Topic 2

Architectural Layers of Cloud Computing

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Introduction to Cloud Computing

- Cloud computing is the on-demand delivery of computing services (servers, storage, databases, networking, software) over the internet.

- **Key Characteristics:**
  - On-demand self-service
  - Broad network access
  - Resource pooling
  - Rapid elasticity
  - Measured service (pay-as-you-go)

Delivery of Computing Services

- Servers
- Storage
- Databases
- Networking
- Software
- Analytics
- Artificial Intelligence

Why Cloud Computing?

Business Advantages:

Scalability for growing workloads

Cost-effective model (operational vs. capital expenses)

Faster deployment of new services

Global reach and availability

Technical Advantages:

Automated software updates

Simplified infrastructure management

Resilience and redundancy

Cloud Computing Layers

High-Level Layers in Cloud:

1. **Infrastructure as a Service (IaaS)**
2. **Platform as a Service (PaaS)**
3. **Software as a Service (SaaS)**

- **Goal:** Abstract complexity for end users and businesses.

Understanding the Layered Model

- **Layered Approach:**
  - Each layer builds upon the capabilities of the layer below.
  - Users at each layer only focus on resources they directly manage.
- **Analogy:**
  - SaaS: The complete package (like using a fully-furnished apartment).
  - PaaS: The foundation to build upon (like an empty apartment where you bring your own furniture).
  - IaaS: The raw materials and space (like the land and building framework).

Software as a Service (SaaS)

- Software distribution model in which applications are hosted by a third-party provider and made available over the internet.

- **Key Characteristics:**
  - No local installation required
  - Subscription or pay-per-use pricing
  - Accessible via web browser or thin client

- **Examples:**
  - Salesforce, Microsoft 365, Google Workspace (Gmail, Docs), Dropbox

SaaS – Benefits and Challenges

Benefits:

Quick deployment and minimal setup

Reduced IT overhead (maintenance, updates are handled by provider)

Access from anywhere, on multiple devices

Challenges:

Limited customization compared to on-premises software

Dependency on internet connectivity

Potential data privacy and compliance concerns

Software As A Service (SAAS)

Platform as a Service (PaaS)

- A set of tools and services designed to make coding and deploying applications quick and efficient.

- Providers manage the underlying infrastructure; developers focus on the application itself.

- **Key Components:**
  - Runtime environment (language runtimes, frameworks)
  - Development tools
  - Databases and integration services
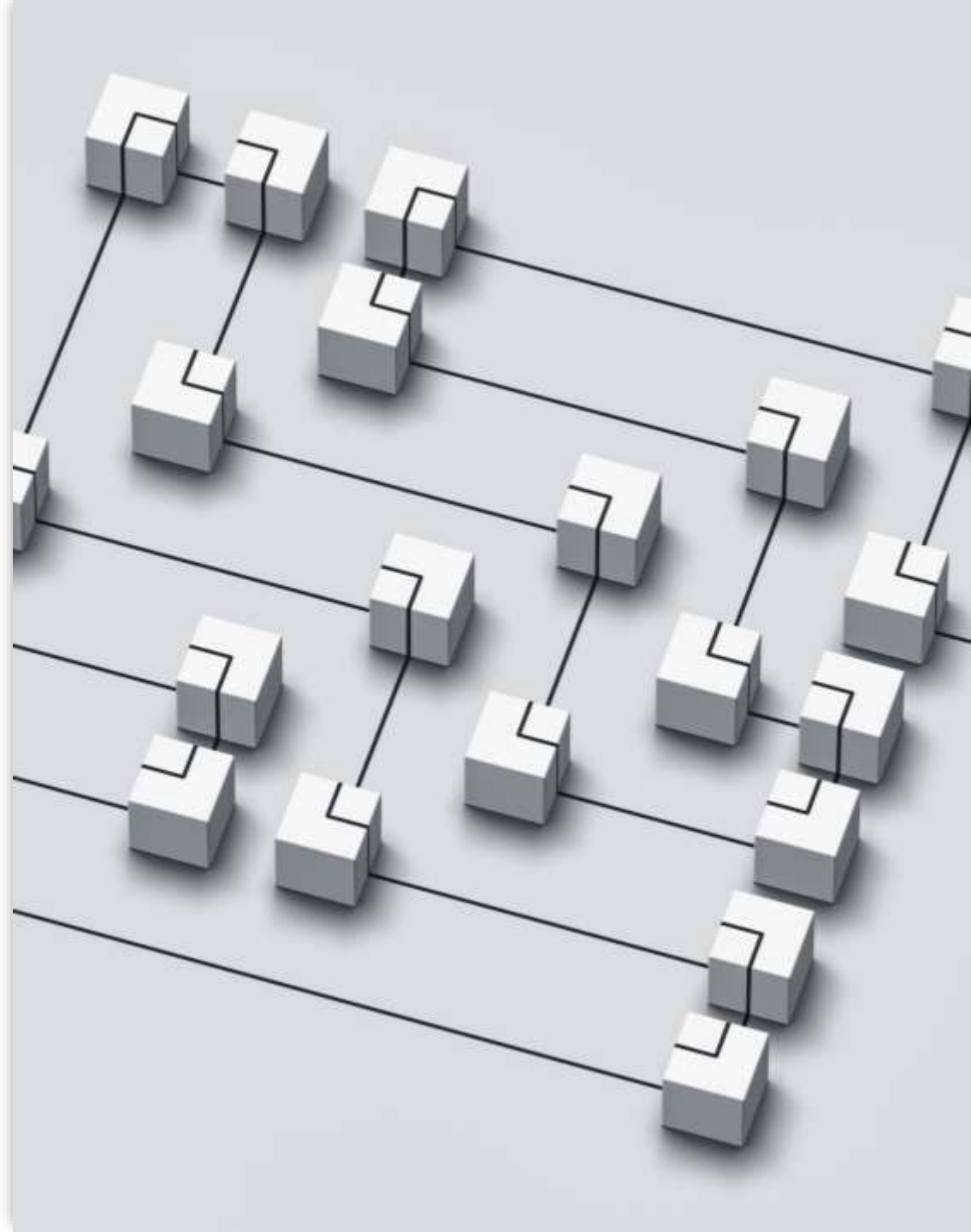
PaaS - Benefits and Challenges

Benefits:

Simplifies development and
deployment

Less complexity in managing
servers, storage, or networking

Automated scalability

Challenges:

Might be restricted to provider-
specific tools/languages

Risk of "vendor lock-in"

Costs can grow if the application
scales rapidly

Examples of PaaS Providers

Major PaaS Offerings:

Heroku (Salesforce)

Google App Engine (Google Cloud Platform)

Azure App Service (Microsoft Azure)

AWS Elastic Beanstalk (Amazon Web Services)

Key Services Offered:

Hosting environments

Integrated development environments (IDEs)

Database and storage integrations

Platform As A Service (PAAS)

Infrastructure as a Service (IaaS)

- Virtualized computing resources over the internet, including servers, storage, and networking hardware.

- Users install and manage operating systems, applications, and middleware on provided infrastructure.

- **Key Components:**
  - Virtual machines (VMs)
  - Storage (object, block, file)
  - Networking (virtual networks, firewalls, load balancers)
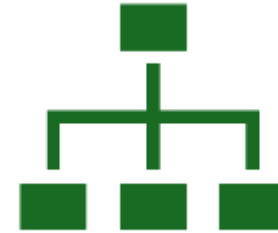
IaaS - Benefits and Challenges

Benefits:

High flexibility and control over resources

Pay-as-you-go model for infrastructure

Easy scalability and rapid provisioning

Challenges:

Requires in-house expertise to configure and manage

Security and compliance are partly the customer's responsibility

Potential complexity in managing virtual machines and networks

IaaS Providers and Use Cases

Major IaaS Providers:

Amazon Web Services (EC2, S3, etc.)

Microsoft Azure (Virtual Machines, Azure Storage)

Google Cloud Platform (Compute Engine, Cloud Storage)

Typical Use Cases:

Hosting web applications

Big data processing

Backup and disaster recovery

Development and testing environments
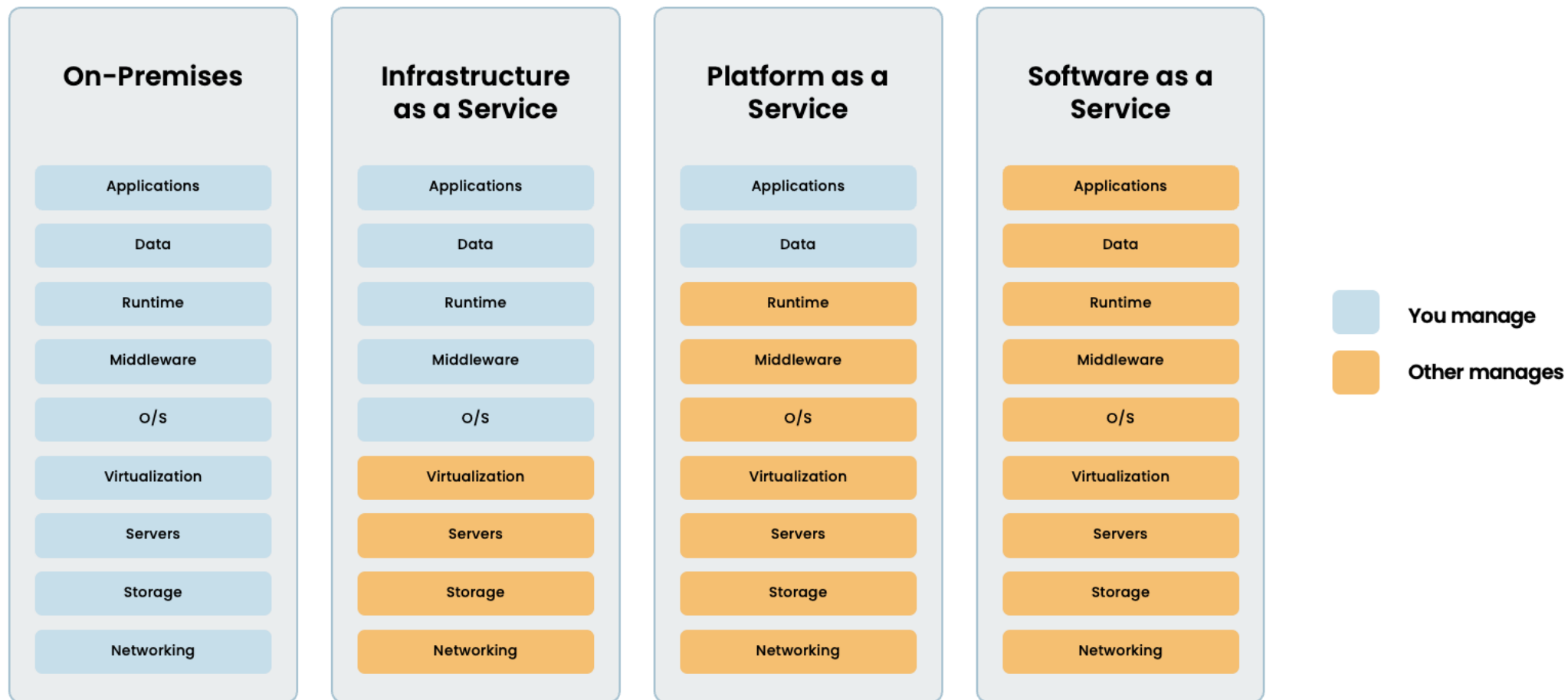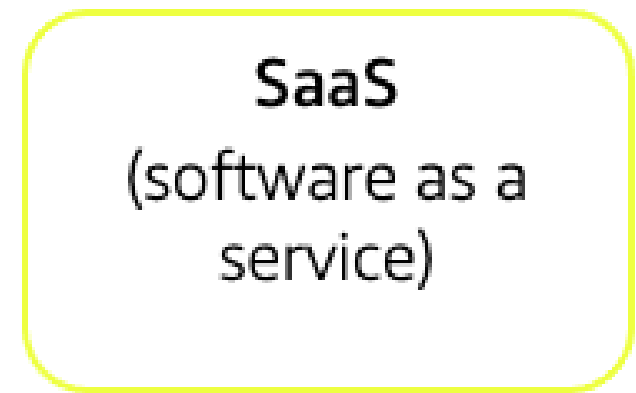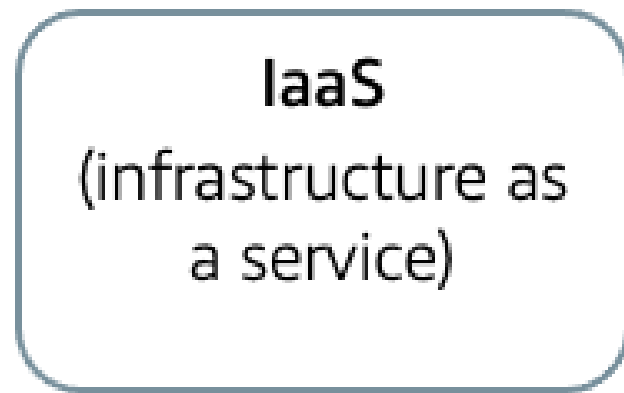
Infrastructure As A Service (IAAS)

Dynamic Infrastructure

The ability to quickly adapt and reconfigure IT infrastructure resources as demands change.
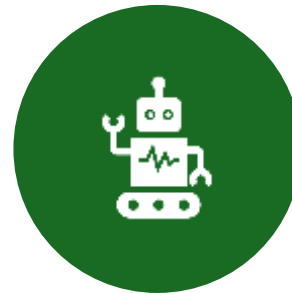
Often enabled by virtualization, automation, and orchestration technologies.

Ensures optimal performance, cost efficiency, and high availability

Facilitates continuous integration and continuous deployment (CI/CD)

Key Components of Dynamic Infrastructure

Virtualization - Abstracts hardware into virtual resources (VMs or containers)

Automation - Scripts or tools to streamline provisioning, configuration, and scaling

Orchestration - Systems (like Kubernetes, Docker Swarm) that manage the lifecycle of multiple resources

Monitoring & Management - Tools to observe and adjust resource usage in real time (e.g., AWS CloudWatch, Azure Monitor)

Benefits of a Dynamic Infrastructure

Scalability
- Easily add or remove resources in response to traffic or workload changes

Agility
- Faster deployment of new applications and updates

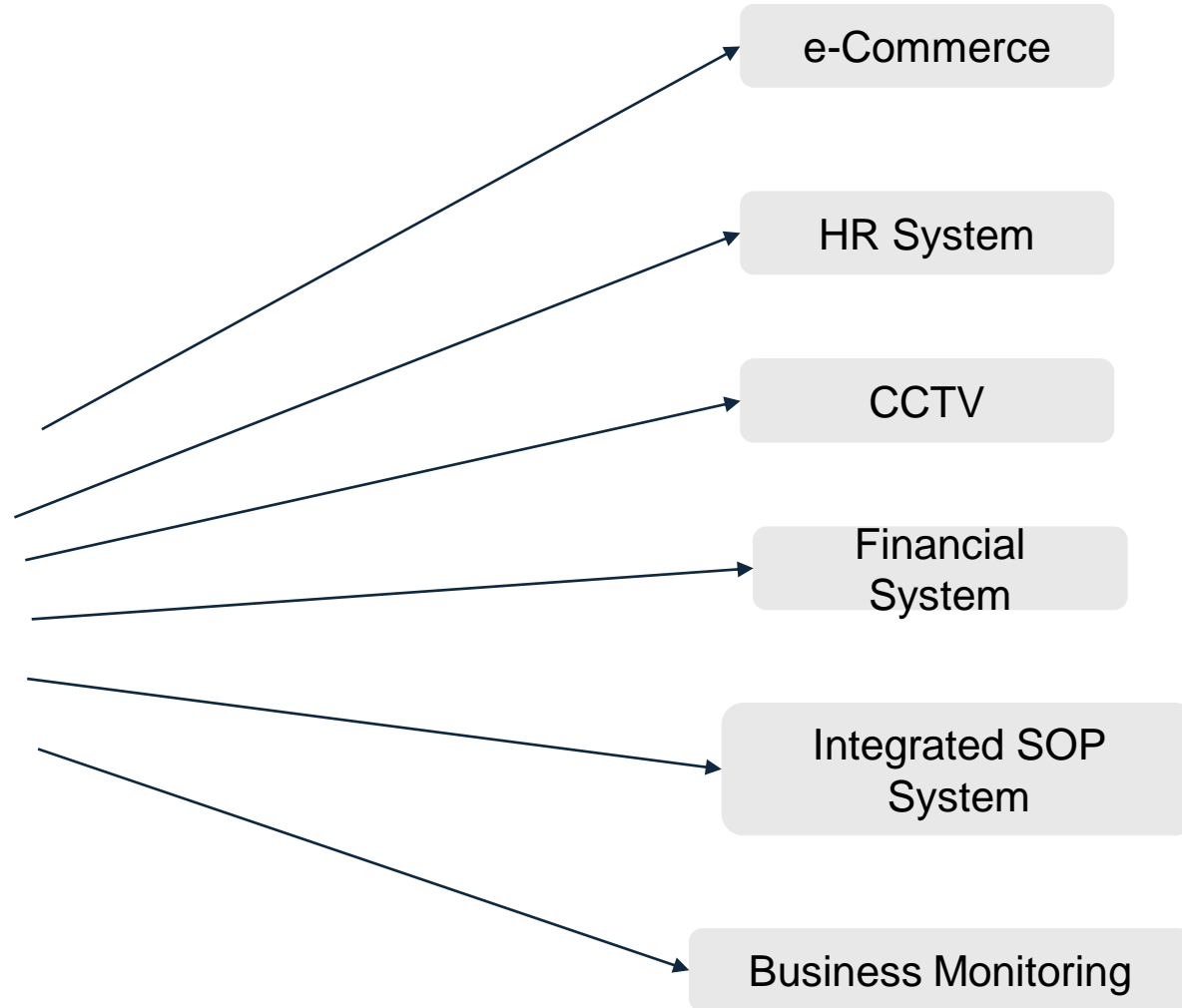## Cost Optimization
- Pay only for the resources actually in use

Fault Tolerance
- Automatically shift workloads if a server or region fails

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- e-Commerce
- HR System
- CCTV
- Financial System
- Integrated SOP System
- Business Monitoring

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Traditional way:

- Weeks/months to setup the infrastructure
- Running business on paper

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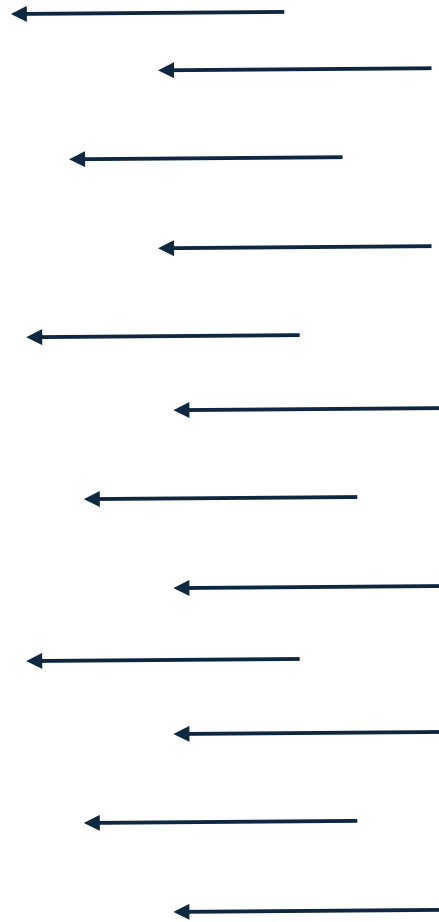

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Modern way:

- Cloud hosting
- Server deployment in minutes
- Everything integrated
- Easy accessibility anytime

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Heavy Traffics

Scalable

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Vertical Scaling
(Increase size of instance (RAM ,
CPU etc.))

Horizontal Scaling
(Add more instances)

Challenges of Dynamic Infrastructure

Complexity

Multiple layers of abstraction can be difficult to manage

Skill Gap

Advanced knowledge required for automation/orchestration tools

Governance

Ensuring compliance and security policies in rapidly changing environments

Monitoring & Debugging

Dynamic scaling can make troubleshooting more complex

Type of Cloud Deployment

Another thing about Cloud Computing is how accessible it is. For this,
we can differentiate cloud computing in three different ways :

- **Public Cloud**
- **Private Cloud**
- **Hybrid Cloud -**
  - **Mixture of Private & Public**
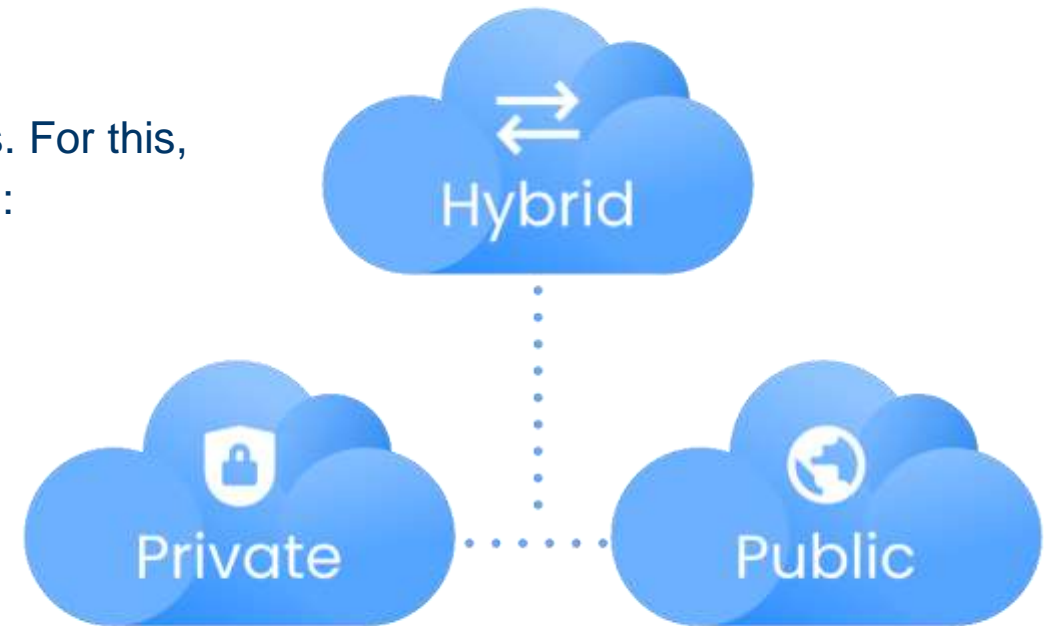
Putting It All Together

Layered Approach Recap

SaaS: Complete software solutions provided to end users

PaaS: Platform that abstracts infrastructure and offers tools for development

IaaS: Core infrastructure (servers, storage, networking) delivered virtually

Dynamic Infrastructure - Underpins all these layers with flexibility and automation

Choosing the Right Model - Depends on your business needs, development expertise, and desired level of control

Summary

- Cloud computing offers different service models (SaaS, PaaS, IaaS) to suit various needs.

- Dynamic infrastructure enables scalability, agility, and cost-effectiveness.

- Understand the trade-offs (control vs. complexity, cost vs. flexibility).