Cloud Application & Development Foundation

[BE SE Sixth Semester]

Nepal College of Information Technology
POKHARA UNIVERSITY

Unit I: Introduction

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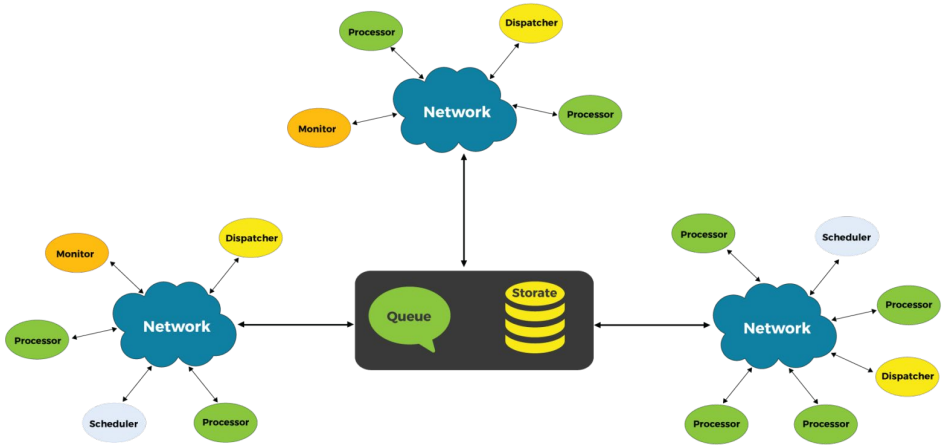
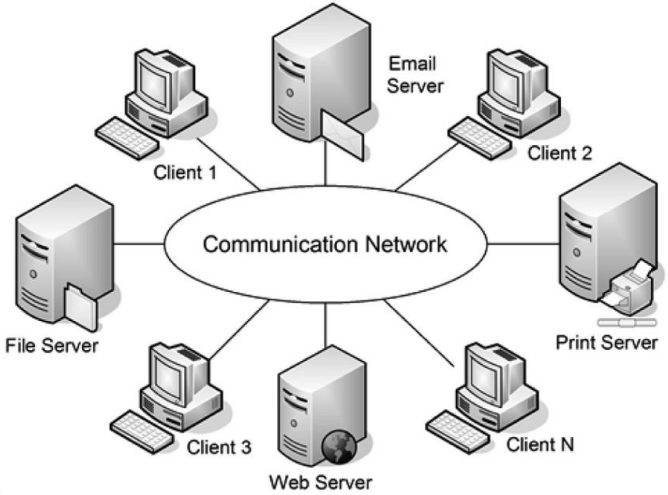
Distributed Computing

- Distributed computing is a field of computer science that involves a network of independent computers working together to solve a problem by sharing tasks and resources.
- Each computer, or node, operates independently while communicating with others to achieve a common goal, often improving efficiency and performance.



Distributed Computing



Advantages of Distributed Computing

- Scalability: *Easily add resources to handle growing workload*
- Availability: *System stays accessible despite failures or load*
- Consistency: *Ensures all nodes have the same data*
- Transparency: *Hides details; users see single unified system*
- Efficiency: *Maximizes resource use for faster, cost-effective performance*

Challenges of Distributed Computing

- Complexity: *Managing multiple systems increases design and maintenance challenges.*
- Consistency: *All nodes reflect the same data state reliably.*
- Performance: *Measures system speed and responsiveness under load.*
- Network Failure: *Communication breakdowns disrupt coordination between nodes.*

Collaborative Computing

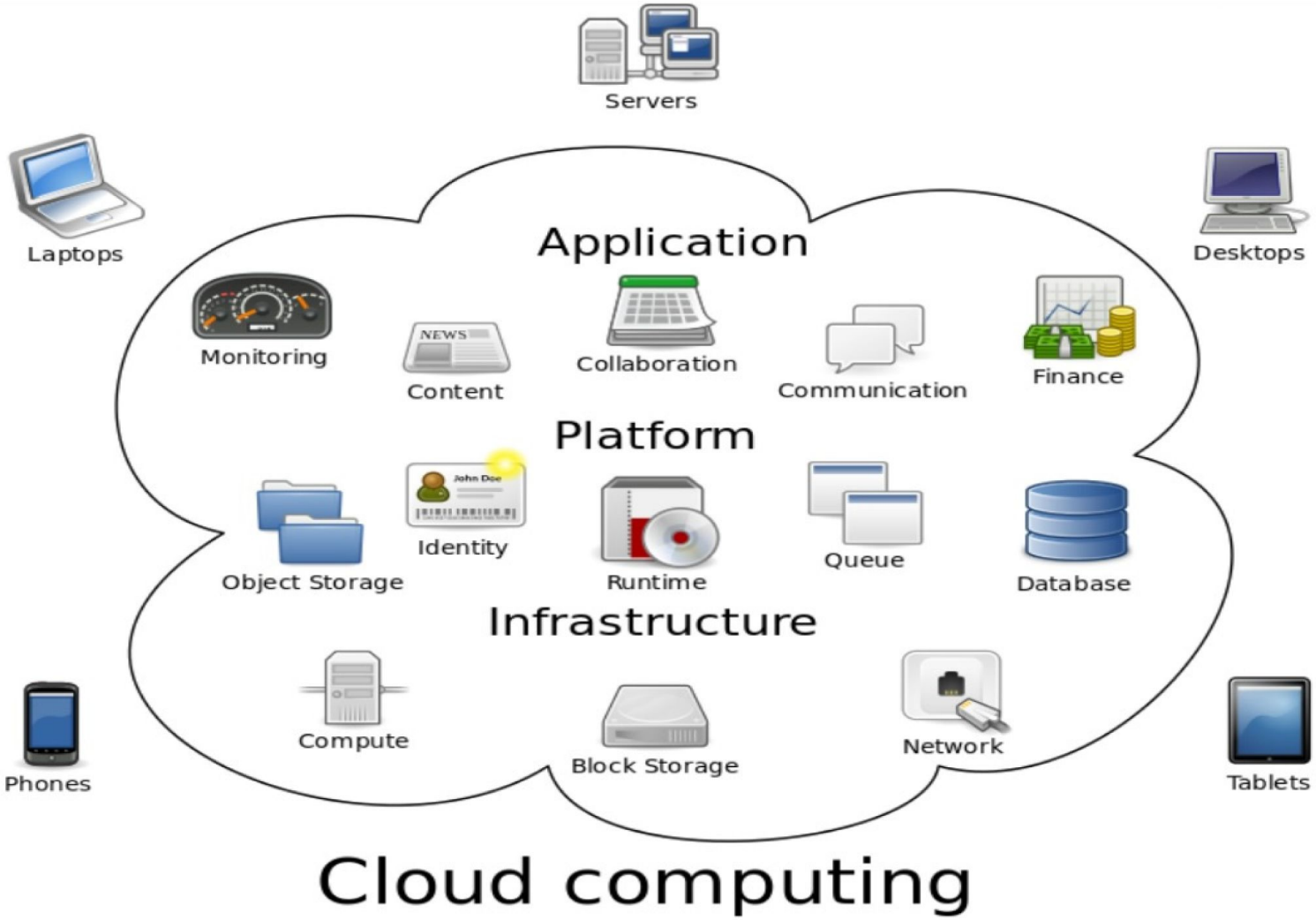
Collaborative Computing refers to applications that enable the sharing of information and resources among multiple users, facilitating efficient communication, document collaboration, and real-time interactions without the need for physical presence in the same location.

- Collaborative computing helps people work together online—sharing files, chatting, editing docs—without needing to be in the same room.
- Shared documents and cloud storage, Real-time communication (chat, video calls), Task and workflow management tools
- Examples: *Google Docs, Microsoft Teams, Discord, Zoom*

Cloud Computing

- The cloud computing is the delivery of computing services over the Internet.
- Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations.
- Cloud computing is the dynamic delivery of information technology resources and capabilities as a service over the Internet.
- It is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet.

“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources(e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models” - NIST



Cloud computing

Functioning of Cloud Computing

Well-Defined Interface: access cloud services through easy-to-use apps or websites—no need to know the technical stuff behind it.

Available Everywhere, On Any Device: Whether you're on your phone, laptop, or tablet—at home or in a café—you can reach your files and tools anytime.

Scales on Demand: The cloud gives you more resources instantly, and you don't have to buy new hardware.

Reliable: Your data is backed up in multiple places, so even if one server fails, you don't lose access.

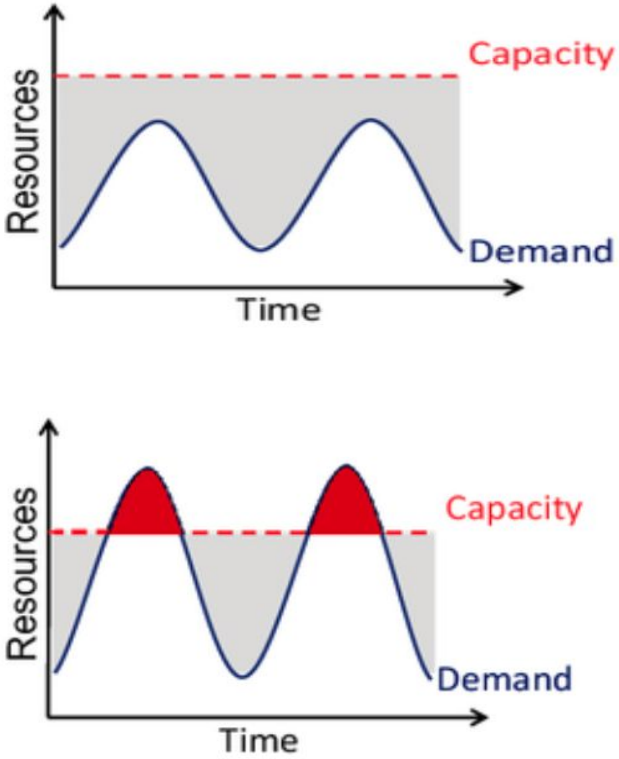
Low Upfront Cost (Capital Expenditure): You don't need to buy expensive servers or equipment—just sign up and start using what you need.

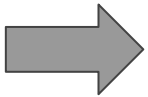
Pay-as-You-Go: Only pay for what you actually use—like you pay for electricity or mobile data.

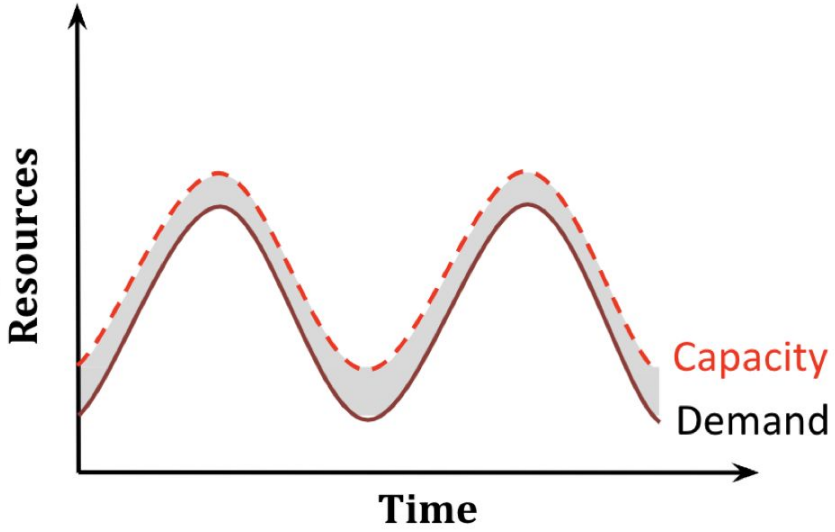
Comparing Cloud Services to a Data Centre

Traditional Data Center	Cloud Computing
Needs hardware, space, power, and cooling	Runs on shared, virtualized resources
Requires manual OS, app management & updates	Resources managed and automated by provider
Needs upfront software licensing	Pay only for what you use
Hard to scale efficiently	Scales easily on demand
High capital costs	Low upfront cost, flexible pricing
Full control—but also full responsibility	Less management, more convenience
Local setup	Accessible via Internet or private connection

Emergence of Dynamic Provisioning







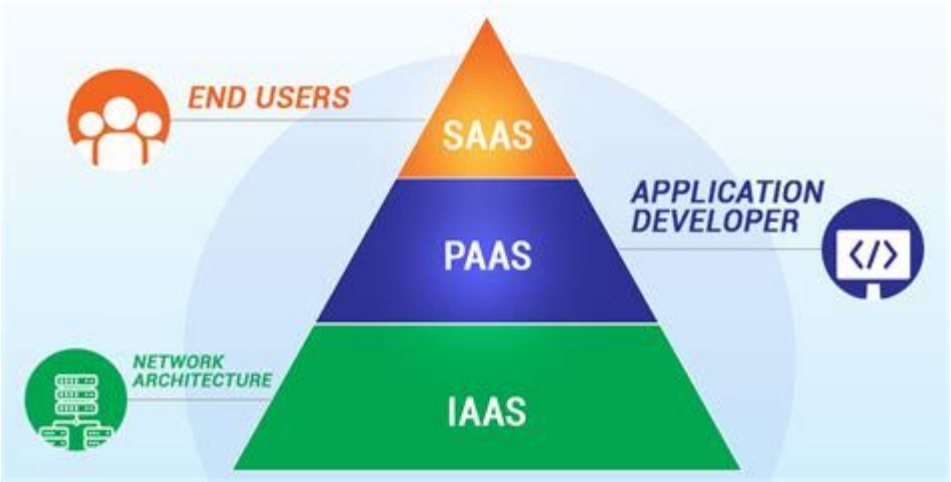
Cloud Architecture

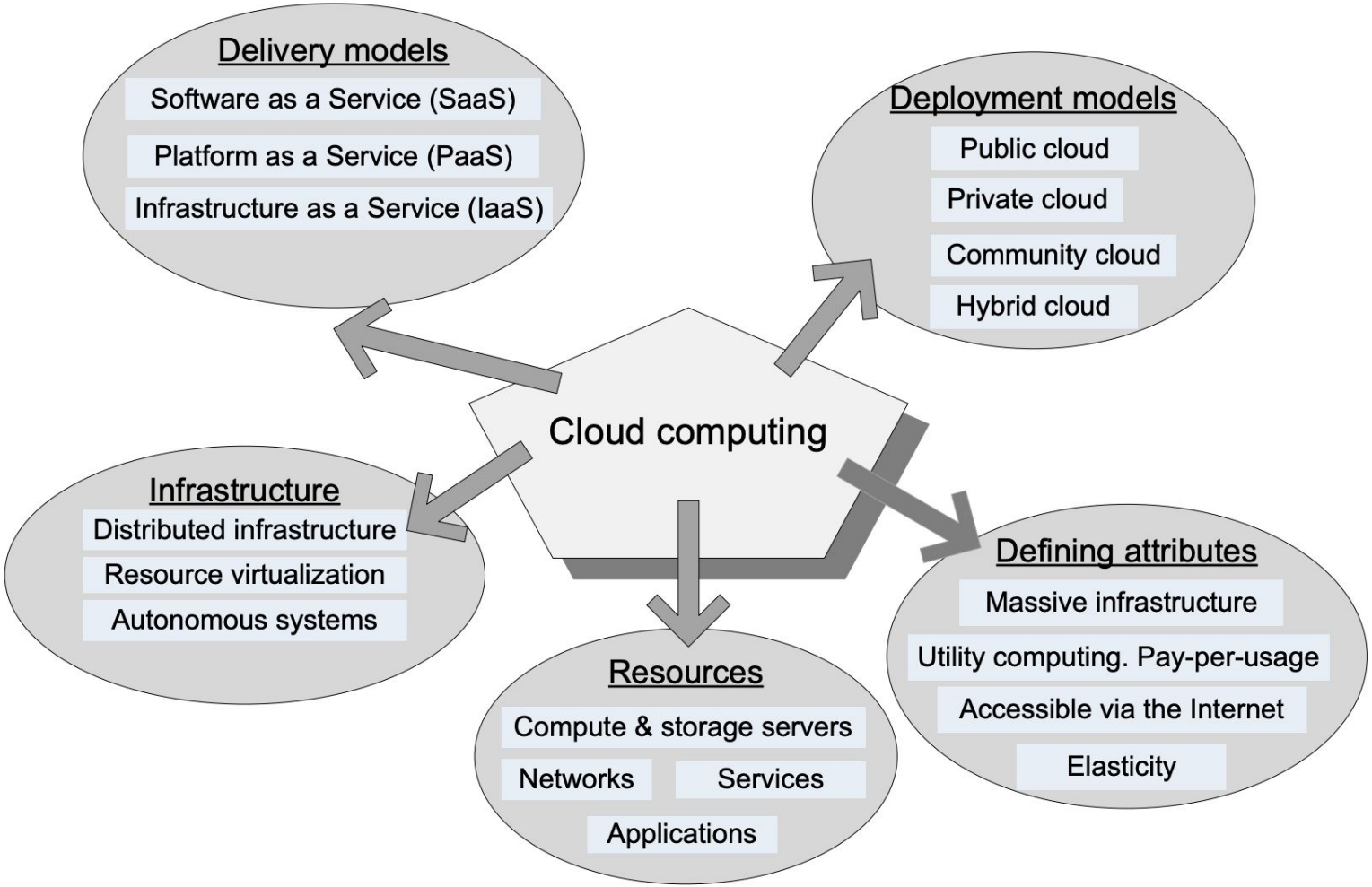
- Cloud architecture refers to the components and subcomponents required for cloud computing.
- The design and structure of cloud systems
- Defines how services like storage, compute, and networking are delivered
- Three key service models:

  IaaS – Infrastructure as a Service

  PaaS – Platform as a Service

  SaaS – Software as a Service




Delivery models
Software as a Service (SaaS)
Platform as a Service (PaaS)
Infrastructure as a Service (IaaS)
Deployment models
Public cloud
Private cloud
Community cloud
Hybrid cloud
Cloud computing
Infrastructure
Distributed infrastructure
Resource virtualization
Autonomous systems
Resources
Compute & storage servers
Networks
Services
Applications
Defining attributes
Massive infrastructure
Utility computing. Pay-per-usage
Accessible via the Internet
Elasticity

Infrastructure as a Service (IaaS)

- Infrastructure is compute resources, CPU, VMs, storage, etc
- The user is able to deploy and run arbitrary software, which can include operating systems and applications.
- The user does not manage or control the underlying Cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of some networking components, e.g., host firewalls.
- Services offered by this delivery model include: server hosting, storage, computing hardware, operating systems, virtual instances, load balancing, Internet access, and bandwidth provisioning.

Infrastructure as a Service (IaaS)

IaaS provides virtualized computing resources over the internet—servers, storage, networking, and more. It’s like renting infrastructure instead of owning it.

- Self-service provisioning of resources
- Pay-as-you-go billing
- Full control over OS, middleware, and applications
- Scalable up or down depending on demand

Examples: *Amazon EC2, Microsoft Azure VMs, Google Compute Engine*

Platform as a Service (PaaS)

Allows a cloud user to deploy consumer-created or acquired applications using programming languages and tools supported by the service provider.

The user:

- Has control over the deployed applications and, possibly, application hosting environment configurations.
- Does not manage or control the underlying Cloud infrastructure including network, servers, operating systems, or storage.

Not particularly useful when:

- The application must be portable.
- The hardware and software must be customised to improve the performance of the application.

Platform as a Service (PaaS)

PaaS offers a development and deployment environment in the cloud. It includes tools, libraries, and services needed to build applications—without worrying about the infrastructure underneath.

- Pre-configured runtime environments
- Integrated development tools (CI/CD pipelines, databases)
- Automatic scaling and updates
- Focus on coding, not infrastructure

Examples: *Google App Engine, Microsoft Azure App Service, Heroku, IBM Cloud Foundry, Netlify, Vercel, Render, MIT App inventor*

Software as a Service (SaaS)

- Applications are supplied by the service provider.
- The user does not manage or control the underlying Cloud infrastructure or individual application capabilities.
- Services offered include: Enterprise services such as: workflow management, communications, digital signature, customer relationship management (CRM), desktop software, financial management, geospatial, and search.
- Not suitable for real-time applications or for those where data is not allowed to be hosted externally.

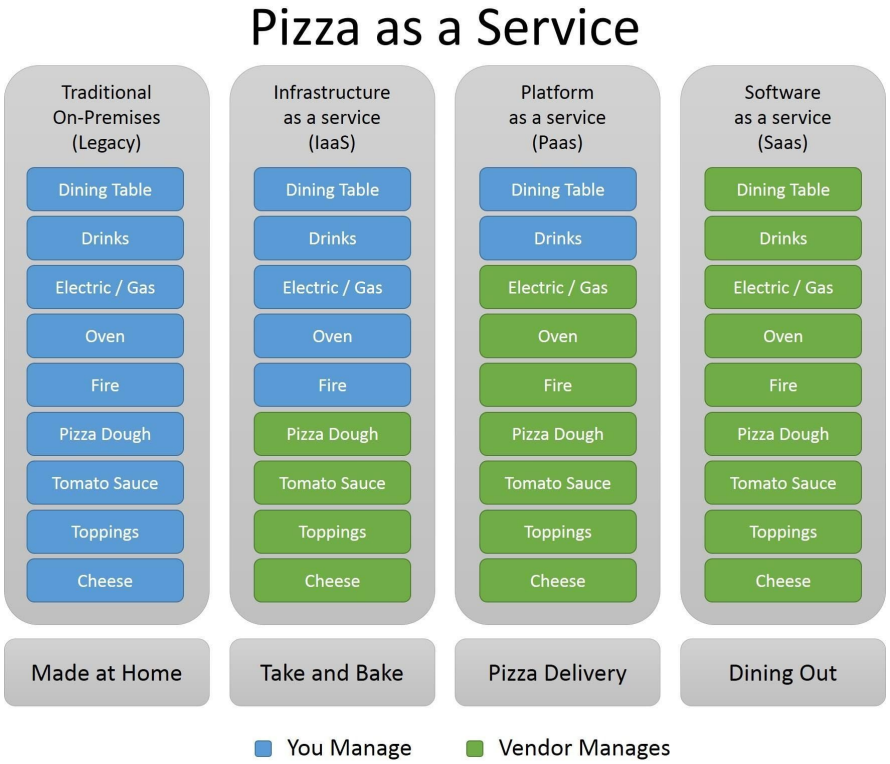
Software as a Service (SaaS)

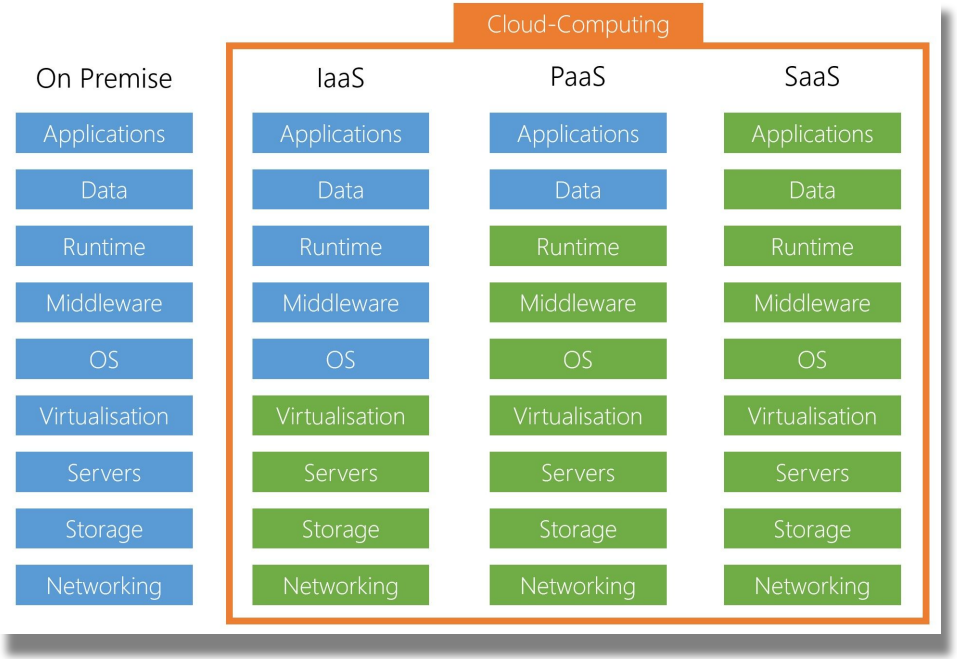
SaaS delivers ready-to-use software over the web. Users access apps via browsers or thin clients—no installation, no maintenance.

- Hosted and maintained by provider
- Automatic updates and patches
- Access from any device, anywhere
- Subscription or usage-based pricing

Examples: *Google Workspace (Docs, Sheets, Gmail), Microsoft 365 (Word, Excel, Outlook), Dropbox, Zoom, Salesforce*

Cloud Architecture [IaaS, PaaS, SaaS]

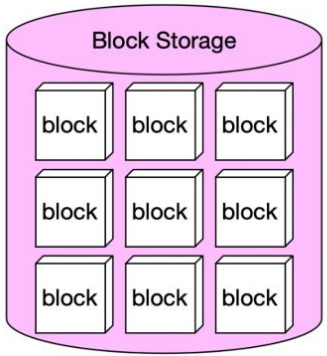


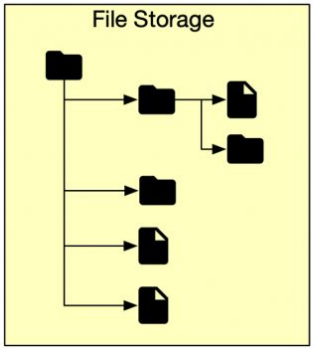


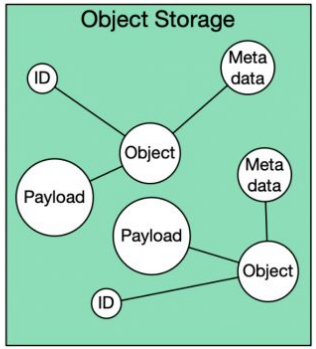
Cloud Storage

Cloud storage allows users to store, manage, and access data over the internet instead of using local drives.

- Data is stored on remote servers maintained by providers
- Accessed via the web or API
- Eliminates the need for on-premise hardware







Types of Cloud Storage

1. File Storage
    - Traditional file system format (folders, files)

    E.g., Dropbox, Google Drive, OneDrive
2. Object Storage
    - Stores data as objects (ideal for multimedia, backups)

    E.g., Amazon S3, Google Cloud Storage
3. Block Storage
    - Data is stored in blocks (used in databases, virtual machines)

    E.g., Amazon EBS, Azure Disk Storage

Cloud Services

Service	What It Offers	Examples
IaaS	Virtual hardware, networking	Amazon EC2, Azure VMs
PaaS	App development tools & environments	Vercel, Heroku, Google App Engine
SaaS	Ready-to-use applications	Google Docs, Zoom
FaaS	Code execution without server management	AWS Lambda, Azure Functions

Industrial Applications

Industrial applications of cloud computing refer to the use of cloud-based solutions in manufacturing, logistics, healthcare, energy, and more.

- **Supports automation, big data analytics, remote monitoring**
- **Enables smart factories and predictive maintenance**
- **Improved efficiency and automation**
- **Cost savings through optimized operations**
- **Enhanced collaboration and data-driven decisions**
- **Easier compliance with regulations via centralized data**

Benefits of Cloud Computing

Cost Savings: Lower capital costs; pay-as-you-go with minimal upfront investment.

Easier Access to Computing Power: No need for large in-house IT teams or infrastructure.

Scalability & Flexibility: Start small, grow fast, and scale back when needed—ideal for changing demands.

Reliability: Multiple backup sites support uptime, disaster recovery, and business continuity.

Low Maintenance: Providers handle updates and maintenance; no local installations required.

Mobile Access: Work from anywhere—ideal for remote teams and on-the-go productivity.

Thank you