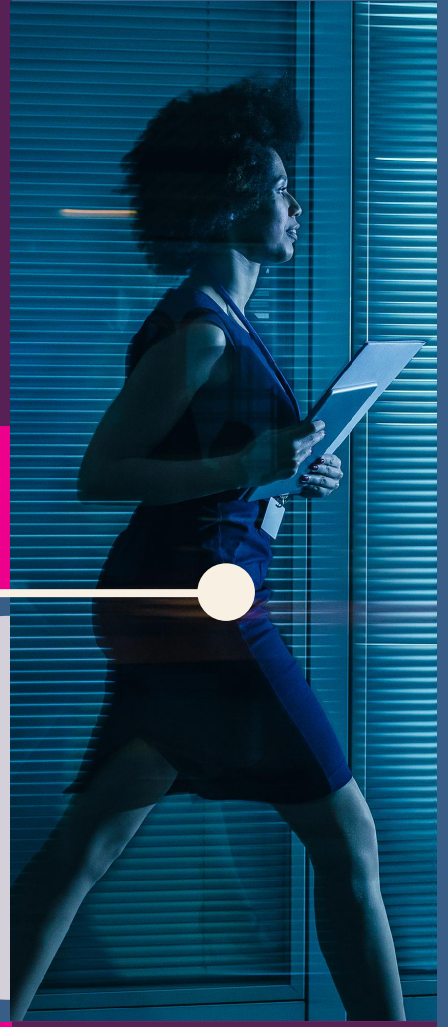
CLOUD REVOLUTION



- Rise of Personal Computers and Client-Server Model (1980s - 1990s):
- The PC Revolution: Companies like Intel with their microprocessors and Microsoft with their MS-DOS operating system fueled the rise of affordable personal computers. This led to a shift from centralized mainframes to distributed computing with individual applications.
- The PC Revolution: Personal computers (PCs) became powerful enough to handle individual applications. This led to a decentralized approach with individual PCs performing tasks.
- Client-Server Model: IBM and Microsoft remained key players with their server operating systems like IBM OS/2 and Microsoft Windows NT. These servers housed data and applications accessed by networked PCs. Cisco emerged as a leader in networking equipment, enabling communication within these client-server networks.

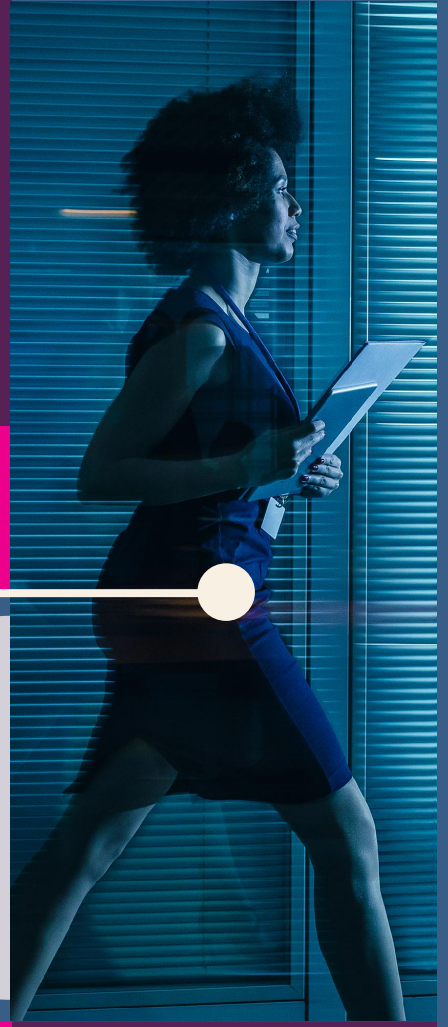
IBM mainframes: large, expensive computers offered centralized processing power for businesses and governments.

- Access was limited to trained personnel in controlled environments. The software was often custom-built for specific tasks, making it inflexible and costly.
- Client-Server Model: Networks emerged, connecting PCs to central servers that housed data and applications. This improved accessibility but still required significant hardware investment and IT management.



PEER-TO-PEER COMPUTING

- **Decentralized Model:** Computers communicate directly with each other.
- **Shared Resources:** Each computer can act as both a client and a server, sharing files, applications, and storage.
- **Examples:**
  - File-sharing applications (e.g., BitTorrent)
  - Collaborative workspaces (e.g., early online document editing tools)
- **Limitations:**
  - Security concerns: Difficulty controlling access and data integrity.
  - Performance limitations: Reliant on individual computer resources.
  - Lack of central management: Scalability and maintenance challenges.



DISTRIBUTED COMPUTING: SHARING THE WORKLOAD

Distributed Processing Power: Multiple computers work together on a single task.

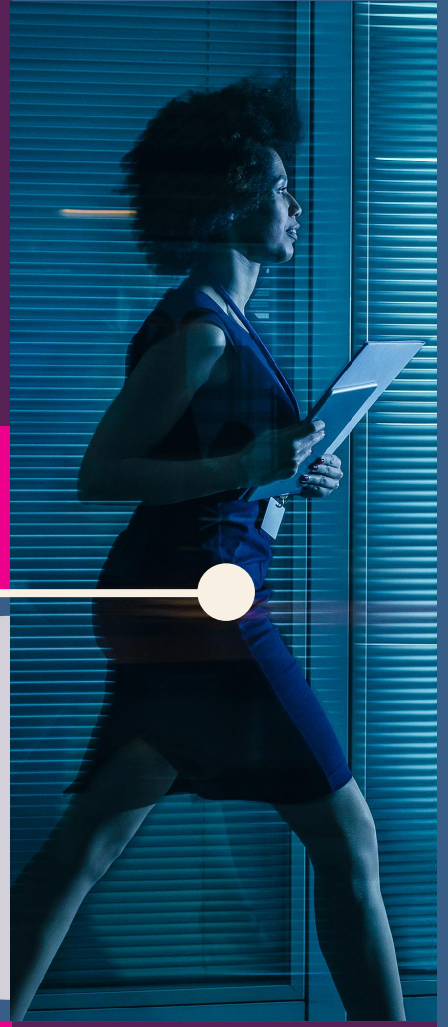
Networked Systems: High-performance computing clusters or geographically dispersed systems.

Advantages:

Increased Processing Power: Complex tasks are broken down and tackled by multiple computers simultaneously.

Improved Scalability: Additional computing resources can be easily added to the network.

Enhanced Reliability: The system remains operational even if individual computers fail.



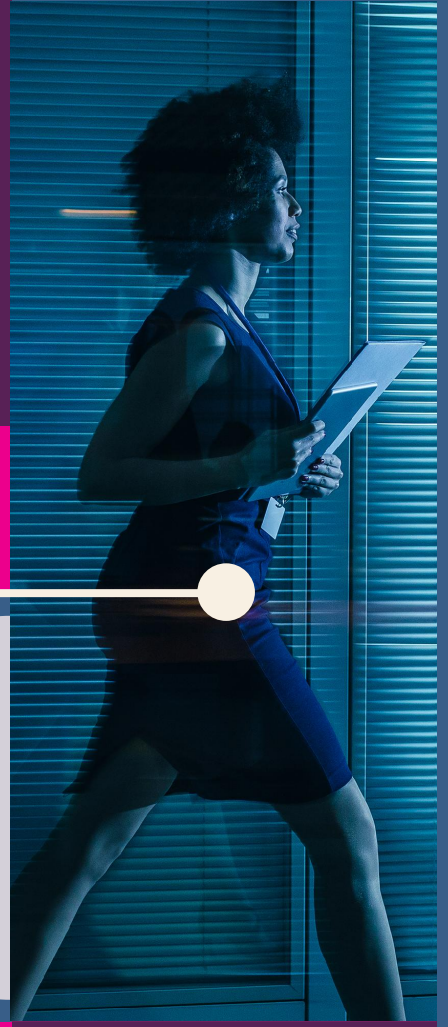
COLLABORATIVE COMPUTING

Shared Workspaces & Applications: Enables real-time collaboration on documents, projects, and data.

Cloud-Based Platforms: Google Docs, Microsoft 365, Trello, etc.

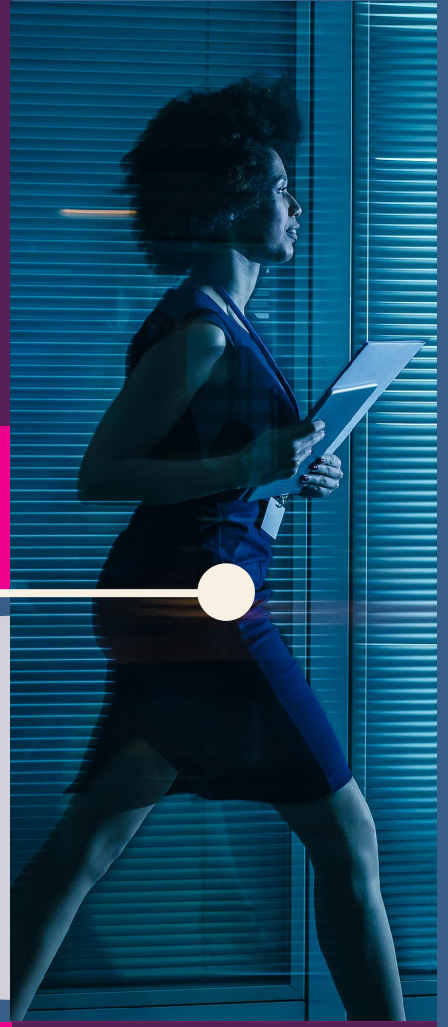
Benefits:

- **Improved Communication & Teamwork:** Enables geographically dispersed teams to work on projects simultaneously.
- **Enhanced Efficiency:** Streamlines workflows and version control.
- **Increased Accessibility:** Access documents and applications from any device with an internet connection.



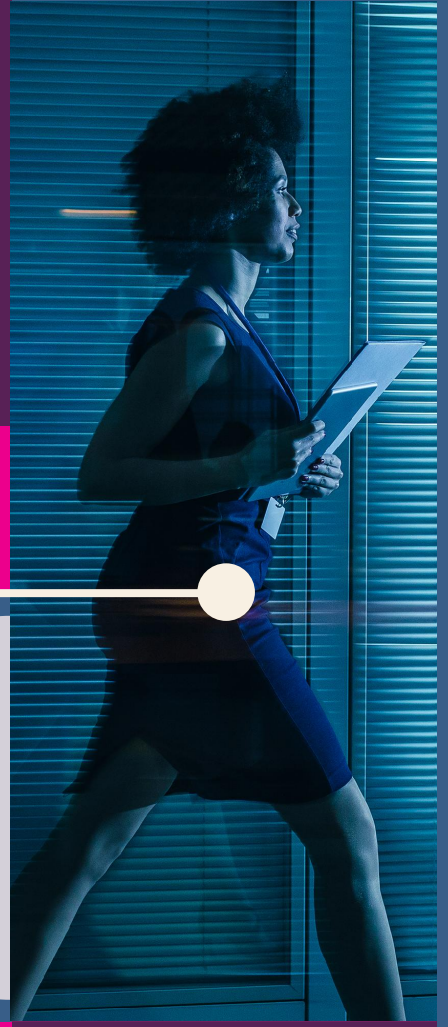
CLOUD COMPUTING:
ON-DEMAND COMPUTING RESOURCES

- **On-Demand Services:** Access computing resources (servers, storage, databases, software) over the internet.
- **Pay-as-You-Go Model:** Eliminates upfront costs for hardware and software.
- **Scalability & Flexibility:** Easily scale resources up or down based on needs.
- **Benefits:**
  - Cost Reduction: Eliminates upfront infrastructure costs and reduces maintenance overhead.
  - Increased Agility: Businesses can adapt to changing needs by quickly scaling resources.
  - Improved Accessibility: Access applications and data from anywhere with an internet connection.



FUNCTIONING OF CLOUD COMPUTING: A BEHIND-THE-SCENES LOOK

- **Pooled Resources:** Vast pools of computing resources (servers, storage, network) are managed by cloud providers.
- **Virtualization Technology:** Creates multiple virtual machines (VMs) on a single physical server, optimizing resource utilization.
- **Self-Service Model:** Users can provision and manage their cloud resources through a web interface or API.
- **On-Demand Elasticity:** Users can scale resources up or down as needed, paying only for what they use.



CLOUD SERVICES:

Diverse Service Offerings: Cloud providers offer a wide range of services beyond storage, including:

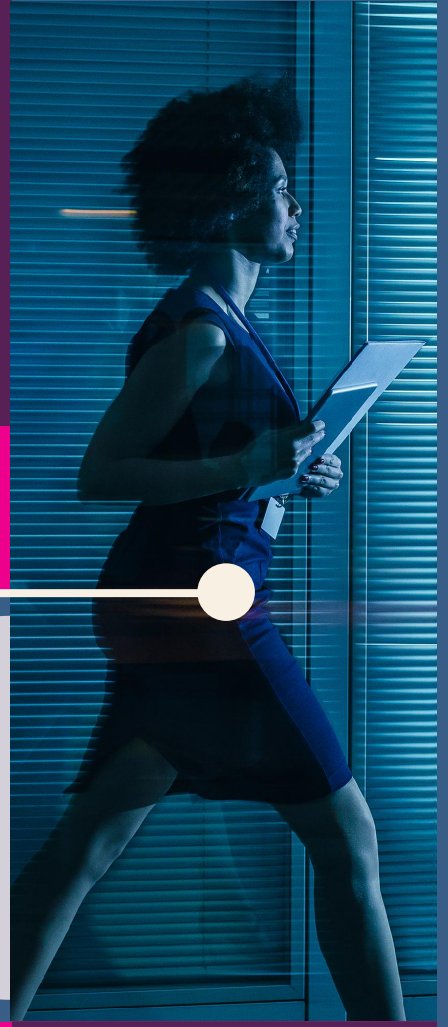
Databases: Managed database services for various needs (e.g., relational databases, NoSQL databases)

Networking: Scalable and secure virtual networks for cloud resources

Analytics & Big Data: Tools and platforms for data processing, analysis, and visualization

Machine Learning & AI: Access to powerful AI and machine learning capabilities on demand

Management Tools: Tools for monitoring, provisioning, and managing cloud resources

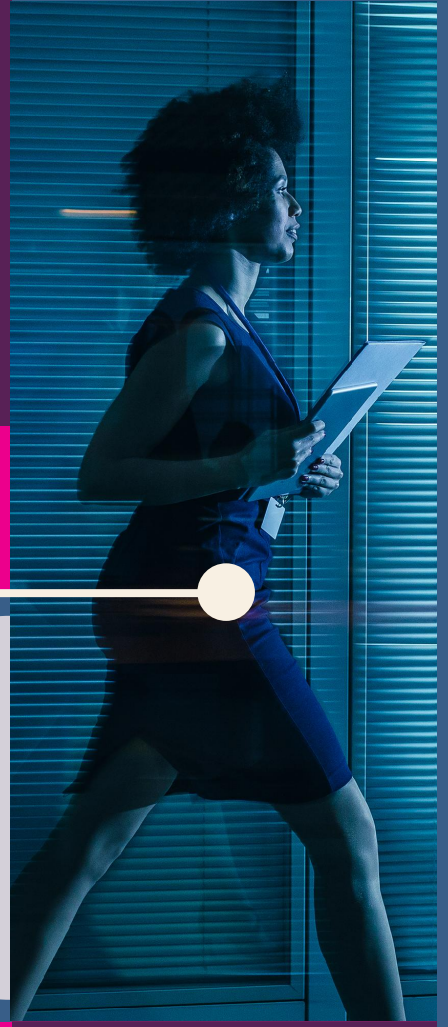


CLOUD SECURITY: MITIGATING RISKS

Shared Responsibility Model: Cloud providers secure the underlying infrastructure, while users are responsible for securing their data and applications.

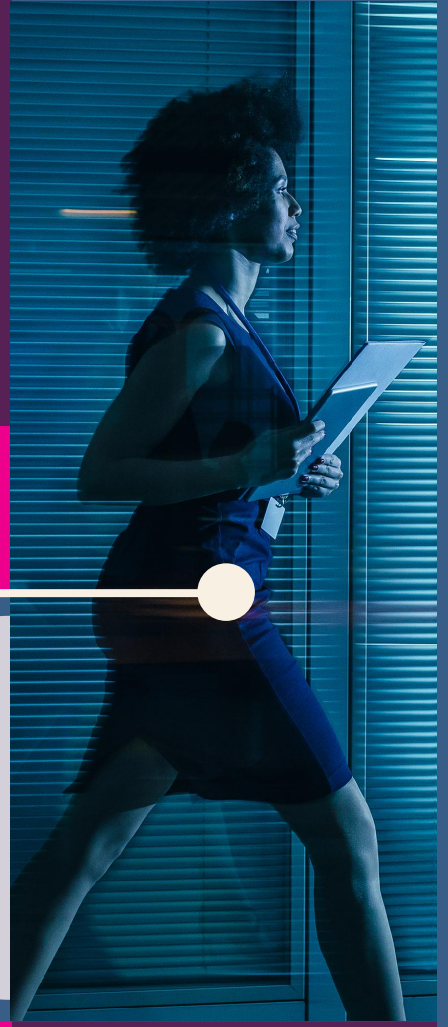
Security Features: Cloud providers offer a range of security features, including encryption, access control, identity and access management (IAM), and vulnerability management.

Best Practices: Following best practices like strong passwords, data encryption, and regular backups is crucial for robust cloud security.



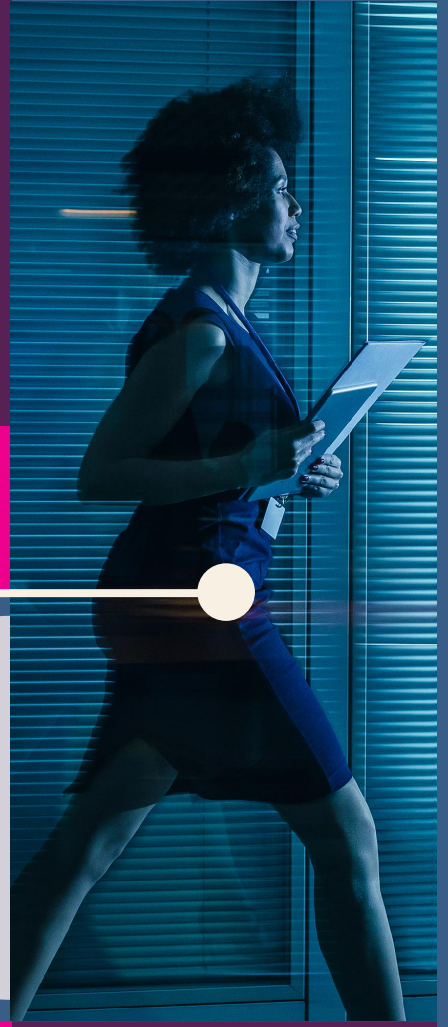
CLOUD COST MANAGEMENT

1. **Cost Transparency:** Cloud providers offer detailed billing reports and cost monitoring tools to help users track and analyze their cloud spending.
2. **Cost Optimization Strategies:** Several strategies can optimize cloud costs, including:
    1. **Rightsizing resources:** Ensure you're using the appropriate resources (e.g., VM size) for your needs.
    2. **Reserved Instances:** Purchase reserved instances for predictable workloads to get significant discounts.
    3. **Spot Instances:** Utilize unused cloud capacity at a discounted rate on a short-term basis.
    4. **Automated Scaling:** Automatically scale resources up or down based on usage patterns to avoid overprovisioning.



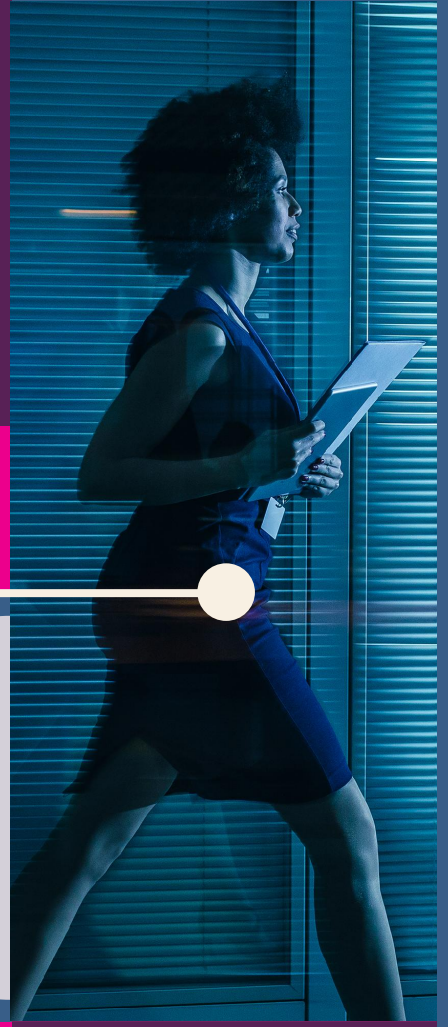
CLOUD ADOPTION STRATEGIES:

1. **Phased Approach:** A well-defined, phased approach to cloud adoption minimizes disruption and ensures a smooth transition.
2. **Planning & Assessment:** Start with a comprehensive plan, assessing your current IT infrastructure, cloud needs, and budget.
3. **Migration Strategy:** Develop a migration strategy for your data and applications, considering factors like complexity and downtime tolerance.
4. **Optimization & Management:** Continuously optimize your cloud deployment and implement effective cloud management practices.



CLOUD STORAGE:

1. **Scalable Storage:** Provides on-demand storage capacity, eliminating the need for physical storage limitations.
2. **Data Durability & Accessibility:** Cloud storage replicates data across geographically dispersed locations, ensuring high availability and disaster recovery.
3. **Storage Options:** Offers a variety of storage options like object storage, block storage, and file storage to suit different data types and access needs.
4. **Security & Compliance:** Cloud providers invest heavily in security measures to safeguard data privacy and adhere to industry regulations.



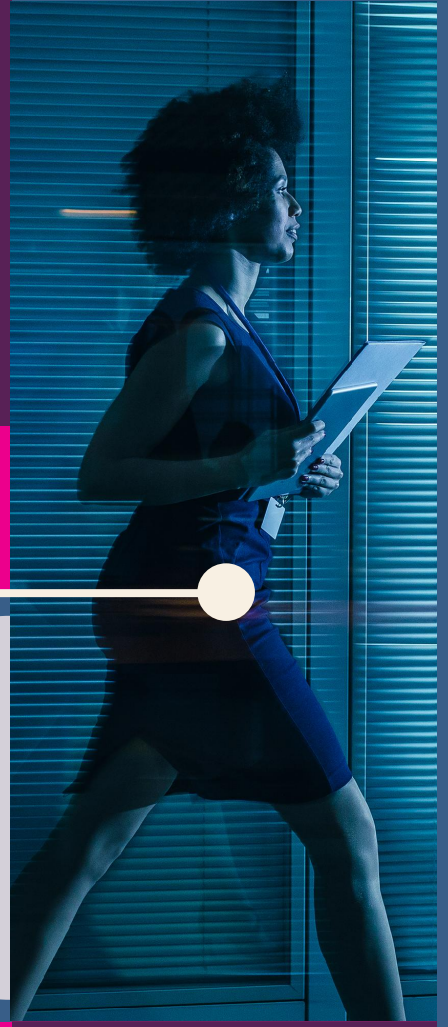
INDUSTRIAL APPLICATIONS OF CLOUD COMPUTING

Manufacturing:

- Cloud-based Manufacturing Execution Systems (MES) for production planning, scheduling, and real-time monitoring.
- Predictive maintenance using sensor data and analytics to prevent equipment failures.
- Supply chain optimization with improved visibility and collaboration throughout the supply chain.

Energy & Utilities:

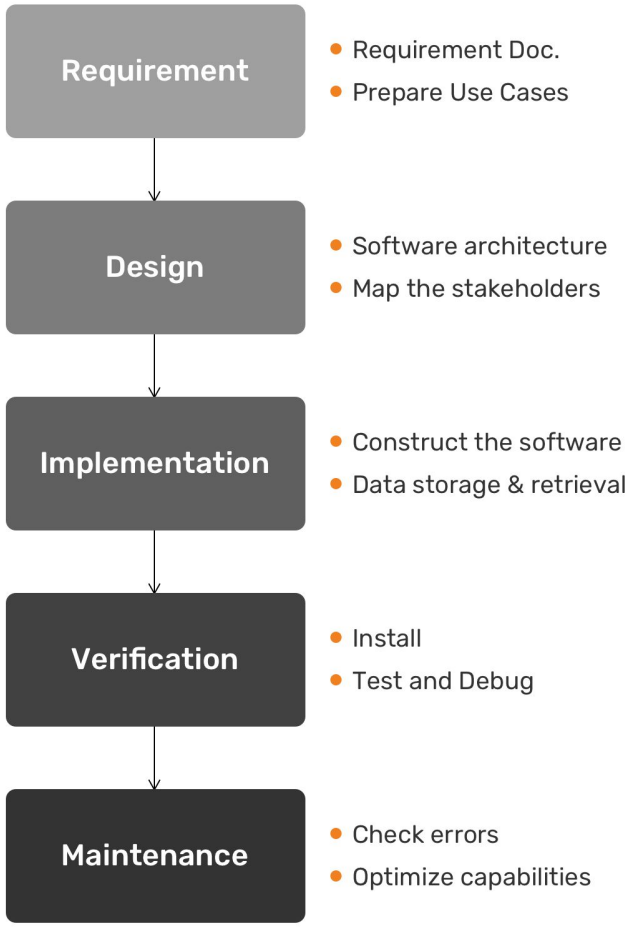
- Smart grids for efficient energy management and demand-response programs.
- Data analytics for optimizing energy production, distribution, and consumption.
- Cloud-based asset management for monitoring and maintaining power plants and distribution networks.

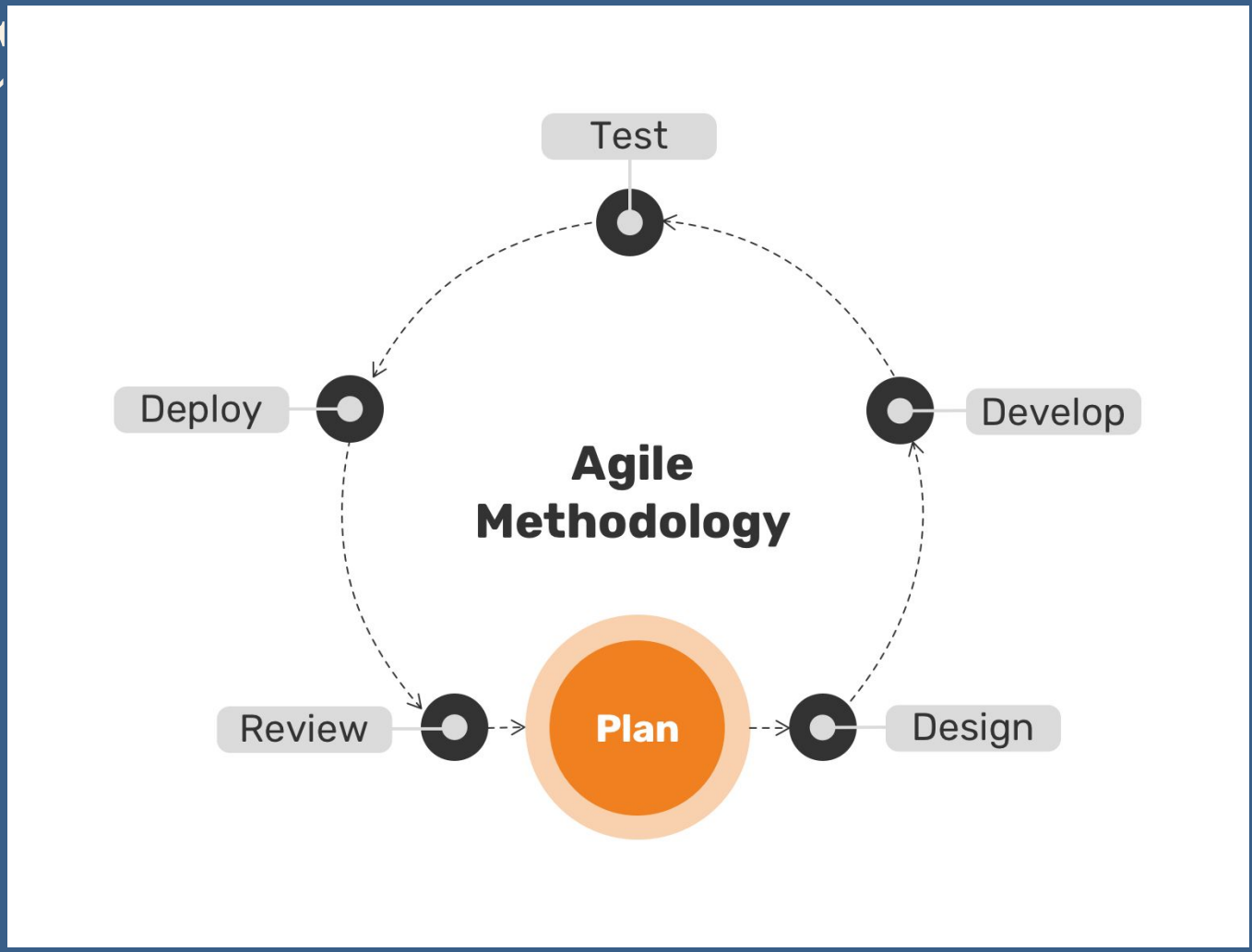


VIRTUALIZATION IN CC:

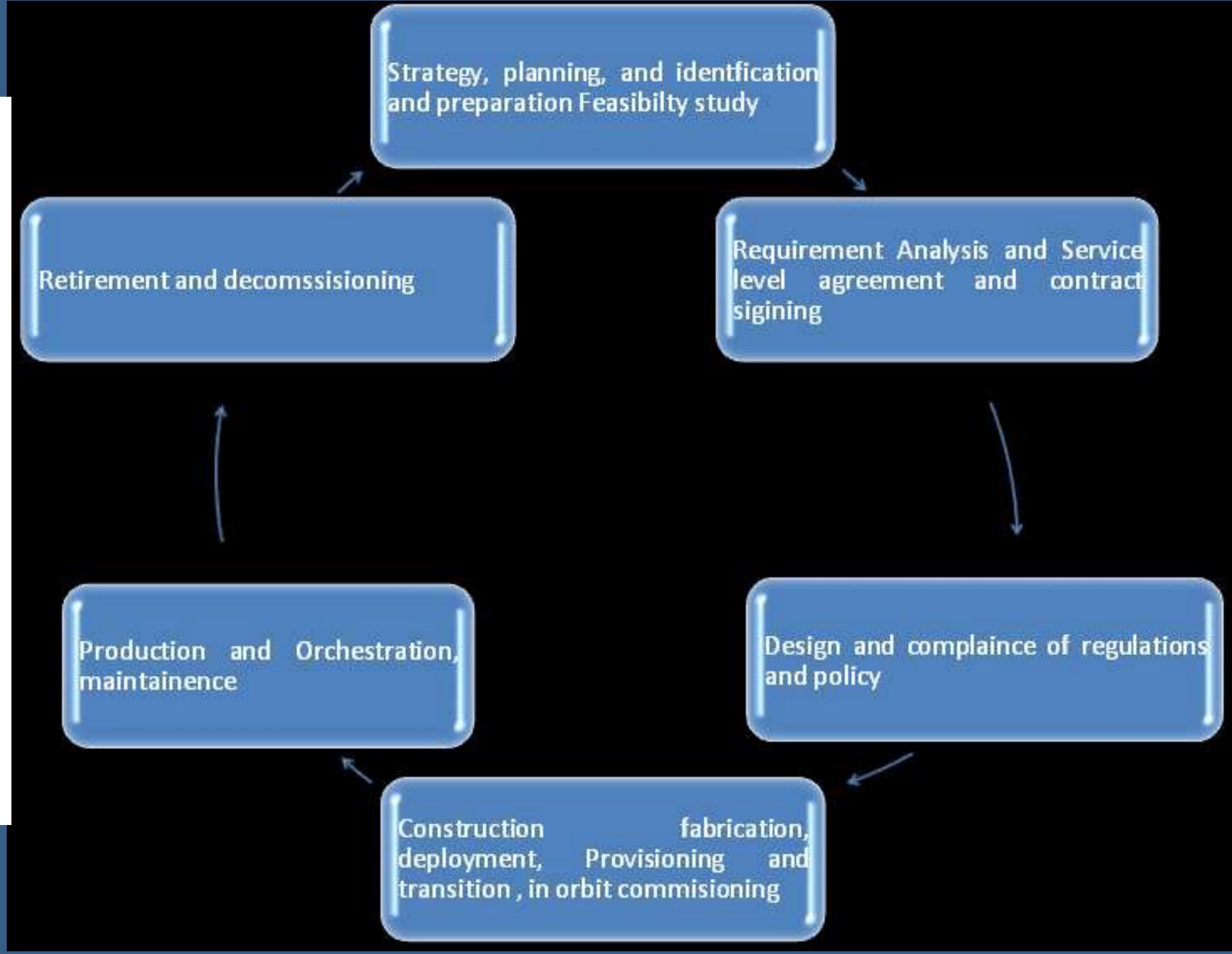
- Server
  - Processor
  - RAM
  - ROM
  - Network
- **Only one instance –** means only physical presence
- **Hypervisor program –** used to create virtual machines
- **Single instance – multiple machines**
- Now the server will be considered as the **host machine**
- The created Virtual Machines are called **Guest Machine**
- Hypervisor is called the **post machine**

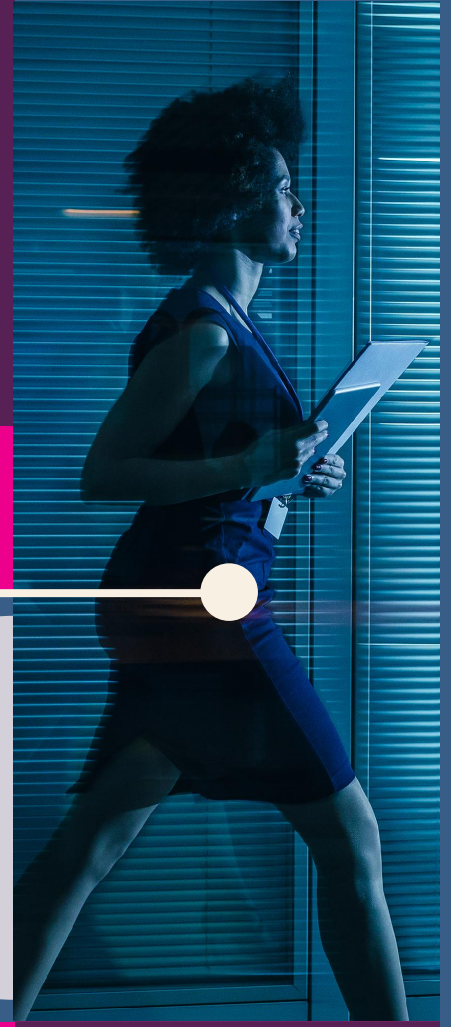
CDLC – CLOUD LIFE C





- **Requirement**
  - Requirement Doc.
  - Prepare Use Cases
- **Design**
  - Software architecture
  - Map the stakeholders
- **Implementation**
  - Construct the software
  - Data storage & retrieval
- **Verification**
  - Install
  - Test and Debug
- **Maintenance**
  - Check errors
  - Optimize capabilities





CLOUD ECOSYSTEM

MSP (Managed Service Provider)

CS-Provider (SaaS, IaaS, PaaS) ***AWS***

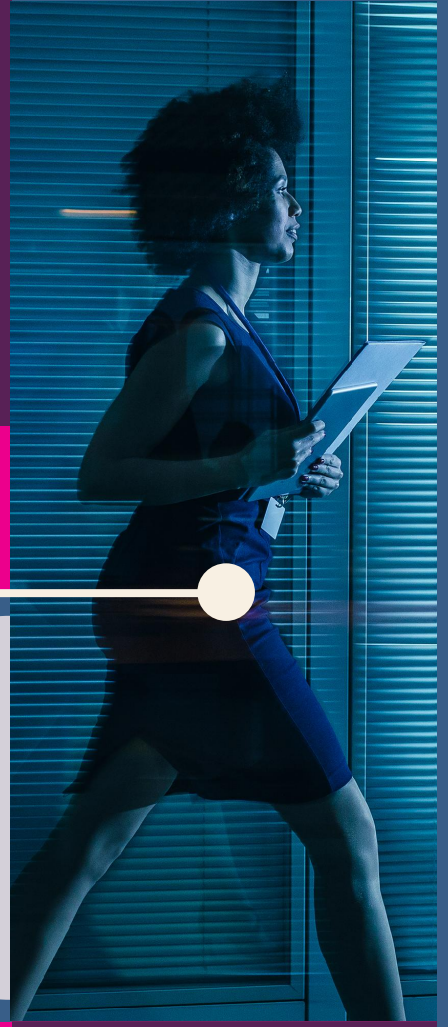
CS-User

CS-Intermediate Users

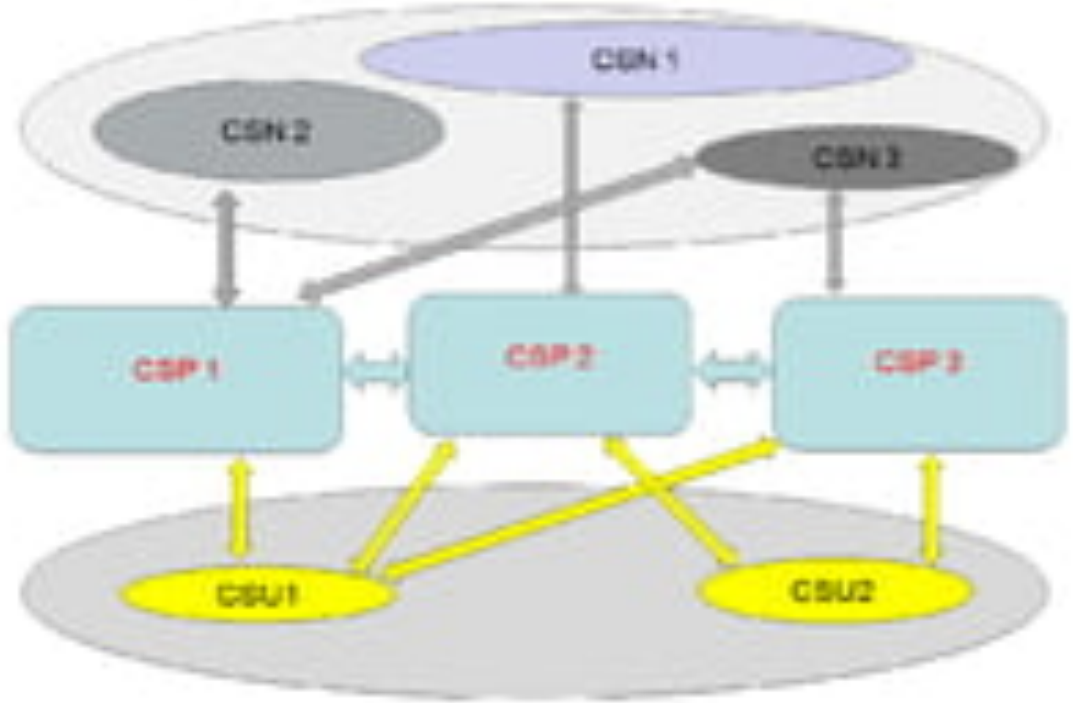
CS-Enterprise

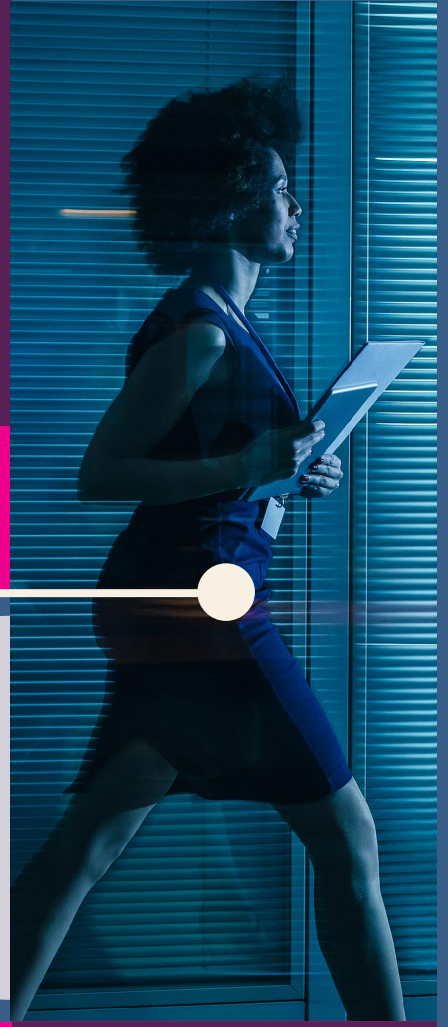
WHAT EACH ACTOR DOES?

- **Cloud Service Provider (CSP):**
  - Deliver on-demand,
  - Scalable cloud computing services to users and businesses.
- **Cloud Service User (CSU) (User):**
  - Leverage cloud services for their personal or departmental needs (depending on context).
- **Cloud Service User (CSU) (Enterprise):** Utilize cloud services to support and optimize enterprise-wide operations.
- **Managed Service Provider (MSP):**
  - Manage and optimize cloud deployments for clients, *providing expertise*, ongoing support, and potentially additional services beyond just the base cloud offering.



The three actors of cloud ecosystem





EACH ACTOR'S EXAMPLES

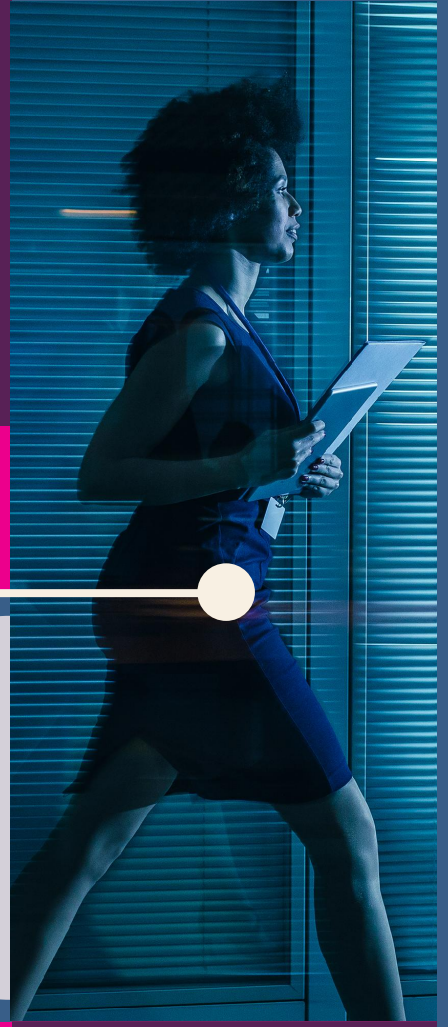
Cloud Service User (CSU):

User:

- Mr. X, a freelance graphic designer, uses a cloud-based photo editing software called Adobe Photoshop through a subscription model.
- He's a Cloud Service User leveraging cloud services for his personal needs.

Enterprise:

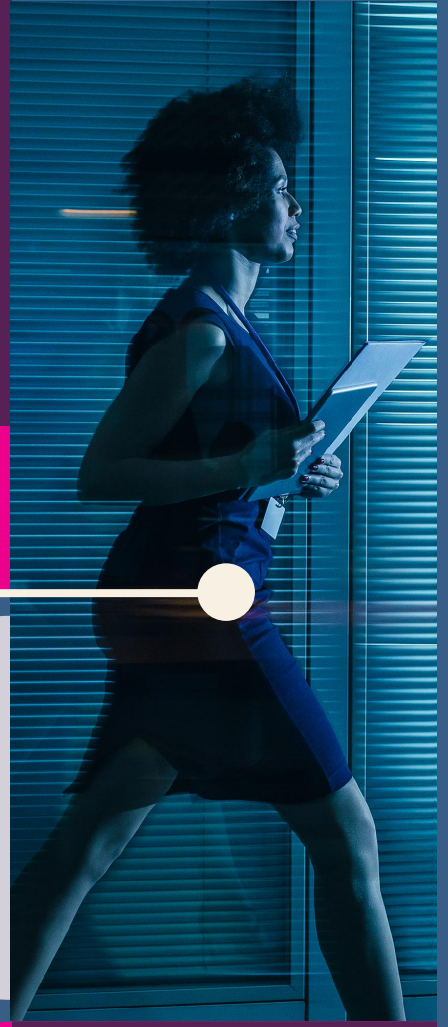
- The marketing department of a large corporation uses a cloud-based customer relationship management (CRM) platform like Salesforce to manage customer data and interactions.
- In this context, the marketing department acts as a Cloud Service User within the larger enterprise, utilizing cloud services to support its specific departmental functions



EACH ACTOR'S EXAMPLES

Managed Service Provider (MSP):

- Acme Corporation uses Google Cloud Platform (GCP) for its core infrastructure.
- They partner with a Cloud Service Partner called Cloudwise.
- Cloudwise takes responsibility for managing Acme's GCP environment.
- This includes tasks like provisioning resources, monitoring performance, applying security patches, and providing ongoing technical support.
- Cloudwise might also offer additional services like cloud cost optimization, migration assistance, or developing custom applications on top of GCP.



EACH ACTOR'S EXAMPLES

Reseller: Imagine a small company called CloudX that doesn't have its own cloud infrastructure.

- CloudX partners with a major CSP like Amazon Web Services (AWS) to resell AWS services to its customers.
- CloudX might offer additional services like initial setup, basic customer support, or bundled packages with specific functionalities built on top of AWS services