

**Hardware Networking**

**Cloud Computing - Fundamentals**

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**1. What is Cloud Computing?**

Cloud computing is a technology that provides on-demand access to computing resources—such as servers, storage, databases, networking, software, and analytics—over the internet. Instead of maintaining physical hardware and infrastructure, businesses and individuals can use cloud services provided by third-party vendors like **Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP)**.

Cloud computing follows a **pay-as-you-go** model, meaning users only pay for the resources they use. It provides flexibility, scalability, and cost-efficiency, making it ideal for businesses of all sizes.

**2. Cloud Computing Deployment Models**

Cloud computing deployment models define how cloud resources are hosted, accessed, and used. There are four main deployment models:

**a) Public Cloud**

* Hosted and managed by third-party providers such as AWS, Azure, and Google Cloud.
* Resources are shared among multiple users.
* Examples: **Google Drive, Dropbox, Microsoft OneDrive**.
* **Pros:** Cost-effective, scalable, and easy to use.
* **Cons:** Less control over security and data.

**b) Private Cloud**

* Used exclusively by a single organization.
* Can be hosted on-premises or by a third-party provider.
* Offers greater security and control.
* **Examples:** Banks, government institutions, and large enterprises use private clouds.
* **Pros:** High security, better performance, and customization.
* **Cons:** Expensive and requires IT expertise to manage.

**c) Hybrid Cloud**

* A combination of **public and private clouds**.
* Organizations can store sensitive data in a private cloud and use a public cloud for general applications.
* **Example:** A business using AWS for web hosting but storing sensitive customer data in a private cloud.
* **Pros:** Balances cost, security, and flexibility.
* **Cons:** Complex to manage.

**d) Community Cloud**

* Shared infrastructure for organizations with similar needs (e.g., government agencies or research institutions).
* Helps organizations **collaborate while maintaining security and compliance**.
* **Example:** Healthcare institutions using a community cloud to share patient data securely.
* **Pros:** Cost-sharing, improved security, and compliance.
* **Cons:** Limited scalability and higher setup costs.

**3. Components of Cloud Computing**

Cloud computing consists of several key components:

**a) Infrastructure as a Service (IaaS)**

* Provides **virtualized computing resources** such as servers, networking, and storage.
* Users can scale resources as needed without managing the physical infrastructure.
* **Examples:** Amazon EC2, Google Compute Engine, Microsoft Azure Virtual Machines.

**b) Platform as a Service (PaaS)**

* Provides **development platforms and tools** to build, test, and deploy applications.
* Developers don’t have to manage the underlying infrastructure.
* **Examples:** Google App Engine, Microsoft Azure App Services, AWS Elastic Beanstalk.

**c) Software as a Service (SaaS)**

* Provides **ready-to-use software applications** over the internet.
* Users don’t need to install or maintain software.
* **Examples:** Gmail, Microsoft Office 365, Zoom, Salesforce.

**d) Serverless Computing**

* Developers can run applications without managing servers.
* **Examples:** AWS Lambda, Google Cloud Functions, Azure Functions.

**e) Storage & Databases**

* Cloud providers offer storage solutions such as **Amazon S3, Google Cloud Storage, and Microsoft Azure Blob Storage**.
* Cloud databases include **Amazon RDS, Firebase, and Google BigQuery**.

**f) Networking & Security**

* Cloud providers offer **firewalls, VPNs, identity access management (IAM), and encryption** to secure data.
* **Examples:** AWS Virtual Private Cloud (VPC), Azure Security Center.

**4. Advantages and Disadvantages of Cloud Computing**

**Advantages of Cloud Computing**

1. **Cost Savings**
   * No need to invest in expensive hardware.
   * **Pay-as-you-go** pricing model reduces costs.
2. **Scalability & Flexibility**
   * Resources can be increased or decreased based on demand.
   * Businesses can handle traffic spikes without infrastructure changes.
3. **Accessibility & Collaboration**
   * Cloud applications can be accessed from anywhere with an internet connection.
   * Teams can collaborate in real-time using tools like **Google Docs and Microsoft Teams**.
4. **Security**
   * Cloud providers offer advanced security features such as **encryption, multi-factor authentication, and regular updates**.
   * Data is backed up in multiple locations, reducing data loss risk.
5. **Disaster Recovery & Backup**
   * Cloud providers offer **automatic backup solutions** to recover data in case of failure.
   * **Example:** AWS Backup, Google Cloud Backup.
6. **Automatic Updates & Maintenance**
   * Cloud providers handle **software updates and maintenance**, reducing the IT burden.
7. **Performance & Speed**
   * Cloud services offer **fast deployment** and performance optimization.
   * **Example:** Content Delivery Networks (CDN) speed up websites.

**Disadvantages of Cloud Computing**

1. **Internet Dependency**
   * Requires a stable internet connection.
   * Service interruptions can impact business operations.
2. **Security & Privacy Risks**
   * Storing data on third-party servers raises security concerns.
   * Data breaches and cyber-attacks are potential risks.
3. **Limited Control & Customization**
   * Users depend on cloud providers for security, performance, and feature updates.
   * Private cloud solutions offer more control but are expensive.
4. **Hidden Costs**
   * While cloud computing is cost-effective, **unexpected costs** can arise due to bandwidth usage, additional storage, or premium features.
5. **Vendor Lock-in**
   * Switching from one cloud provider to another can be difficult and expensive.
   * Applications and services may be **designed for a specific provider**, making migration challenging.
6. **Compliance Issues**
   * Certain industries have strict **data compliance regulations** (e.g., healthcare, finance).
   * Businesses must ensure cloud providers meet compliance standards such as **GDPR, HIPAA, and ISO 27001**.